DESIGN FOR PERFORMABILITY
IN NYLON STRUNG ACOUSTIC GUITARS

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ABSTRACT

DESIGN FOR PERFORMABILITY IN NYLON STRUNG ACOUSTIC GUITARS

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Mastery on musical instruments is an acquired ability, often gained by the musician's lifelong commitment to practise for reaching high musical expression. Although, a concrete definition of virtuosity has not been introduced yet, it would be wise to suggest that, it is affected by the playability of a musical instrument. *Playability*, as a concept, can be described qualitatively or quantitatively. However, literature has random and shallow descriptions rather than coherent and unified definitions.

This PhD study intends to shed light on virtuosity and how to reach it especially from early periods of training by elaborating on two concepts, *playability* and *performability* from different perspectives. Therefore, it seeks to understand how different stakeholders in music production, i.e. luthiers, performers and composers, interpret those terms. Eventually, it aims to explore the extent to which superiority in musical performance could be improved by industrial design –that is, whether the concept of "*design for performabilty*" can be articulated and realised; or superiority in musical expression can be boosted by training aids and design interventions. The study aims to understand the links between **(a)** theorising and formulating the concepts of "*superiority in musical performance and expression*", "*performability*", and "*playability*" **(b)** understanding and theorising product qualities of musical instruments which offer improved playability **(c)** identifying the necessary qualities to become a virtuoso and designing training aids to simplify these steps **(d)** elevating performability through product design interventions.

Keywords: classical guitar design, luthier musical instruments, performability, playability, virtuosity

ÖZ

NAYLON TELLİ AKUSTİK GİTARLARDA İCRA EDİLEBİLİRLİK İÇİN TASARIM

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Müzik aletleri üzerindeki ustalık, bir yetenek değil, yüksek müzikal ifadeye ulaşmayı amaçlayan ve çoklukla hayat boyu süren pratiğin sonucu kazanılan bir yetkinliktir. Günümüzde virtüözlüğün tutarlı bir tanımı henüz yapılamamış olsa da, çalgı aleti çalınabilirliğinin bu kavramı etkileyebileceğini söylemek yerinde kabul edilebilir. Enstrümanlarda "*çalınabilirlik*" niteliksel veya niceliksel olarak tariflenebilir. Öte yandan, ne olduğuna ve nasıl elde edilebileceğine dair tanımlamalar sığ ve bütünlükten uzaktır.

Bu doktora çalışması, virtüözlük kavramına ve öğrenme sürecinin başlangıcından itibaren ona nasıl ulaşılacağı konusuna ışık tutmayı amaçlar. Bunu yaparken iki kavramı farklı perspektiflerden ele alır: çalınabilirlik ve icra edilebilirlik. Bu sebeple, luthiye (çalgı aleti yapımcısı), icracı, eğitimci ve besteci gibi, müzik sektöründe çalışan farklı profesyonellerin bu kavramları nasıl yorumladıklarını anlamaya çalışır. Neticede, müzik performansındaki üstünlüğün endüstriyel tasarım eliyle nereye kadar yükseltilebileceğini, "*icra edilebilirlik için tasarım*" kavramının gerçekleştirilmesinin veya müzikal ifadenin, tasarlanan eğitim araçlarıyla yükseltilmesinin mümkün olup olmadığını anlamayı amaçlar.

Çalışma **(a)** "*müzikal performans ve ifade*", "*icra edilebilirlik*" ve "*çalınabilirlik*" konseptlerini kuramlamayı, **(b)** yüksek bir çalınabilirliğe sahip naylon telli gitarların ürün kalitelerini anlamayı ve teorileştirmeyi **(c)** virtüöz seviyesine ulaşmak için gerekli adımları incelemeyi, bu aşamaları kolaylaştırmayı hedefleyen çalışma araçları tasarlamayı **(d)** ürün tasarımı müdahaleleriyle icra edilebilirliği yükseltmeyi amaçlar.

Anahtar kelimeler: klasik gitar tasarımı, luthiye müzik aletleri, icra edilebilirlik, çalınabilirlik, virtüözlük

To My Parents

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CHAPTER 1

INTRODUCTION & METHODOLOGY

Musical performance is a reciprocal communication between a performer and an audience via musical instruments. The performer, a biological entity, and an instrument, made with organic or inorganic substances, have an unintuitive gap between that needs to be connected with product qualities of the instrument, and technical, emotional and intellectual capabilities of the performer. Bridging this gap between these two mediums in an attempt to enable fluent communications is an area of expertise often contributed by different occupational groups including luthiers, composers, physiologists, critics, neuroscientists and engineers. However, this body of knowledge falls short concerning contributions of designers (Boyette, 2005; Marmaras & Zarboutis, 1997). Subjective and intangible product qualities of whimsical musical instruments lack designerly ways of thinking and acting, which are considered valuable towards the enhancement of musical experience.

Many musical instruments lack usability and human body fit criteria as a major design input (Boyette, 2005). Traditional orchestral instruments, for example the piano or violin, have a history across several centuries, and were designed and constructed within manufacturing methods and production standards of their time. Hence, the human body fit, legibility, usability and related design standards of our day weren't the primary concerns for those luthiers who designed and constructed these instruments in the first place. They used ergonomics and body dimensions as an input up to a certain level, but they used this data in order to build tailored "made to order" musical instruments (Bijsterveld & Schulp, 2004). This does not, however, mean that these instrument builders were inspired by human anatomy, how these instruments would be performed with ease and more intuitively.

On the other hand, there certainly are examples of musical instruments designed to fit the human body and ergonomics, where usability and legibility are of primary importance. One such example is the musical keyboard. Adopted from the church organ keybed in the 1930s, the keyboard has since become a regular target for professional design activity. This activity has aimed to create highly playable and powerful musical instruments, and through technological developments have harnessed electric, electronic and digital principles. The design research and activity behind the musical keyboard became very successful and in turn made this instrument capable of replacing the sound of an entire orchestra, as a "one-man band". Another example is the clarinet. It is a fairly new instrument that at its launch was technologically advanced with respect to its time. The clarinet incorporates many technologically advanced parts for its time such as rings, rods, keys and pads underneath its keys (Ahrens, 1996). If the Clarinet was made using traditional construction methods and materials without the aforementioned technology-bound parts, the instrument would absolutely be as playable as other period instruments at its best.

A candidate for a technologically augmented musical instrument that offers improved playability over predecessor instruments would be the electric guitar. At the beginning, it was an acoustic guitar devised with tungsten pickups and amplification. The electric guitar, as we know today, offers improved playability and ease of use because of its comfortable fretboard, low action string height and thin neck. There would be much to learn from electric guitar developments about how to plausibly "*design for performability*[1]". However, due to a lack of standardisation in electric guitar design, performance, education and lutherie, it was not chosen as the focus for this current research.

Instead, this research focuses on performability for the Classical guitar – an instrument that shares a similar background to other 'more traditional' instruments such as the violin or piano. In other words, the Classical guitar has seen limited design input, which is to say, it hasn't really been 'designed' in the sense of the word as understood today. The Classical guitar is the final and most refined version of its

[1] *See Section 1.2 on page 6*

ancestors, the vihuela and lute. Antonio de Torres Jurado (1817-1892) is often referred to as the 'father' of the modern guitar in the 19th century. He synthesised guitar making traditions and instrument typologies that came prior to him, which existed across divergent forms, sizes and string-tuning systems, having crossovers with the vihuela and lute, and put what is considered to be the 'final touches' on the guitar as it existed at that time. After Torres' input, a 'blueprint' for guitar design became accepted widely by his descendants, such as José and Manuel Ramírez, Santos Hernandez and Domingo Esteso. In the present day, the Torres design is referred to as the standard Classical guitar by many. However, there are claims that Torres' work did not reach a final conclusion (Thomas, 1993), and hence, the Classical guitar is still not a market standard beyond questioning. These claims have increased since the late 1970s, giving rise to a handful of design alternatives to the Torres design and bracing system.

Apart from novel ideas regarding the bracing system and top plate geometry, since the traditional Classical guitar was not designed with the human body in mind, there have been cases in which the instrument has been blamed for some health issues and injuries of players (Johnson, 2009). The majority of injuries were reported to have arisen from incorrect technique, misguided practise and wrong playing posture. Even though, there seems to be a dramatic increase in pedagogy, methods and tools aiding Classical guitar education since the 1990s, those who do not have access to high quality education still suffer from injuries in their late careers.

This PhD study came about with the initial intention of shedding light on virtuosic skill of performers, how to reach it, especially from early periods of training and the aid of musical instruments to boost their performative capacity. Reaching a high level in instrumental performance, as well as other performative arts including dance or singing, requires a great amount of practise in order to acquire the necessary technique, motor movement skills and muscle memory, in addition to artistry and sentimental sensitivity. Without any doubt, the "playability" phenomenon helps boost the superiority in musical performance of a musician, by reducing that instrument’s resistance and fight against the best intentioned actions of the performer. However, virtuosity-playability duality creates a grey area where it gets uneasy to tell whether it is the performer’s technique or the instrument’s design features that make a performance sound masterly.

1.1. Problem Definition

Mastery on musical instruments is an acquired ability, often gained by the musician's lifelong commitment to practise for reaching high musical expression. Different occupational groups in the music production business possess varying opinions, and there is no prevailing agreement as to how mastery and virtuosity relate to a high level of performance, nor how they are affected by external phenomena such as the quality of an instrument, comfort, playability, concert venue and audience appreciation. Although a satisfactory definition of virtuosity has not been introduced yet, one would argue that the performative quality of a virtuoso player is affected by an array of variables ranging from product qualities of the instrument (i.e. playability, comfort) to spatial and psychological reasons (i.e. the acoustics and historic value of a concert venue), as well as a knowledgeable audience.

Playability, as a concept, can be described qualitatively or quantitatively up to a certain point. However, literature is not rich in describing this concept rather than coherent and unified definitions. For instance, those definitions often mention ease and comfort of an instrument as the source of playability (e.g. Denyer, 2004; Woodhouse, 1993); but the concert venue size, acoustics and whether a specific instrument will be used for a concert or for recording often go unnoticed. One of the intentions through this PhD study is to understand how different stakeholders involved in music production interpret those concepts.

What we know about virtuosity is rather ambiguous and far from cohetent and structured. In addition, very little is known about education towards virtuosity, and how design can pave the way for promising students vowing to reach that status. Since the 1980s, design and engineering as professions have made great contributions to the development of instruments that are produced for so-called virtuosi performers (Anke & Glaser, 2011; Hoover, 2014; Thidell, 2013). In addition, thanks to the dedicated tutors in this field, Classical guitar pedagogy has stepped into a new age and numerous tools and practice aids have started to be used in the service of instrument students. These tools vary from mobile recorders to simple tools and devices that limit and manipulate muscle movements and posture.

In short, virtuosity requires a lifelong commitment to practise and the aspiring student's learning is said to have been aided either by playable instruments or learning aids. Nevertheless, the design of so-called 'playable guitars' keep their obscurity to many; and numerous luthiers have been criticised for decreasing their guitars' timbral qualities in order to improve playability. There are luthiers acknowledged to have decreased the fight of a performer against their instruments, by designing comfortable instruments that ensure an effortless performance. These luthiers often become a central part of long arguments and criticism. For instance, Thomas Humphrey and Stephan Connor are known as the creators of possibly the most controversial two design interventions. As explained Chapter 4, besides those who praise and support their designs, a number of professionals criticise them to have decreased the tonal and dynamic resources of their instruments and projection capabilities.

Against this backdrop, the work in this thesis has been guided by the following five main Research Questions.

1. How can we define the links among virtuosity, playability and performative quality for the Classical guitar?
2. What are the shared and unique views of different stakeholders (those who have direct dealings with the Classical guitar) on the instrument quality, playability and virtuosity?
3. Which instrument qualities (generally) and Classical guitar design qualities (specifically) are associated with performative skills and dimensions of

virtuosity, and why?

4. In what ways do various stakeholders have different views on instrumental qualities towards improving performative qualities?
5. In what ways might it be possible to elevate performative skills through industrial design?

1.2. Aim of the Study and Research Contribution

Through the Research Questions just listed, this study seeks to explore the extent to which the playability of a guitar can be supported by industrial design – that is, whether the concept of '*design for playability*' can be articulated and realised. Note that later in the thesis, the term 'playability' was found to be inadequate in conveying the full spectrum of concerns for instrument performance – and the term '*design for performability*' was used as a useful extension of the concept. Since improving the playability of an instrument in turn affects the level of performance, and thus the musical quality, it shares strong links with mastery and virtuosity. Therefore, in order to investigate the matter, the priority for the study was to gather insights of professionals involved in making, playing or writing for the Classical guitar. The research has sought to understand how different stakeholders in music production, i.e. luthiers, performers and composers, interpret the terms that define playability and performability. From this, a further aim has been to explore whether Classical guitar performance and mastery can be boosted by training aids and design interventions. In summary, the flow of the investigation is as follows: to understand the links between (a) theorising and formulating the concepts of 'superiority in musical performance and expression' and 'playability', (b) understanding and theorising product qualities of musical instruments which offer improved playability, (c) identifying the necessary qualities to become a virtuoso and designing training aids to simplify these steps, (d) understanding and theorising product qualities of musical instruments manufactured for virtuoso performers, and (e) elevating performability through product design interventions.

The study is intended to accumulate knowledge in industrial design, performative arts and instrument manufacture fields. The *virtuosity concept* is a grey area in contemporary literature; it is lacking a historical background, well-structured definitions and views of different professionals. Besides, there are contrasting opinions and views regarding how to pave the way to reach the virtuoso status for an aspiring learner. In addition, there is some uncertainty as to how tools and devices, which are designed to aid learners, can actually help. The PhD study was expected to shed light on what to include and what to avoid when designing practise aids and tools.

The *playability of musical instruments* in general, and the Classical guitar in particular, is a controversial subject that has received no serious research attention. Unfortunately, the only published resources regarding playability are magazines, instrument descriptions on the websites of sellers, and "coffee table" books. Those resources mention playability usually in a passing way and often as a stand-alone term unrelated to ergonomics, anthropometrics, psychological and spatial factors that amongst designers and design researchers are well known to be interconnected. The study will be useful about the production and consumption of music for wider public understanding. In addition, the topics of the research regarding playability were known to be of relevance to other stringed musical instruments, such as the lute or cello.

There is a potential that *guitar training* can be supported by the use of specialist tools. The retail products market has a wide range of training tools designed to support students and even advanced performers aspiring to reach virtuosity, but these tools are unknown to many learners and they are lacking a structured and explanatory inventory and assessment. Elucidating on these tools and devices that help with instrumental practise has been one of the aims of this study.

Through the literature review, the PhD study develops an argument that there is a link between the *quality* of a musical instrument and a high level of *musical* *expression*. Analysing subjective and intangible design qualities of Classical guitars was always thought to be essential to research in the area, contributing to the creation of know-how on assessing qualities of Classical guitars. Furthermore, the study was conducted with the mindset that product design details may be identified amongst the lines of enquiry, through which instrumental virtuosity can be elevated.

The research objectives, if taken from the point of view of the three main stakeholders (luthiers, learners, performers), are as follows.

For luthiers:

- Providing theoretical information as to what increases an instrument's playability.
- Giving different perspectives about preferences and needs of their clients: performers.
- Bringing insight of different stakeholders about playability and various performative qualities which would support and widen their knowledge.

For learners:

- Insight about possible health issues and expected steps for reaching a virtuoso status for the Classical guitar.
- Exploring the extent to which we can classify what it is that turns a musician into a virtuoso from different perspectives, and what routes and methods can be followed.
- Functioning as a guide to help purchase decisions for a new concert instrument.

For performers:

- Systematically explaining and exemplifying product qualities and controversial features of Classical guitar design that make those instruments playable or sonically appealing.
- Bringing in composers' ideas and expectations about performance quality and virtuosity.

- Elaborating on the links between product qualities and constraints in the context of achieving or demonstrating virtuosity.

1.3. Methodology

The PhD research has been conducted through a review and synthesis of literature sources, followed by a series of semi-structured in-depth interviews with experts in relevant fields to uncover perspectives, insights and knowledge not obtainable through literature. Apart from the semi-structured interviews, a focus group study followed by self-evaluation forms have been used to help generate and evaluate proposed design interventions inspired by the results of the interviews and literature review.

1.3.1. Literature Sources

Three broad areas of literature have been incorporated into the study: music history and psychology, embodied music cognition and behavioural studies, and instrument design traditions and benchmarking. For music history and psychology, the following guidance questions were posed.

1. *How can we define virtuosity?*
2. *Is it possible to assess virtuosity?*
3. *How does the listener perceive and understand technical perfection?*
4. *Do psychological factors affect the communication of performers and listeners?*

Musical tastes and appreciations of virtuosity have changed significantly over the last two centuries. The 19th century introduced the star virtuoso notion. However, in the second half of the same century, there was almost a battle against virtuosity. In the present day, machine-like virtuosity is praised for the precision it possesses. Literature in music history provides insight into the evolution of virtuosity across the ages. The literature review in this area tackles discussions about the definition and dimensions of virtuosity.

The psychology of music encompasses a wide range of research subjects. The literature review in this field has elucidated on the intersection of music performance, brain functioning and psychology. Expressive intentions, stage behaviour, listeners' perception and satisfaction from musical virtuosity, phenomenology of music performance, and the psychological state of musicians on the stage are important factors influencing performative skills, virtuosity and interpretation. Jane Davidson (1993, 2007, 2012) writes extensively on body movements and expressive musical performance, which brings insight into perception, assessment and appreciation of musical virtuosity. Research and experiments in audiovisual perception can generate a basis on how listeners perceive the expressiveness of a performer and how they evaluate the performer's level of technical perfection depending on what they hear and/or what they see. Mihaly Csikszentmihalyi's (1975) notion of "flow" is used to generate an argument on the attributes of virtuosity (i.e. is it timeless? can it be affected by the stage or acoustic qualities of the concert hall?).

For embodied music cognition and behavioural studies, the following guidance questions were posed.

1. *How does a performer's mind work/behave while they develop technique and skill?*
2. *How does a performer internalise their instrument?*
3. *What are the differences between a high calibre performer and non-performer's neural system plasticity?*
4. *How does a virtuoso guitarist organise their hand and finger movements and what are the advantages?*

Literature in this field seeks for ways to shed light on bridging the gap between the mind and body. The field is represented by a group of researchers led by Marc Leman, whose work is used to help develop an understanding of how a musical instrument becomes a part of a performer's body.

By reviewing the literature in neuroscience and behavioural studies, the intention has been to uncover biomechanical and neuromuscular strategies behind virtuoso performances enabled by the performer's technique. Neuroimaging studies show the human body to have innate neural and biomechanical constraints. According to Furuya and Altenmüller (2013), in order to acquire highly skilled movements, essential for virtuoso performances, one has to develop an exceptional skill that is an intersection of the neural system's plasticity and organisation of a redundant number of degrees of freedom. The literature review in this area has helped to establish understanding of what is it that makes a true virtuoso, aside from instrument quality and learning aids.

Finally, for instrument design traditions and benchmarking, the following guidance questions were posed.

1. What are the milestones in Classical guitar design? Can we understand the evolution through historical instruments?
2. What has been changing since the establishment of the modern guitar? How much room is there for further design interventions?
3. What are the boundaries of the Classical guitar design and manufacture? What is accepted as the "Classical guitar" and which features would make it another instrument of the same family?
4. What sort of aids and supports are there in the market that support the learning and technical development of students?
5. What is it that makes a guitar more playable or improves its capability to reveal and support the performer's musicality and interpretation?

Reviewing and researching into guitar manufacture traditions has created methodological knowledge about the design features, boundaries and product qualities used by prevailing luthiers who have proven successful in bringing their instruments to market. Usually, it is the intangible qualities of a musical instrument that make it charming or playable. However, one would be amazed about how little is known regarding what really makes instruments stand out from the crowd. The literature review in this area has unveiled what has already been done and what is remaining to be done, or whether there is room for improvement to the Classical guitar through design.

1.3.2. Semi-Structured Interviews

Semi-structured interviews have been carried out with multiple stakeholders who have direct dealings with, or opinions about, concert Classical guitars: virtuoso guitarists, luthiers and composers. Figure 1 is an abstract map of relationships between musicians, composers, luthiers and audiences, and it shows the focus of intention to obtain professional know-how from related fields. Content of interviews and the planned direction of questioning were determined by key concepts that emerge from the literature review and which seem, argumentatively, to relate to phenomena which fall into the scope of product (guitar) design. The interviews with each stakeholder group have contributed to a different part of Figure 1. Whilst interviewing luthiers has brought their opinions on making instruments that help to realise the skill and expressive communication of a performer, interviews with composers have brought insights about the source of music and what they understand from the sub-concepts of playability, a high level of performance and virtuosity. It should be noted that interviews with audience members were not included within the scope of the PhD, since 'listening' does not require a professional skill. Nevertheless, the audience-performer duality is a topic covered within a section of the literature review.

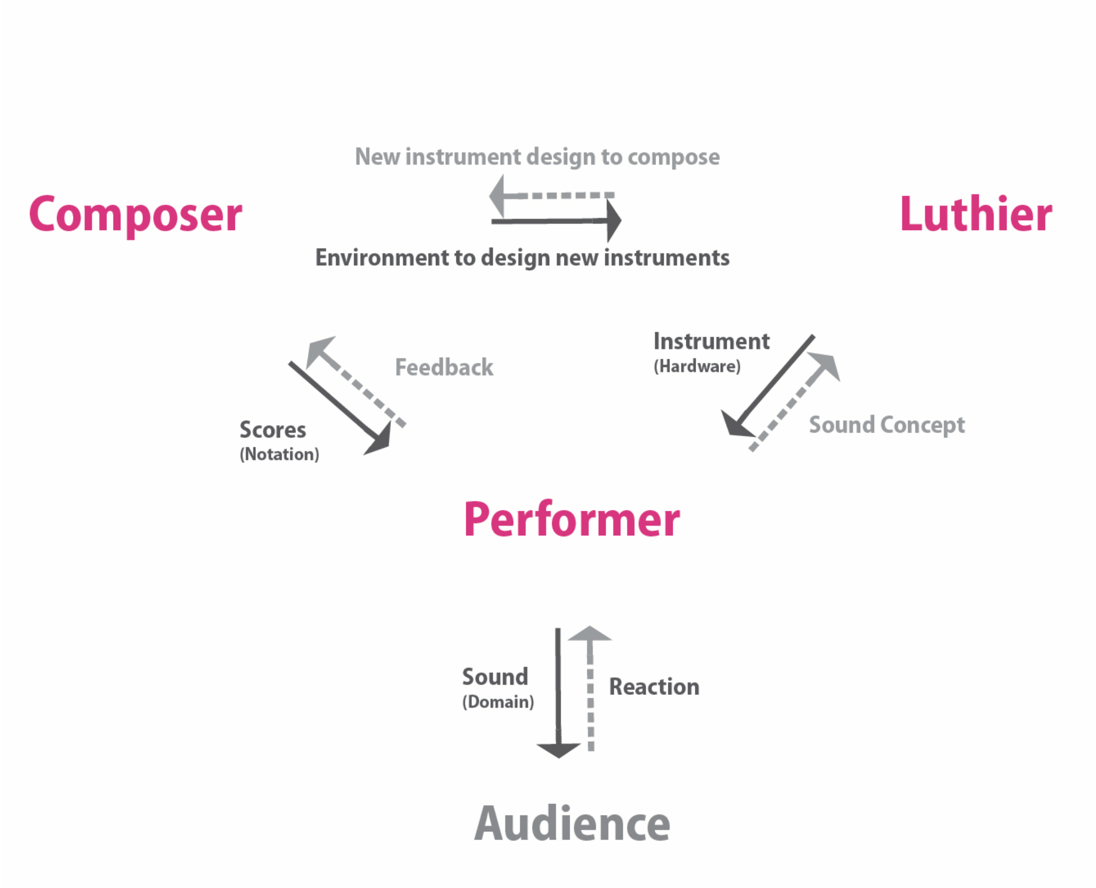


Figure 1 Mecahnisms of performers and related stakeholders in musical production business

In order to describe the trustworthiness of a qualitative content analysis – as applied to the analysis of interview transcripts – it was important to take into account the concepts of credibility, dependability and transferability (of data and results). Concerns related with credibility include the focus of the research and how successfully this intended focus is addressed and analysed (Polit & Hungler, 1999). In other words, selecting the participants, tools and methods to gather and process data are essential to achieve credibility. To this end, participants with a wide range of perspectives and experiences were selected in order to bring insight into the research questions from different viewpoints. In this sense, the variety in interviewee backgrounds refers to different specialisation areas, such as different approaches to composition or instrument making, to playing slightly different music genres, i.e. Flamenco in addition to the classical music, as well as to differences detected based on particular stakeholders (composers, luthiers, performers) and their authority levels. High calibre Classical guitar concert artists and academics in various conservatories were interviewed to generate a variety of responses. Traditional composers and contemporary music composers brought different perspectives and opinions, which in turn widened the depth of the study. Likewise, luthiers needed to be selected with respect to their manufacturing styles, i.e. whether they employ traditional or contemporary methods – with importance placed on interviewing luthiers from both schools.

Interviews were recorded and/or filmed where participants agreed to such recordings taking place. Afterwards, the recordings were transcribed verbatim into text. In analysing the text, according to the intentions of answers and comments, similar items were grouped into categories and subcategories. Ideas and opinions were rewritten as 'meaning units' (Holsti, 1969), with a guiding principle of being short, but long enough to convey the participant's ideas properly. The search for similarities and differences between meaning units and subcategories, within and across participant transcripts, played an important part of the data analysis.

Dependability is a criterion related to a plausible change in multiple participant responses, because of an extended time period between initial and final interviews. This is inevitable and acceptable so long as the amount of change is not unreasonable, especially because observations gained from the earlier interviews, or different perspectives of related stakeholders, may necessitate to increase the variety in topics and questions in subsequent interviews. This actually is a positive effect of semi-structured interviews conducted in a spirit of open and revised enquiry. Therefore, the interviews were prone to minor changes, whilst the evolutionary character of an interview was never denied (Graneheim & Lundman, 2004). Nevertheless, asking questions from a similar perspective to all participants was one of the primary concerns.

Transferability (or generalisability) is another matter of trustworthiness, which refers to the possibility of transferring the findings acquired during the study to other subjects and fields. Outcomes and findings of this present study are expected to be partially applicable to other plucked (or strummed) string instruments. However, the outcomes and findings would not be fully applicable; although general musical concepts and definitions are similar among different musical instruments of the same family, participants were always expected to propose instrument-specific (Classical guitar centred) definitions and comments.

An interview is based on the interaction between a researcher and participant, and takes place as a communication act. In order to reach realistic and justifiable results concerning similarities and differences across stakeholder groups, content analysis was carried out. As a characteristic of qualitative content analysis, the study has aimed to evaluate the differences between, and similarities within, codes and sub-codes of the analysed interview text transcripts. Therefore, the number of codes and sub-codes –in other words their *groundedness*– and density had a certain importance, because this research method is sometimes referred to as *quantitative analysis of qualitative data* (Morgan, 1993) and the number of times a theme is mentioned carries weight. Interviews are expected to have (a) manifest and (b) latent content (Graneheim & Lundman, 2004). Manifest content can be summarised as the explicit meaning presented in the text, whereas the latent content can be explained as what is implicitly contained in the text. In addition, interviews include other indicators, e.g. silence, hesitation in answers, gestures and changes in tone of voice, which can be taken into account as part of the latent content. That is, content analysis was not the only method incorporated; and the latent content caused a slight convergence to discourse analysis. Participants sometimes expressed ironically, or their intention was obviously different from their words' explicit meaning. Discourse analysis is a successful method to consider "*the ways that the use of language presents different views of the world and different understandings*" (Paltridge, 2012, p. 2). Hence, the research method to analyse the text in this PhD study can be seen as a hybrid of content analysis and discourse analysis which, according to Herrera and Braumoeller, "*can be used together*" (2004, p. 18) and in that form they "*can be complementary*" (2004, p. 15).

The interviews with *guitarists* were intended to bring insight into product design qualities of Classical guitars. The interviews were constructed around (i) playability and performability –i.e., various qualities of guitars that make them comfortable and enjoyable to play; and (ii) guitarists' opinions about performative quality, virtuosity and technical mastery. Virtuoso guitar players were chosen for interview from classical music performers and related musical genres such as Flamenco, in order to increase and widen expected perspectives. Multi-genre artists were especially important, since they interact with -and have knowledge of- various styles and genres. Guitarist interviews were distributed internationally, and performers from several countries such as Spain, Turkey and Germany were interviewed.

Composers writing for the guitar often work together with a guitarist, partly because they normally are not taught about the Classical guitar. They have some expectations from performers who perform their music. The interviews with composers were structured to unveil the part that they want to get from the guitar and performer, and in doing so, aimed to unveil the links between an instrument and its performer. Composers chosen for interviewing were Classical guitar composers as well as orchestral composers, writing for a wide range of musical instruments, including the Classical guitar, in different genres from ethnic music to contemporary "new music".

Interviews with *luthiers* brought insights into product design and crafting qualities of Classical guitars. The interviewed luthiers were all professional practitioners within Classical guitar lutherie, often born into luthier families. They were chosen to participate on the basis of their backgrounds, which were determined to be either (a) makers following traditional techniques and methods, or (b) builders making contemporary instruments in addition to traditionally manufactured guitars. Having participants from both approaches enriched the outcomes and findings. Furthermore, the selection of luthiers to interview was guided partially by the inclusion of cities that have their own manufacturing traditions, thus are famous for their style of guitar making, e.g. Granada (Spain) school makers or Madrid (Spain) school makers. The first group remains in Classical guitar building traditions. Although those luthiers that fall in the first group, manufacture traditional instruments, they see no harm in applying their own innovations that developed through their long-standing practise and are based on their tacit knowledge. These luthiers' output is essentially based on Spanish guitar building traditions in terms of material, design and bracing, although nowadays they might be seen as represents of German, Granada, Madrid or French guitar making schools. Their production is largely conventional, however, they prefer to apply, rather minor, novel design ideas to improve the playability (i.e. slightly raised fretboard, double sides), as long as the guitar does not lose its essence. That is, their guitars do not feature high-tech materials or advanced manufacturing methods, but their unique construction methods. The second group includes luthiers who use non-traditional and advanced materials to elevate playability such as Nomex, carbon or balsa.

1.3.3. Focus Group Studies and Self-Assessment Forms

Mention has already been made that, one of the aims of this PhD study is to propose design interventions and learning aids for the Classical guitar. The design alternatives were realised on a theoretical basis. Testing some of these design interventions and aids has formed an integral part of the overall research activity. In order to assess the designs, potential intermediate and advanced students have been sourced from classical guitar departments of Hacettepe University, Yaşar University and Dokuz Eylül University. Their teachers kindly volunteered to take part in these focus group studies. Mock-ups of the designed product were distributed to students for user tests. The purpose of the research and methodological background of the tool was explained to them; and the students were advised by their tutors and the PhD researcher as to how to use the designed tool. After focus group studies, students tested and evaluated the design for defined time periods. They were asked to (i) practice and (ii) perform with the tool. Finally they were asked to fill out the self-assessment forms personally (see Appendix C).

CHAPTER 2

LITERATURE REVIEW

Virtuoso performers have ultimate aims beyond a mere performance, like making music to express their feelings. They express their artistry using musical instruments, and in a sense regenerate the written music and bring it to life. Unlike a singer, an instrumentalist cannot benefit from lyrics or a variety of voice tones. They have a relatively limited range of timbral colours, dynamics, and their unique characteristic articulations which are shaped by their technical skills. Although it may get uneasy to differentiate whether it is a unique quality of a particular instrument or a performer, one musical instrument will sound different while played by different performers. The Classical guitar, among other plucked string instruments, gives clearly different feedback to different nail shapes and sizes, attack angles and plucking placement (whether it is plucked close to the rosette or the bridge). This chapter uses literature to build an understanding of the links between design and manufacturing quality of instruments and technical, performative, cognitive and artistic skills of performers. An overview of musical instruments from a broad perspective and in-depth inspection of Classical guitar performance/practice-related tools as well as mental and cerebral aspects of performance have been intended to understand these links. Literature findings from different fields are explained to gain insight on what turns performance into art, how music performances can be aided by design, how performers take care of their musculoskeletal health and how their appearance on stage affects the audience appreciation. However, the subject area is quite *unrich* considering conferences, meetings, fairs or festivals where luthiers, performers and composers come together to share their perspectives and experiences on instrument design innovation; or in terms of published material concerning potentials of design novelty. It is roughly a few annual conventions such as "*WoodMusICK, Multidisciplinary Approach to Wooden Musical Instrument Identification*" and Guild of American Luthiers conferences in addition to a handful of articles published on bulletins or personal websites such as those of Sebastian Stenzel, José Rubio or Gregory Byers mentioned in this thesis.

2.1. Definitions

High-end musical instrument dealers, whether they advertise flutes, pianos or violins, often include the term "*playable*" in the explanation section of their advertisements along with a "*concert instrument*" description. Catalogues and websites of international dealers have numerous instances (personal observation). The reader or prospective buyer understands that this instrument offers comfort and ease of play, and it was made for virtuoso players to play concerts. Apart from the fact that these advertisements are often quite optimistic, the reason for a virtuoso to select particular instruments might be compounded as these advertisements are not long enough to explain the reasons in detail. Star virtuosi do not always select the most comfortable instrument. Some of them are known for playing on rather difficult instruments. For instance Alirio Díaz, among many, is known for performing on high action guitars for greater volume, or Andrés Segovia asked Jose Ramírez III to build larger instruments for him in the 1960s (Huber, 1994) which, by any standards, were not 'easy'. Among contemporary star virtuosi, Aniello Desiderio prefers thicker necks (Heike Matthiesen, personal communication, August 9, 2015) which requires strong finger muscles and are not very playable for many. Virtuoso performers sometimes select these somewhat 'difficult' instruments because these instruments make the real aim of music easier for them, which lies in the realms of communication and expression. The literature sources is used to build an understanding of what playability and virtuosity mean, and how they relate to phenomena such as music cognition, player technique and stage presence.

2.1.1. Playability

Performers seek for sonic appeal, expressiveness and comfort from their instruments (Türckheim, Smit, & Mores, 2009). Musicians use various terms like *playability*, *comfort* or *expressive* to describe strong aspects of particular instruments, such as ease of play and facilitating technical aspects, as opposed to a colourful voice which is considered as a tool to express personal interpretations of individuals. However, investigating these subjective qualities and defining what makes an instrument more playable is a challenging task (Serafin, 2004). What is extraordinary about musical instruments is that their design and built quality can make a big difference regarding expressive resources; a well-made instrument's design details and meticulous care of its maker for each detail bring all the sophistication to light. As it is explained in the Chapter 4, performers can barely explain what it is that make an instrument more playable. Obviously, it is not magic, but great attention to every single detail makes them so unique. Performers assign psychological meanings to their instrument such as "*there is no perfect guitar, but there is the beloved guitar*" (Ahmet Kanneci, personal communication, January 11, 2016) or "*[y]our hand-made instruments are like your children. You love them not because they are beautiful, cute, smart or anything [functional, playable, etc.] but because they are your children*" (Matsunobu, 2013).

Another ambiguity is the meaning of playability when different instruments are concerned. For the Violin, the playability concept may mean the minimum bow force limit for playing steady notes (J. Woodhouse, 1993) or can be defined as volume with good tone (Serafin, 2004). The literature of rare and authentic instruments like the Clavichord, Harpsichord or old Pianos, mentions the playability phenomenon as the state of these instrument whether they are in good condition, so that they could be played, or not. For the Classical guitar it is defined as the action of a guitar by Denyer (2004). Apart from that definition, playability can variously encompass volume, projection, string tension or ergonomics of a guitar.

Websites of high quality handmade concert guitars are rife with the term "*playable*". However, there is very little research into instrumental playability in the literature. Some of the very few academic studies are Türckheim et al. (2009), Fabre, Gilbert, Hirschberg and Pelorson (2012), Matsunobu (2013), Serafin (2004) and Woodhouse (1993). Türckheim et al. (2009) intend to understand these qualities and set out to test two different violins in addition to a traditional violin. They used (i) a Silent

Violin (SV), which is filled with polyurethane foam and does not produce audible resonances, (ii) a modified violin (VA), on which the bridge feet stands on two exchangeable aluminium bars instead of the top plate and (iii) the participants' personal violin. In their study, the participants' personal instrument was rated the highest in most cases. They developed a method in order to understand the links between performers' subjective opinions on playability and observations on objective technical aspects and found out that measuring playability by directing the musicians' attention to the haptic feedback of an instrument became successful. Fabre et al. (2012) argue based on their research into wind instruments that a small change in the inner geometry of current model, for instance the mouthpiece can cause a substantial increase in the playability of an instrument.

One striking result is that, musicians stated perceived playability values depending on their bowing techniques (Türckheim et al., 2009). Their findings imply that, playability, besides its subjective nature, is an ancillary quality often affected by a performer's skill and technique. Therefore, playability has been considered insufficient in defining an instrument's quality entirely, thus, the concept of performability was introduced (see Section 2.1.2.), which relies on the *interaction* between an instrument and a player.

2.1.2. Performability

Musical instruments offer varying *potentials*. If we compare instrument potentials to affordances of artefacts, which are available to the majority of users without considerable differences between individuals, instrument potentials bring out substantial differences among individuals. Instruments of the same type, say the Classical guitar, made by different luthiers, can offer slightly different potentials between them. Although basic potentials of Classical guitars are fixed (that is six strings, nineteen frets, six machine heads and so on), some Classical guitar designs, for instance Thomas Humphrey guitars, are aimed to improve these potentials, sometimes at the cost of timbral quality. What is of greatest interest in the instrument potential-technical skill duality is that the *gain* of a particular player from an instrument can be significantly different from another player. *Figure 2* attempts to visualise an abstract image of performability and virtuosity from the instrument potential-technical skill duality. As can be seen from *Figure 2*, a player with great technical skill can make use of the potentials of an instrument which gives insight concerning the concept of *performability* and how it relates to *virtuosity*. The performability concept, reaches a plateau in the condition that a player has advanced skills. However, this performer is not considered worthy of a *virtuoso* title yet. Virtuosity occurs in another *realm*: in the world of emotions and colours. As seen in *Figure 2*, the blue dashed line is an extension of performability and progresses into the realm of '*intellectual knowledge and experience*'. It is possible to extend beyond performability and overpass the potentials of an instrument when a performer reaches the realm of *virtuosity*.

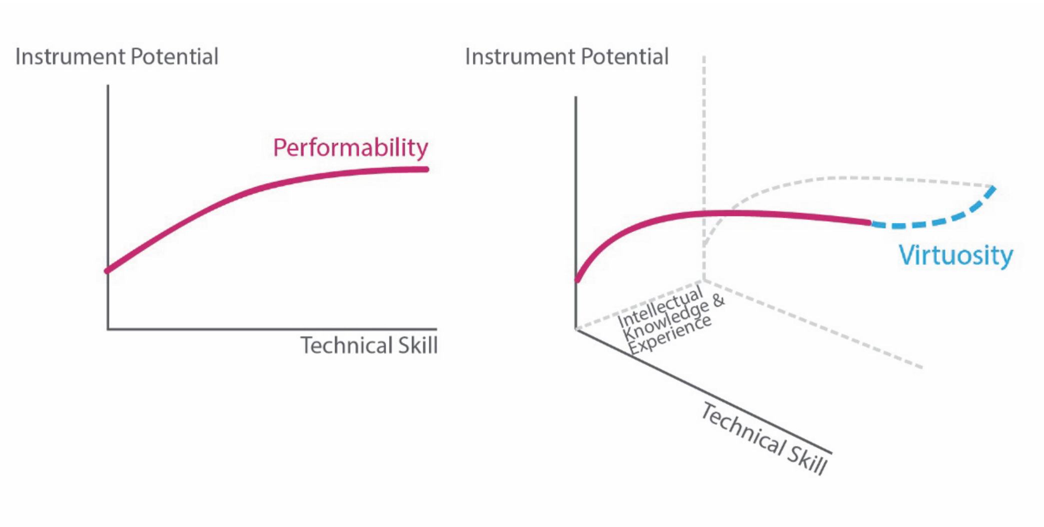


Figure 2 Instrument Potential, Technical Skill and Virtuosity

The technical capability of a player to perform on a musical instrument defines the amount that specific player can gain from an instrument's potentials. In other words, when musical instruments are concerned, some specific abilities and physical advantages of a player need to be taken into consideration to fully understand their product qualities. Differences between individuals, such as stretch and flexibility of hand-span and fingers, can make substantial differences between the performative quality of players. For example, Niccolò Paganini is said to have owed his unprecedented technique partly to his long and thin fingers which suited his demonic style. Similarly, it is often expressed by musicians or luthiers that different virtuoso guitarists are able to generate different timbre qualities from the same instrument.

Classical music education does not often encourage technical differences among performers. Although posture and press - release - relax mechanisms have considerably changed, old school technique is not totally alien today. However, when 'non-classical' music genres are concerned, such as jazz or ethnic music, performers are apparently freer to alter their technique and their instruments through some modifications. In those musical activities, "*the development or application of novel effectivities can, thereby, promote the emergence of action possibilities that could not have been foreseen by the instrument's original designers and primary users*" (Windsor & de Bezenac, 2012). Baily (1985) in his ethnic music studies argues that musical structures are shaped with an influence from instrumental design and sensorimotor factors. Following on from this point, he adds, "*creativity in music may often consist of deliberately finding new ways to move on the instrument*". (Baily, 1985, p. 257). Using these *extended techniques*, "*instruments can have different affordances when in the hands of individuals with different or deliberately changed effectivities*" (Windsor & de Bezenac, 2012, p. 110). In this sense, subjective interpretations of a virtuoso is in line with Norman (1988) who suggests that a well-designed object should have a rich set of affordances which enables the individuals to operate in a way that the designer had never imagined. It can be claimed that, only a virtuoso can sense these different '*affordances*' of various instruments.

An acquired skill that draws upon natural ability and could be mastered with practise cannot find its encounter in literature. Mention has already been made that a new term was coined in this study to cover this point. Performability was neither pronounced by any expert during the interviews, nor is present in the literature (see Chapter 5.1). However, the aim for this term is that it explains the potential of a high-end concert instrument that demands technical and musical skills from the performer to achieve the most out of it; only a masterful touch can get it, and only a master would push it to its limits.

2.1.3. Virtuosity

An ordinary audience may not have any conception of the level of difficulty of a performance. In many cases, the audience cannot understand why the performance of a certain music piece has something to do with a progression to virtuosic mastery of instrumental expression. As the proposed visual abstraction suggests (*Figure 2*), virtuosity takes place in another realm and might go unnoticed for musically non-educated listeners who may not realise this quality which is thought to be beyond the technical skill of a performer. Besides, there are always misconceptions as to how and why an instrumentalist is identified as a virtuoso, as well as a misuse of the term *professional instrumentalist* for virtuoso. Although history of virtuosity is well explained in literature, it falls short in making a concrete definition and theorising its dimensions. There are attempts to formulate virtuosity (Chladni and Weber as cited in Jackson, 2008) but, they did not prove solid and consistent theories. Virtuosity shouldn't be defined only by a progression to a certain level of technical skill; it is rather an emotional and expressive state of mind and body, and a virtuoso player is able to express his or her character through a musical instrument. Therefore, the definition of virtuosity should encompass refined articulations and timbral varieties, because these assets of musicians that underpin the reputation of a virtuoso performer are influenced by subjective tone production and articulation qualities of virtuoso players.

Mark (1980) criticises the existence of wrong and shallow opinions about the definition of virtuosity, such as making the piece "sound easy". He argues in favour of an excellence in interpretive skill which makes the performance sound like the player has no difficulty in playing it. Following on from this point, he suggests that the virtuoso instrumentalist realises interpretatively, thus, a virtuosic performance is an interpretive realisation. Similarly, Gomart and Hennion describes virtuosity as an ability to play "*without fighting the instrument*" (Gomart & Hennion, 1998, p. 240).

Pincherle and Wager (1949) suggests a more flexible definition: Virtuosity requires an expressive skill, as well as "*pleasure in dexterity, in agility, in contended muscular activity*" (Romain Rolland as cited in Pincherle & Wager, 1949, p. 227). Heine (as cited in Hirt, 2010) and Hanslick (1854) write in parallel to Rolland; they agree that musical performance is not a mere display of technical skill and precision, but an expression of spirit should be conveyed. In short, a successful performance is the one in which *"the human spirit remains*" (Heine as cited in Hirt, 2010, p. 118). An example proposed by Heine to spiritual artist is Chopin. According to him, one can "*forget completely the mastery of piano technique, and sink into the sweet abyss of the music*" (Heine as cited in Hirt, 2010, p. 118).

Howard (2008) mentions the contextual misuse of virtuosity for other professions such as mechanic or surgeon. These professions, he explains, execute task specific duties but lack some essential aspects, such as reflective self-criticism, which are mandatory to virtuosity. He explains the contextual misuse by giving a cheetah and hare example in which a cheetah pursues its pray, a hare. The cheetah's behaviour in the pursuit is, if not totally, largely intrinsic, which means that the cheetah neither learns, nor shows any sign of practice dependent improvement. This example is in accordance with the above mentioned professions: virtuoso surgeon or mechanic can be acceptable as a metaphoric description, yet lacks the presence of a meaningful expressive system of signs or symbolic significance that disqualifies them from being the doer of a virtuosic performance. Actually, the cheetah (or a so-called virtuoso surgeon) is "*neither a virtuoso, nor a performer*" (Howard, 2008, p. X), its purposeful physical ability proposes a limiting case which does not permit it to critic and improve its exceptional technique.

Likewise, the doer of these professions, say the surgeon, does not perform in a context of symbolic meanings and their duty does not depend on interpretational expression. Their result-oriented profession forces them to get satisfactory results rather than having satisfactory performances. To go back to performance, Howard argues that, unlike musicians, surgeons or mechanics, professions do not "perform" because performing is not in the scope of their professional duties. Howard points to a resemblance between the task oriented nature of these professions and machines. Machines are designed for some specific tasks by designers and engineers. They perform tasks, but they are not performers. One would argue that the key concept here is the *intention* and "*performance is thoughtful action with intent, and that to be a performer is to act thoughtfully with such intent*" (Howard, 2008, p. 4). Moving on after this definition, what distinguishes a virtuosic music performance from the abundance of performers of different artistic skills is its dependence on interpretation; a virtuoso instrumentalist realises interpretatively, thus, in accordance to Mark (1980), a virtuosic performance is an interpretive realisation. On the other hand, Gooley (2004) proposes a new perspective. According to him, virtuosity usually requires shifting, replacing and redrawing limits. As long as a musician crosses a limit and recreates new impossibilities, they qualify to be virtuoso performers. In contrast to Howard, Gooley argues that a sportsperson or magician – also performing professions – could also be a virtuoso as long as they replace limits.

Virtuosity is itself an artwork. An example is given by Mark (1980) regarding Vladimir Horowitz (1903-1989, American virtuoso pianist) performances of music written by Frédéric Chopin (1810-1849, Polish composer and virtuoso pianist) which reads "*in the performance by Horowitz of a piece by Chopin we confront two artworks, not one; we confront an instance of the artwork by Chopin and we confront the performance, which is an artwork by Horowitz*" (Mark, 1980, p. 40). However, not a timeless one. Unlike the ageless and immortal music of Chopin, virtuosity is not timeless, nor is it free of emotional burnout (Russell, 1997). Virtuoso performers do have bad performances, or some of their records might sound "better" than the rest. On the other hand, they have their own standards; a virtuoso's performance does not fall out of these standards (top and bottom limits). Their muscle memory, musicality, biology and reflexes do not let them play below their performance bottom limit which presumably is significantly advanced compared with lesser skilled performers.

Until the 19th century, there was no music school whose teachers were trained as virtuosi (Wehmeyer as cited in Hirt, 2010). In the 19th century, Carl Czerny, Liszt's teacher and a famous piano pedagogue, was one of the few musicians who taught his pupils high virtuosity in mind. It was this century in which high dexterity in instrument playing technique gained momentum; and pedagogical techniques underpinning dexterous skills started to become standard aspects of instrumental training giving way to star virtuosi such as Paganini and Liszt. Press - release - relax techniques, posture and hand positions were "reinvented" and it was these years that piano started to be used as the primary instrument in music teaching. "*The rise in popularity of the instrument and its technical demand on the performer influenced the rise of virtuosic playing and virtuoso contests throughout the nineteenth century*" (Hirt, 2010, p. 96). This is what Wehmeyer claims to be a moving away from the creative approach in musical creation. "*Music education, especially training at an instrument did not move in the direction of creativity at all, but in the form of drills, effort, and flawless playing readily composed rather than self-invented pieces*" (Wehmeyer as cited in Hirt, 2010, p. 96). Heine argues against increasing number of instrumentalists aspiring to become virtuosi and prefer being remembered with mechanical genius of their technique rather than spiritual grandeur. On the other hand, general notion against virtuosity was not justice when different instruments are concerned. For instance, the violin was accepted to have emotions and human character, thus a virtuoso on violin was not criticised so harshly. "*Paganini, as a violinist, therefore, masters the instrument in that the emotion comes from the violin, rather than the persona of the performer*" (Hirt, 2010, p. 116).

In the following decades, there was almost a battle against the virtuosity. Camille Saint-Saens writes it was an "*absurd, impious battle declared against the concertos, even those of Beethoven and Mozart*" (Saint-Saens as cited in Gooley and Gibbs, 2006, p. 75). Eduard Hanslick divided the history of the 19th century into four phases. He named the years between 1800 and 1830 as the *Virtuoso Era* and he considered the virtuoso era as a *dark* age. According to Hanslick, it was an oversaturated sauciness in sensuality and enthusiasm that exhausted the listener. He stated that the public became tired of the attitude of virtuosi due to the way they performed. In a letter Hanslick critics especially pianists: "*It makes one sad that so many young people still sacrifice their time, energy, meagre savings and higher education in order to devote their live to skill at a box of strings… Play less piano, learn something!*" (Hanslick, 1986, p. 112).

Nevertheless, it didn't stop the rise of technically precise players of the era. The first half of the 19th century witnesses unprecedented virtuosic performances, those of Niccolò Paganini (1782-1840) in general, and Franz Liszt (1811-1886), in particular. As a consequence, this period in music history witnessed a shift in the definition of virtuosity "*away from the melodious playing of slow, moving pieces to the performance of rapid passages requiring so-called digital gymnastics*" (Jackson, 2008, p. 106). These *wizards* weren't identified as musicians by many. Nevertheless, their machine-like precision rather than creative subjectivity brought about astonishment. It was this very astonishment that inspired physicists to measure virtuosity quantitatively. Some argued that virtuosity could possibly be quantified by timing rapid notes (i.e. 64th and 128th) or difficult hand positions (i.e. double-stops on the violin[2]). "*In 1827 Gottfried Weber challenged acousticians to proffer a physical explanation on why two virtuosi playing the same instrument summoned forth two different timbers*" (Jackson, 2008, p. 106). Weber's challenge roots from his interest to explain physical and mechanical aspects of playing by physics. Chladni responded to Weber's call and he came up with a theory to explain the signature sound of a virtuoso. He argued that every difference in the form of the bow, which sets the string in motion, results in different timbre qualities. Chladni's theory could be further applied to the guitar; functional encounter of the violin bow is the performer's right had in classical guitar. "*The resulting curves of the sound waves produced depend upon the spot on the string where the bow strikes, the string's elasticity, and the angle of the bow to the string. These factors affect the violin's timbre*" (Chladni as cited in Jackson, 2008, p. 106) in line with the alienation and placing of the right hand on the guitar. Both of these processes help create the

[2] *double-stop: two voices played simultaneously on bowed instruments*

signature sound of performers. Weber and Chlandi share parallel opinions regarding the 19th century musical aesthetics which propose that attempts that try to explain a pianist's touch rather than physics were "*attempts at magic*" (Jackson, 2008, p. 107). These physicists were big believers in physics and other quantifiable methods in favour of understanding and supporting virtuosity. Hermann von Helmholtz was another physicist to try to establish a mechanical explanation of vibrations of piano and violin. In addition, Bennati argued that Paganini' virtuosity could be explained based on his medical history including his nervous system. On the contrary, Jackson (2008) disagrees and claims that virtuosity cannot be explained or realised with quantifiable tools, thus "*[a]ny attempt to emulate the virtuoso was doomed to fail from the outset*" (Jackson, 2008, p. 108). Similar to Hanslick and Heine who write extensively on the relationship between virtuosity and musical automata, Jackson (2008) intends to elaborate on the exchange among music and physics. He starts with the comparison between real performers and automated instruments (i.e. player pianos). According to him, although these music machines were inferior to real musicians at the beginning, due to the improvements in musical automation technologies developed mainly by highly qualified clock makers of their time, they possessed expressivity and style.

Although Scherer (as cited in Hirt, 2010) claims that pedagogues of the first star virtuosi era (19th century) intended to redefine the focus of instrumental training and promoted learning the spirit of musical creativity, Gooley and Gibbs disagree. According to them, Hanslick's and Heine's reviews of the present day musical life was overwhelmed by show-off and technical proficiency lacking creativity, yet those were "just a minority" thus they shall not reflect on the general taste of the era: "*They came principally from a small class of composers, performers, critics and teachers whose tastes hardly corresponded the those of the majority*" (Gooley and Gibbs. 2006, p. 75).

In recent years Berio (1977) proposed new dimensions of virtuosity which he terms the '*new virtuosity*'. According to his definition, virtuosity is described as the "*most* *obvious and external*" element that could be seen through all of his Sequenzas in common (Luciano Berio, 1977). This new terminology points out to some other difficulties in virtuosic music performance apart from the physical difficulty. Besides the physical difficulty, he argues, there are psychological and intellectual complexities. Toop (1993) gives a detailed account of these different difficulties in music performance. The difficulty may be both psychological and intellectual. This may mean that "*the score calls for a level of technical competence that I don't have… [o]r it might be that the work looks conceptually difficult. This is where the intellectual element enters… Suppose that I have seven notes to play in the left hand, against five in the right: is that mainly a physical problem, or a mental one*?" (Toop, 1993, p. 45). Berio and Toop account for other aspects of music making, such as meaning, historical context, rhythmical structure or timbral approach and accept these qualities as important agents of virtuosity.

Recognising a performer from their tone and playing style without seeing them, in circumstances where the listener cannot see or otherwise be aware of who is performing, is considered by many -notably Kanneci, (2001 - 2012), as a feature of virtuosic performance. In line with the literature sources, interviewed participants mentioned recognisability as a fundamental sign of virtuosic mastery. This perspective finds a wide reflection from musicians or music related professionals that virtuoso performers have their own *stamp* on their performance. Research has shown that expressive timing and articulations in themselves (contrary to the prevailing opinion) are sufficient enough for virtuoso recognition (Repp & Knoblich, 2004). In their study, twelve pianists recorded twelve unfamiliar music pieces and several months later they were presented those recordings and asked to use a scale to rate if they could recognise their performance (1: no, 5: yes). They gave clearly higher ratings to their own performances. In the next step, recordings were edited and tempo differences, overall dynamic level and dynamic nuances were removed by the use of a computer software. "*The pianists' ratings did not change significantly, which suggests that the remaining information (expressive timing and articulation) was sufficient for self-recognition*" (Repp & Knoblich, 2004, p. 604).

2.2. Dimensions of Performability

In this PhD research, the dimensions of performability selected for literature review cover a wide area including cognition and embodiment, posture and actions, motor movements, playing technique, muscular torque, practice tools and learning aids, audience appreciation, stage presence and flow. The reasons why these phenomena were selected is multifaceted. First of all, understanding the concept of performability requires to get familiar with the literature of these subjects. The desktop research and review of the published literature sources facilitated the coding process. Secondly, in order to design guitar parts or practice tools to aid the playing technique one should know the neural and especially biomechanical strategies behind the playing technique. In other words, before designing a practise tool, a designer needs to be familiar with the mechanical background of the movements happening in a player's musculoskeletal system. The third reason is that the literature partly lead to these dimensions, because commonalities, which could be identified as dimensions, were detected in the literature sources and pilot interviews. Surprisingly, initial interviews with the performers and luthiers pointed out to a certain amount of health problems and musculoskeletal disorders which find their roots in posture, motor movements, cognition and embodiment. And the performer psychology lead the literature review towards stage presence and flow subjects.

In short, these phenomena were selected from a wider boundary of dimensions of performative quality. In the course of live performance, emotions in the performer body could be correlated with certain movements and gestures. In other words, expressive playing has an anatomy that reflects on (a) micro movements –fine and skilled finger or hand movements– (b) gestures and larger movements of performers –arm movements or body swinging. Looking at expressive playing, one can argue that it is created through these little *ingredients*. These bodily resources are considered important through understanding and theorising performative skills of musicians. Understanding the ancillary gestures of performers has been an intriguing subject and received academic attention. It is considered to be important because defining virtuosity and heightened performative skills also requires the terminology and relationships between posture and actions. Therefore these topics fall within the scope of the PhD study and researched in this section.

2.2.1. Music Cognition and Embodiment

Music cognition is the study of what the human brain does when it is learning, playing, listening to or imagining music. It seeks to understand why music takes up such an important part of humans by exploring their environments, emotions, personal differences, beliefs and other factors. Current paradigm has two tendencies to explain it. The first one is disembodied (classical, computational) theories of cognition, according to which musical meaning is based on a perception-based analysis of musical structure. Disembodied (cerebral) Music Cognition intends to see the human body as an extension of, thus is controlled with, brain. Hence, it establishes a direct relationship between mind and music. In contrast to cerebral music cognition, Leman (2008) and Reybrouk (2005) intended to split action and perception to develop an embodied cognition. But in opposition to Leman and Reybrouk, Windsor and de Bezenac (2012) argue that conjunction of perception and action underpins the links between the performance, composition and reception.

The Embodied Music Cognition (EMC) paradigm has arisen as an alternative to disembodied theories of mind-music interaction and cognition, and has been popularised by Marc Leman in its full integrity. Leman (2008) argues that the human mind can make sense out of a sound by relating it to corporeal movements. He argues in favour of a human body, as a mediator, which interacts with music, and this interaction is grounded on corporeal engagement (and movement), expression and feelings. EMC has a focus on human body and its role in relation to musical activities. Unlike cerebral approach to music, EMC argues that what happens in the mind (the process of music making) is dependent upon the body and its properties such as kinaesthetic properties. It has a tendency to decipher music perception as based on actions of body. An example can be the listeners' body movements when they listen to music. In a player’s part, it could the bodily movements, gestures, mimics and rhythmic swinging of a performer’s body. These movements influence listeners' appreciation and how they enjoy a concert (Dahl & Friberg, 2007; Davidson & Malloch, 2009). Figure 3 is a visualisation of the stages through which music is produced and consumed. Besides the technical ability and muscle memory, a performer's body has an important duty in music making. The audience gives meaning to music partly through movements of performers (Behne & Wöllner, 2011); thus, concerning design activity to develop new tools or instruments for performers, one should take into consideration that visual aspects are of great importance; seeing and hearing musicians point to slightly different phenomena, and the role of embodiment in the perception of music is significantly important.

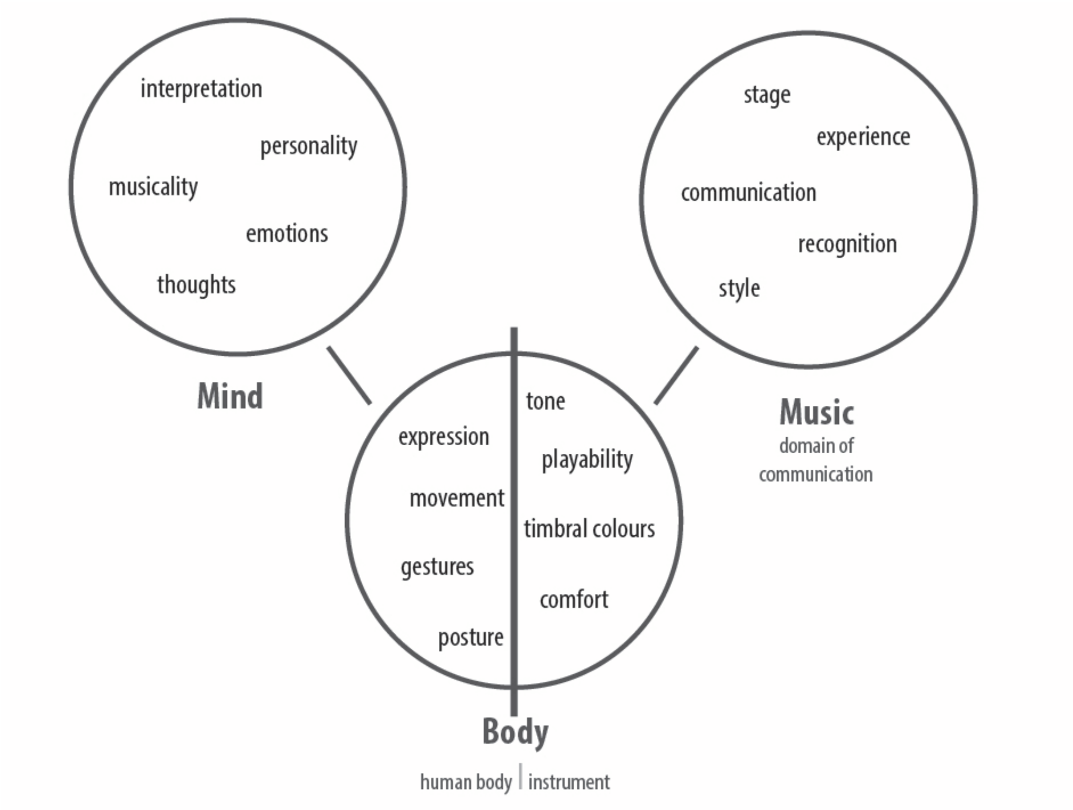


Figure 3 Embodied Music Cognition abstraction based on Leman (2008)

The principles that couple perception and action with a multimodal encoding of audio information are the base-foundation of embodied cognition. Mediation technology is the environment that human mind, and therefore human body, becomes an input extension in the musical domain, which explains the significance of body, posture, finger movements and hand organisation of performers both for timbre production and expressiveness. Embodied music cognition hypothesizes that the nature of musical communication finds its roots in *mind* and *matter*, the first of which is responsible for musical experience and the latter is sound energy. This mind-matter transaction requires human body, a biological entity that mediates in between (Leman, 2008). The biological mediator can transfer physical energy to the level of experiences, values and intentions, which would be *listenership*. Human body can do the reverse with the use of corporeal movements that is central to musical activities. It transfers an idea or mental representation or interpretation into energy to be amplified to masses or recorded on a particular medium. Embodied music cognition argues in favour of a musical signification practice that finds its roots in action, action measurement and action based description of music. Actions play an important role in music mediation between physical and mental worlds, which is music as shaped by beliefs, experience, physical entity and values. Therefore, substantially important aspect of virtuoso recognition, stage appearance and presence, finds its roots in embodiment (see Section 2.2.7).

The humane way of deciphering music –whether live or stored- makes use of experience, evaluation, beliefs and interpretation. As explained in Section 2.1.3., intentionality is of primary importance in the definition virtuosity (Howard, 2004). A virtuosic performance is to be realised around an intention, and the source of the attributed intention is found by interpretation. Otherwise, that performance would be a mere task completion process. Musicians have predictable intentions and their performance can be understood as an intentional object. The intention of a musician is deciphered by interpretation of the performer. First-person (which "*draw upon interpretations of intentions attributed to music*") and third-person ("*which are about repeatable measurements of phenomena*") concepts (Leman, 2008, p. 79) manifest musical intentions. Evaluations related to intentions could be composer-centred, performer-centred or audience-centred using expert judges (see Section 2.2.7. for *knowledgeable audience recognition*). Cerebral aspects of intentionality are linked to thinking and interpretation, and were emphasised by the philosophy on intentionality until recently. According to Erneling and Johnson (2005), this disembodied mental activity and the real world has an unsolved problem. However, recent developments in neurophysiology proposed that "*intentionality refers to an action-based understanding of the world, while cerebral intentionality can be seen as a layer on top of it*" (Jeannerod, 2003, p. 13).

Heinz defines music as a "*tension between matter and spirit*" (as cited in Hirt, 2010, p. 121) whereas Hanslick (1854) suggests the notion of *moving sonic forms* (*tönend bewegte formen*). Corporeal music cognition is striking in its adherence to Heinz, as it puts the body in the centre of matter and mind. Hanslick suggests that music consists of form relationships without defined meanings such as design or architecture. Leman (2008) argues that corporeal engagement has links with Hanslick' moving sonic forms, because those sonic forms move and have an effect on our bodies. Consequently, they -as opposed to cerebral signification- "*have a signification through body action rather than through thinking*" (Leman, 2008, p. 17). Moving sonic forms invoke the action-oriented ontology and corporeal articulations are conceived as this action-oriented ontology. Expressions of musical intentionality's attribution might be corporeal articulations. These articulations indicate synesthetic and kinaesthetic action-relevant processes and their character is predictive and anticipatory. They can be seen as "*activations in human body*" (Leman, 2008, p. 104) and they make for idiosyncratic parts of live instrumental performances: they help make recitals and concerts unique at specific places with particular audiences, because these unique acts of art are time and variable specific and do not repeat.

2.2.2. Motor Movements and Neural System Plasticity

Instrumental performance requires a succession of highly sophisticated tasks which require often unnatural skilled movements. In this sense, the classical guitar is a demanding instrument, which often requires awkward hand positions. Skilled motor tasks in instrumental performance occur in 4D space time continuum and they are affected by some cognitive rules in addition to biomechanical factors. These cognitive rules was introduced by Thomassen, Meulenbroek and Tibosch (1991) and developed by Heijink and Meulenbroek (2002). Studies show that complex movement sequences such as reaching, planting, playing and recharge of instrumental performance "*involve the mechanical control of a variety of cognitive and biomechanical processes*" (Heijink & Meulenbroek, 2002, p. 339). These complex movement sequences are related with arm, elbow, wrist and fingers; sensory-motor movements are learned incrementally and when these movements are mastered they become automatic (Halsband & Lange, 2006). Arm and elbow movements are intended to move the left hand and fingers to the related position on the guitar fretboard (low, middle or high positions), or move the right hand to the related part between the bridge and sound hole for timbre colours from metallic to *dolce* (sweet). Wrist movements enable smaller and finer movements such as approaching to frets. Finger movements are intended for melody, articulation[3] or some effects such as *glissando* or *legato*. The complexity of these movements is closely related to the finger span and the hand position's unnatural structure (see Figure 4). Heijink and Meulenbroek (2002) points to three main biomechanical factors which intervene the perceived complexity on the left hand that are (a) the position on the fretboard -both up and down extreme ends are conceived most complex-, (b) finger span and (c) hand repositioning within note sequences. It should be noted that, the contemporary guitar pedagogy accepts hand repositioning in two levels, one of which consists of position changes in the hand along the fretboard and the other is transitions that doesn't require the hand to make a big move but require the fingers to displace their locations (Baily, 1985).

[3] *Articulation is to determine how long a tone will keep sounding and which tone will be silenced.*

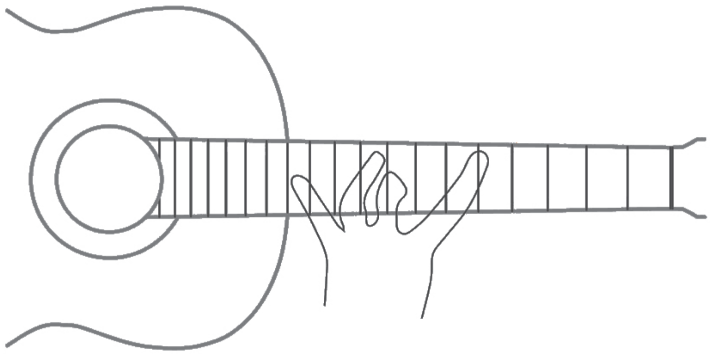


Figure 4 Unnatural left hand positions

The left hand fingers fret the strings on specific locations (frets), which change the length of a string and thus changes the frequency. The fretting of a string is also called *stopping a string*. Different frequencies create different notes. A wide range of notes can be played on different strings, in other words 220 hertz A note could be played on the 6th string (at 17^{th} fret), 5^{th} string (at 12^{th} fret), 4^{th} string (at 7^{th} fret) and 3^{rd} string (at 2^{nd} fret). Therefore, one can make a choice as to where they will stop the string; and they may wish to finger on different locations using any of 4 left hand fingers (index, middle, ring and little fingers). Making these decisions are termed *left hand fingering*, and the same piece could be played using different fingerings. In other words, performers have almost limitless fingering options; and some of those options are easier to operate than the others. Finding the optimal fingering for a specific note sequence has a relation to inverse kinematics problem that we naturally perform and solve in our daily motor tasks such as grasping, holding and pointing (Rosenbaum, Loukopoulos, Meulenbroek, Vaughan, & Engelbrecht, 1995). If and whenever there are different options available to the performer, there appears the degrees-of-freedom problem (Bernstein, 1967), as it always happens when there are multiple means to perform a task, in addition to the reverse kinematics problem. In their daily lives, people perform these tasks with different postures and methods. Just like our daily life, a virtuoso performer's hands may suffer from wrong postures and overused muscular torque.

Degrees of Freedom point to the vast number of joints and muscles incorporated to execute a movement by human body (Bernstein, 1967). It implies that the same movement might be performed via different sets of muscle-joint combinations. In classical guitar performance, it allows for a series of different positions and fingering alternatives of both hands in order to perform a particular piece of melody. This flexibility, namely the reorganisation or neuromuscular system, is aided by neuroplasticity and it boosts performative skills of expert musicians. Furuya and Altenmüller (2013) claim that an approach to clarify the organisation of skilled motor behaviours, neuroplasticity and motor redundancy is to "*describe differences in the movement organization between skilled and unskilled individuals*" (2013, p. 1). Literature in behavioural studies of motor skills points to a number of differences between the novice and expert in neuroplasticity, such as inter-segmental dynamics, muscular torque, source and rotation of muscular torque (Furuya & Altenmüller, 2013; Furuya & Kinoshita, 2008; Heijink & Meulenbroek, 2002; Münte, Altenmüller, & Jäncke, 2002; Parlitz, Peschel, & Altenmüller, 1998; Rosenbaum, van Heugten, & Caldwell, 1996). The novice applies greater muscular force and doesn't show signs of relaxation after the movement is complete. This implies that a long term carrier may create skeletal and muscular problems. On the other hand, expert musicians can produce a louder volume applying a lower force due to their advanced technique, and lower force they apply lets them move their muscles faster with ease (Parlitz et al., 1998).

There are three possible solutions proposed to solve the reverse kinematics problem or the degrees-of-freedom problem in motor control research (Rosenbaum et al., 1996). Two of them approach to the problem from (a) intrinsic movement dynamics and (b) joint coupling focuses. The third one is (c) the planning of a low-cost series of postures (Rosenbaum et al., 1995; Rosenbaum, Meulenbroek, Vaughan, & Jansen, 2001). Research shows that performers prefer a fingering which costs relatively less energy, as long as there are no other musical or cognitive issues or sensibilities, which is the need for a certain timbre effect or dynamics. Virtuoso performers are usually in search for the "*biomechanically easiest fingering*" (Heijink & Meulenbroek, 2002, p. 340) and when joints are in the middle of their range, the posture cost diminishes, but, on the contrary, increases dramatically when they leave the middle equilibrium point. This case can simply be explained by the so-called *middle-is-faster effect* (Rosenbaum et al., 1996).

Research shows that instrumentalists are exposed to risk of developing muscular systems, skeleton and tendon related disorders, and it is reported that an important figure of musicians developing PRMD is caused by the wrong posture and overused force (Heijink & Meulenbroek, 2002; Johnson, 2009). The need for daily practise sometimes exceeding eight hours of daily study which includes repetitive complex movements on unnatural positions are some common problems among musicians such as guitarists and violinists alike. Many performers apply an unnecessarily high torque, and they encounter the risk of repetitive stress injuries especially in their right hand wrist. The left side problems including hand, wrist and fingers are reported to be the most common locations for developing PRMD; and it is stated that classical guitarists have shown significantly more musculoskeletal disorders compared to non-classical guitarists (Fjellman-Wiklund & Chesky, 2006). Their need to practise every day for extended time periods causes serious health issues in the long run. Concertizing instrumentalists are under high risk; but also amateurs and students seem to have suffered from (PRMD). Studies show that the ones who seek for medical treatment is quite low (Morse, Ro, Cherniack, & Pelletier, 2000; Ranelli, Straker, & Smith, 2008), and is believed to be around 15 % (Burkholder & Brandfonbrener, 2004). Zaza (1998) argues that 39 % to 89 % of musicians develop a playing-related illness, and this might be dramatically higher if the 15 % projection of Buckholder and Brandfonbrener proves correct. Above mentioned health issues can be disastrous as there is no proven and successful recovery and it may require to give up doing those muscle and tendon movements. That is, performers who have developed these health problems might be forced to give up performing and quit their career, sadly, there is a great number of musicians who have been forced to quit their career.

Neural mechanisms and neuroplasticity contributing to the technical skill of musicians were researched by neuroimaging techniques such as MEG (magnetoencephalography), EEG (electroencephalogram), PET (Positron emission tomography) or fMRI (functional magnetic resonance imaging) in the past. These studies intended to explain functional and structural neuroplastic changes in brain associated with sensory, cognitive and motor abilities (Münte et al., 2002). Behavioural features of musicians' superior cognitive skills were also investigated. However, very few researchers devoted their work to the behavioural studies of motor skills (Furuya & Altenmüller, 2013). Behavioural studies of motor skills include movement measurement processes using force sensors and motion capture.

2.2.3. Posture and Related Tools

Technical mastery on musical instruments requires control over highly skilled and precise body, muscles, finger movements, and eventually affects the performance quality. In this research, the corporeal control is examined in two broad areas: *posture* and *left and right hand techniques* (Section 2.3.4.). Performer posture has a significant importance on both muscular activity such as effort and torque, and sound production such as expressiveness and timber quality (Johnson, 2009). Playing posture can trigger serious health problems especially in late periods of a professional concert career and the damage can be severe, so that one might be forced to quit their career (Leijnse, 1997; Zaza, 1998). To avoid these future disorders, some musicians receive consultancy from experts. An example is Javier Corroto Arance, a Málaga/Spain based expert giving healthcare service to musicians. The fatality stresses the substantial importance of the playing posture, not only as a quality of a performer's technical ability, but as a well-being criterion, and shows the input of design activity carried on to minimalise, if not eliminate, the risk by design.

Classical guitar posture is a dynamic phenomenon changing across the ages or from one player to another. There have been tendencies to variate the prevailing classical guitar posture ever since this instrument existed. The 19th century witnessed an expedited change in classical guitar design and manufacturing, which leads to the Torres design, as well as the change in prevailing playing positions parallel to the increase in demand for this instrument. Presumably, pedagogical and technological improvements, as well as an increasing awareness in health and well-being ware in the centre of the change. Alternative playing postures and pedagogical changes aimed to improve technical and performative skills and expressive qualities of performers. The contribution Francisco Tárrega (1852-1909) in the evolution was substantial. His approach to holding the guitar became somewhat *standard* following him and his famous students, Miguel Llobet (1878-1938) and Emilio Pujol's (1886-1980) well-deserved success.

Before Tárrega, there had been many schools and different postural approaches. Fernando Sor Spaniard (1778-1839), Mauro Giuliani (1781-1829), Dionisio Aguado (1784-1849) and Matteo Carcassi (1792-1853) are acknowledged for their contribution to the left-right hand techniques and posture, and are still popular among contemporary performers. Especially Fernando Sor and Dionisio Aguado, two famous performers of their time, are known to have dealt with concerns regarding ergonomics of the guitar and healthy posture. Both of them supported a natural holding position that allows access to all registers on the fingerboard from lower positions to higher registers. They both identified the problem of slumping forward and leaning to the left, and underlined the importance of balance and comfort.

Figure 5 Fernando Sor, 1830 (WEB 1)

As seen in Figure 5, Fernando Sor used a table to support the instrument. He mounts the upper bout of his guitar on the edge of a table; presumably causing accessibility problems with the left arm, readability of scores on the table, tone production and reach to high positions. We know that Matteo Carcassi (*Figure 6*) played with a cushion underneath his left foot. Therefore, if not the footstool, a functional substitute - that is a cushion, was available to Fernando Sor, but he still preferred to support with a table.

Figure 6 Matteo Carcassi (WEB 2)

Dionisio Aguado seems to be the most inventive amongst. He is accepted as one of the most innovative teachers of the 19th century and well known among contemporary guitarists for his radical use of a three-legged guitar rest he called *tripódison –tripod–* (*Figure 8* and *Figure* 10Figure 9), to support the guitar. He designed the *tripódison* guitar rest in 1836 inspired by the piano which, as a self-standing instrument, was already central to music education by his time. He desired a similar self-standing instrument. This probably could be accepted as the first guitar rest (Morrish, 2002) in history that influenced other players to use it and luthiers to designed guitars to be used on his guitar rest. In fact, Aguado had designed another guitar rest six years prior to his tripod, which did not catch on. Today, we can find virtually nothing regarding his former guitar rest, the chair guitar support. Even the existence of his guitar chair is unknown, probably he did not get his design produced; it was a concept developed on paper. What is known is that he applied to receive a patent for the chair guitar support. *Figure* 7 indicates a drawing from his patent application (Cruz, n.d.).

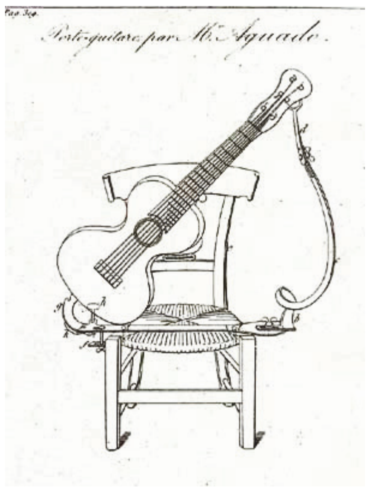
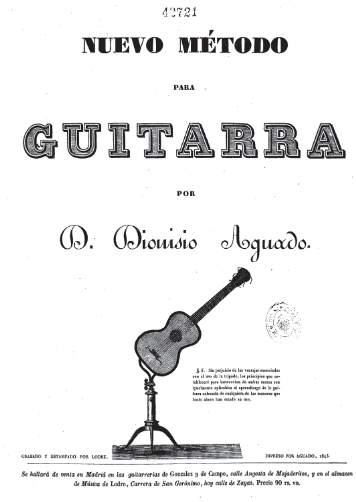


Figure 7 Aguado's Chair Support, reads "Portaguitarra por M. Aguado" [English translation: Guitar rest by M. Aguado] (WEB 3)

His motive, for both rests, was to avoid body contact with the guitar. He argued that having no body contact with the performer to hold and balance the guitar would result in a less damped and more sonorous voice. Aguado (1994) methodised his invention by publishing his method with the title of *the New Method for Guitar* (*Figure* 9).

Figure 8 Aguado, Dionisio, 1843, Nuevo Método para Guitarra, p.3



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NUEVO MÉTODO

PARA

GUITARRA

POR

D. Dionisio Aguado.

§.5. Sin perjuicio de las ventajas enunciadas con el uso de la trípode, los principios que estableceré para instruccion de ambas manos son igualmente aplicables al aprendizage de la guitarra colocada de cualquiera de las maneras que hasta ahora han estado en uso.

GRABADO Y ESTAMPADO POR LODRE. IMPRESO POR AGUADO, 1843.

Se hallará de venta en Madrid en las guitarrerías de Gonzalez y de Campo, calle Angosta de Majaderitos, y en el almacen de Música de Lodre, Carrera de San Gerónimo, hoy calle de Zayas. Precio 90 rs. vn.

Figure 9 Aguado, Dionisio, 1843, Nuevo Método para Guitarra cover page, [English translation: New Method for Guitar with tripódison]

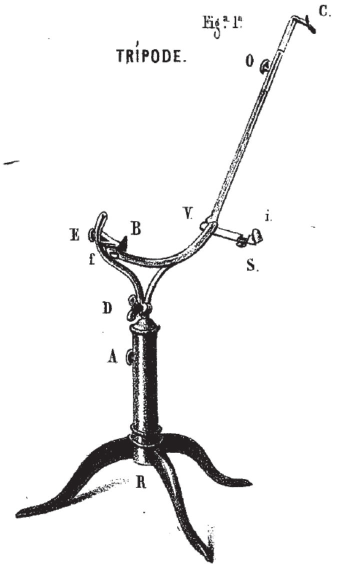

Figure 10 Tripódison, Aguado, Dionisio, 1843, Nuevo Método para Guitarra, p.13

Granada based luthier Deniel Gil de Avalle carried out a restoration work on one of the period instruments labelled and signed by Benito Campo dated 1840. The guitar was made to be played on Aguado tripod. Along with the restoration work, an exact reproduction of Aguado tripod was realised in collaboration with Joaquin Pierre (Gil de Avalle, 2014). *Figure 11* shows the reproduction of Dianiso Aguado tripod by Avalle and Pieere.

Figure 11 Reproduction of tripod by Deniel Gil de Avalle and Joaquin Pierre, (2014, p. 44)

The footstool for the left foot as we understand today was introduced by Francisco Tárrega, which significantly affected the playing posture and left hand technique (Wade, 1990) and soon became a standard in performance. Tárrega's success in publicising the footstool, either through his well-received performances or students he taught, whom later rose to international fame, was noteworthy which in turn made the footstool an absolute must, until the recent rise of concerns regarding skeletal disorders that point to the footstool as one of the reasons.

Figure 12 Francisco Tárrega posture (WEB 4)

Tárrega greatly affected the prevailing guitar playing posture of his time (*Figure 12*). His technique is said to be building upon; before him the Classical Era performers employed a diverse range of different techniques, and he gave a rationalised structure, in a sense summarising or synthesising the prevailing techniques prior to him (Bobri, 1977). Tárrega school technical requirements necessitate that the performer has both hands free. In other words, the instrument should be in balance without the help of hands. The instrument needed to be positioned upon the chest and close to the performer which ensures a comfortable access of both hands all over the fretboard including higher registers above the 12^{th} fret. "*These exigencies led Tárrega to adopt a footstool for the left foot*" (Johnson, 2009, p. 9). Placing the guitar on the left thigh raised by the use of a footstool give the instrument a position that contacts the performer body at three points: left thigh, right arm and chest. Eventually, this 3-point contact holds the guitar in a stable position without the help of hands and arms which keeps them available for performing all the time.

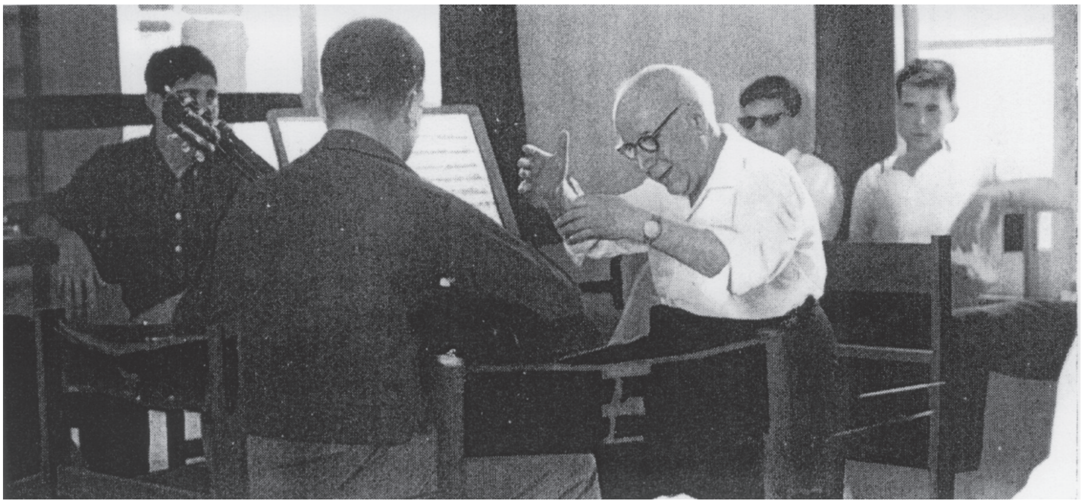

Figure 13 Emilio Pujol, Masterclass (WEB 5)

Despite his success as a performer, composer and teacher, Tárrega didn't write any method books. His technique and educational methods were publicised by his two students, probably the most widely recognised among all, Emilio Pujol (*Figure 13*) and Miguel Llobet. In Pujol's method (1956), which is a rather descriptive method book, Tárrega appears in his posture in a master-disciple manner, and the learner is expected to imitate his posture. Pujol explains that the footstool should be ramped, the front is higher than the back, and it should be high enough to elevate the instrument so that the machine heads are lined with the performer's shoulder. The performer should lean forward to the guitar, which gives the instrument a balance so that the performer doesn't have to worry about holding the guitar. Doing so, the author shows a Tárrega photo and accepts that as a patron to imitate instead of explaining the rationale behind and its pros and cons.

Figure 14 Andrés Segovia introducing his technique (Bobri, 1977, p. 32)

Andres Segovia (*Figure 14*) is recognised as the most important guitarist ever existed by many guitar related professionals, and has made a huge influence on guitar pedagogy and composition. His technique book, co-authored by Vladimir Bobri (1977), has a remarkable resemblance to that of Pujol in describing the allegedly most comfortable posture. However, Segovia's footstool is a flat one, on which the performer should place the front part of the left foot, rather than Tárrega's inclined footstool. Another difference is that he suggests, as the master to be copied, the machine heads should be "*at about the height of the collar bone*" (Bobri, 1977, p.35). Whereas Tárrega and Pujol describe a 3-contact point, Segovia adds the right thigh as the fourth one.

After Segovia, many star virtuosi of their time, including Julian Bream, Narciso Yepes, Alirio Díaz didn't publish method books. However, the number of method books has expanded rapidly whose style was constructed around a rationalistic and *humanistic* approach. The shift away from the descriptive master-disciple model coincides with John Williams' critical statements about Segovia and his school of tutoring, and disconnecting him as an educator. This new *humanistic* approach was "*based on scientific thought and natural laws rather than on an ideal master model*" (Johnson, 2009, p: 10). The newly born approach intended to base the correct playing posture on a minimal and effective use of applied muscular torque that finds its roots in natural sciences perspective. This biomechanical approach to skeletal system and muscle power encouraged performers and pedagogues to adapt one of the allegedly *healthier* guitar supports (Johnson, 2009). The trending away from the old school posture could be summarised by John Duarte who advocated that Segovia was influential as a role model and a great artist, but the correct way to hold the instrument "*cannot be effectively taught from the personal experience and characteristics of one player, no matter how great*" (Duarte, 1975, p. 7).

Charles Duncan, along with Duarte, intends to methodise the correct posture. Both of these two pedagogues have common accounts with those of Tárrega-Pujol and Segovia-Bobri. They all underpin the use of footstool under the left foot, three (or four in Segovia case) contact points and machine heads in line with the shoulder. However, what is humanistic in their tone is that both Duarte and Duncan's intention was to introduce the rationale behind their methodology using somewhat scientific language in order to account for their approach. Duarte argues that the human body and instrument are two parts of an interacting mechanical entity and the human body should be in a way that is natural, but educated, though (Duarte, 1975). In parallel to Duarte, Duncan attempts to methodise the ideas put forward by Tárrega-Pujol and Segovia-Bobri based on *functional tension*, where muscle torque is applied for a specific task and different forces should be equilibrated (Duncan, 1980). As a difference, Duncan suggests to place the instrument with a sharper angle which would bring the headstock closer to the eye level and reduce the need to hunch over the instrument. Lee Ryan in his *Natural Guitar* (1991) stresses the balance and symmetry as the most essential aspects and he introduces the concept of *dynamic relaxation*. As with Duncan, Ryan advises a more acute angle that would provide an easier reach for the left hand.

The offering of a more humanistic approach has proven productive for unique characteristics of each individual student which would otherwise vanish under the supervision of an authoritarian teacher (Wristen, 2000). The new approach has found interest for different instruments apart from the Classical guitar. For instance, an example of alternative approach to piano teaching could be Brenda Wristen's method that is relied on the learners' subjective experiences. The reflection of this ideological shift on the Classical guitar performance is the replacement of the then-traditional footstool with allegedly healthier alternative supports that come in different designs and concepts. They claim to offer a healthier positioning and many performing artists, as well as amateurs and students, have already adopted one, at least as far as practice concerned, if not for the concert venue. Introduction of the first guitar support designs dates back to the 1970s and it took some 20 years to see a method book having a mention of one. Although any specific guitar support hasn't been suggested by a mainstream method book yet due to their abundance in varying designs and shapes, there are methods that draw the learner's attention on these alternatives without giving specific names and brands. For instance, Ryan's guitar method *Natural Guitar* (1991), and more recently Bo Strömberg (1997) and Jan Sejmo (1997) mention these alternatives and have photos of players performing with those tools as well as the footstool.

As it was mentioned earlier, the rising awareness of muscular health, as well as increasing number of concert performers developing illnesses caused by extensive practice, have placed Tárrega's footstool in target as a risk factor to develop PRMD. Although there is no yet scientific proof to blame the traditional footstool regarding the PRMD symptoms, general opinion is that the footstool is not the healthiest option. There is no scientific research to believe that these ergonomics rests offer a healthier posture (Johnson, 2009), but, today the current paradigm supports one of those ergonomic rests for the "correct" classical guitar playing posture. That notion has put numerous performers and pedagogues on the lookout for a healthier alternative to the footstool; and the number of ergonomic supports has expanded in return. These modern guitar supports were first designed and patented in the 1970s, but became widespread in the late 1990s. Although these alternatives have been on the market for over 40 years, they haven't standardised yet (Iznaola, 2000). The reason for that is multi-faceted. Although, these guitar rests have reached a satisfactory ergonomic level, their looks and feel is still considered obtrusive by some. The problem often put forward is that these guitar supports seem very industrial and break the visual beauty of the guitar, especially on stage. In addition, carrying or storing the guitar with them attached is difficult or dangerous for the guitar’s finish. Eventually, it seems that ergonomic rests cannot satisfy every performer, therefore, they haven’t become a standard and there is still some room for design activity. As a result, the traditional footstool is still considered the best alternative for stage performances, whereas ergonomic supports are widely used as far as practice is concerned.

Guitar rests, especially when used together with anti-slip fabrics, offer greater comfort, ease of play and (since the body-instrument contact is lessened) better acoustics. These products were first designed and popularised by companies such as Murata, Dynarette, A-Frame, ErgoPlay, Oasis, Gitano, Barnett, Litchfield (*Figure 15*), Feel, De Oro, Mundo, NeckUp, Tenuto and Ponticello (*Figure 16*). These tools are anchored to the guitar's body using suction cups or magnets (save Dynarette) and they claim to offer better ergonomic qualities. Their primary goal is to adjust the guitar and body posture in a desirable position, in a way it is not possible to that extend by the traditional footstool. As a part of this PhD research, mainstream manufacturers and distributors of ergonomic guitar supports were researched and contacted for further information which is not obtainable through the literature or their websites. Photos that describe the product well were chosen or new photos or drawings were made (otherwise their source is referred to). In addition, online magazines, guitar accessory stores and user comments were researched to hear about the feedback of performers, students or guitar enthusiast regarding these products (Classical Guitar Delcamp, 2013; Mathews, 2015; Strings by Mail, n.d.; Werner, 2012).

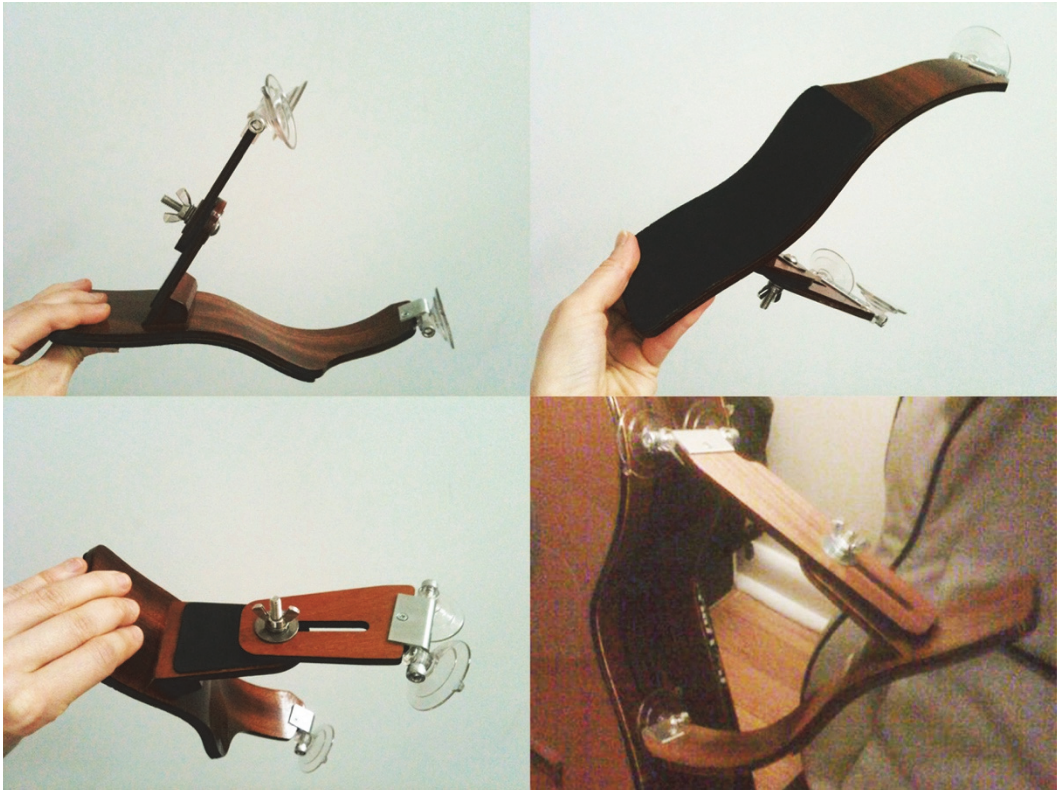

Figure 15 Litchfield Guitar Support (WEB 6)

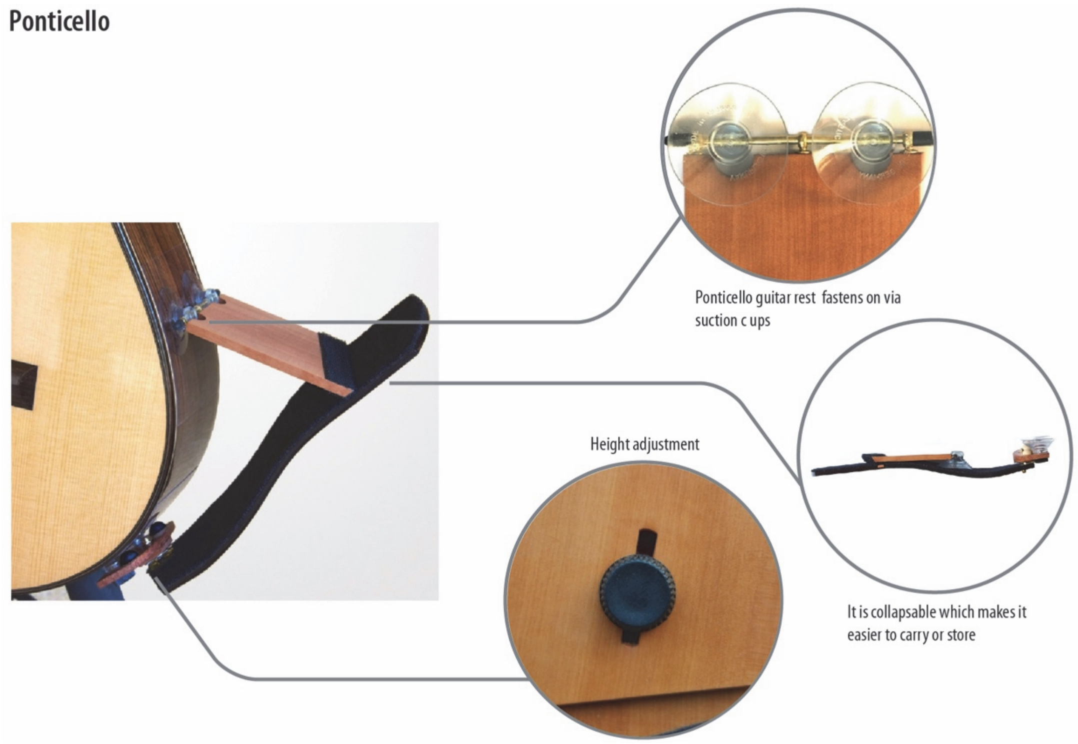

Figure 16 Ponticello Guitar Support (WEB 7)

At the writing time of this thesis, the Murata Company did not have a website or a contact mail address. Murata guitar support is mainly distributed by Strings by Mail, but it is not the brand's official distributor. Therefore, it was not possible to confirm the designer information. Japanese guitar rest Murata with adjustable feet might be the earliest guitar supports back in the 1970s. Although there is no certain data as to when Murata launched their guitar rests, videos from the 1970s of performers playing on Murata rests could be found on mainstream video platforms. Besides, David Stevenson mentioned that when he (with Bob Driggers) acquired the A-Frame patent in 1991 there had been only cushions (the Dynarette) and a Japanese device that clamped onto the guitar - which is supposedly Murata (David Stevenson, personal communication, September 3, 2016).

Murata clamps to the upper bout of the guitar which makes it look like a sci-fi contraption. It is fixed using a bolt that compresses the clamp. The device might not be used on guitars featuring an elevated fingerboard as their upper bout drops a little bit and gets thinner where the upper bout connects the neck. One would feel worried to use this tool because screwing it on a guitar does not seem safe. However, keeping in mind that guitars are made with clamps attached on the sides when the top and sides are glued together to have a bit of pressure, a normal quality guitar should withstand some pressure with the clamp. Since the Murata rest does not have suction cups, which can come off, it is rated safe by concertizing guitarists. The rotatable head and arm pivots the instrument on the thigh of the performer and the performer can move and lean over the guitar. As seen in *Figure 17*, the Murata rest features a head and arm made of hydraulic pressed aluminium with oven-drying black or silver finish, and the base -the part placed on the leg- made of plastic. The arm has height adjustment. Although it is not certain, the ones in videos from the 1970s seem to have a wooden base. However, the product currently features a plastic base. The down part of the base, where it rests on the performer leg, is covered with red velvet as a nice stylistic feature. The guitar support is a finely made product. It has much manoeuvrability compared with some other rests because the head and arm of the rest can rotate 360 degrees.

Figure 17 Murata Guitar Support (WEB 8)

The Dynarette design belongs to George Varney, and was introduced in 1985 (George Varney, personal communication, September 4, 2016). It has been in production since then. The Dynarette guitar support cushion claims to assist players to maintain good posture while seated and reduce muscular stress and fatigue. It has high density polyurethane covered with imitation leather (vinyl). Its back, where it rests on the leg is covered with velvet. The vinyl shell has a zip to remove the inside cushion. The Dynarette has two different size alternatives: 10 and 13 cm (see *Figure 18*). It is tapered, that is one side of it is bigger than the other side (see *Figure 19*), so the guitar leans into the performer. It cannot be used by left-winged performers, as it would lean the guitar away from the performer. The Dynarette is not attached to the instrument and the support uses gravity to hold the guitar, as a result, there is no risk of damaging sensitive French polish of valuable instruments. Sweden based company claims to be the "*only instrument support system that cannot damage the finish*" (Dynarette, n.d.). The nicest thing about the Dynarette is that "*it is beautifully low tech, there is nothing to go wrong*" (Mathews, 2015) in this product. Since the product does not incorporate suction cups, clams or magnets it does not require preparation and can be used directly with any classical or steel strung guitar.

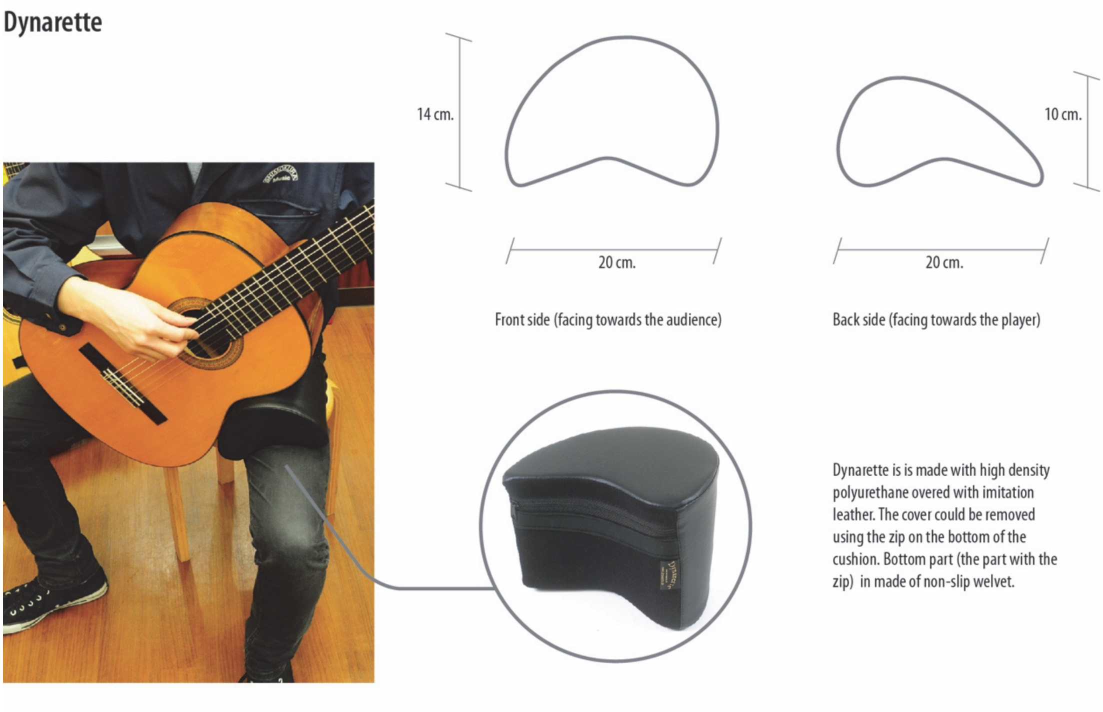

Figure 18 The Dynarette (Guitar player photo source: WEB 9)

The Dynarette is one of the most widely used guitars rests on the market. However, it has downsides such as having no adjustment. In addition, it makes a friction sound caused by the friction of the instrument with the cushion. It may cause balance problems on the concert stage as the performer has to stay stable while they perform, although it is difficult when a performer is nervous; otherwise the cushion might fall.

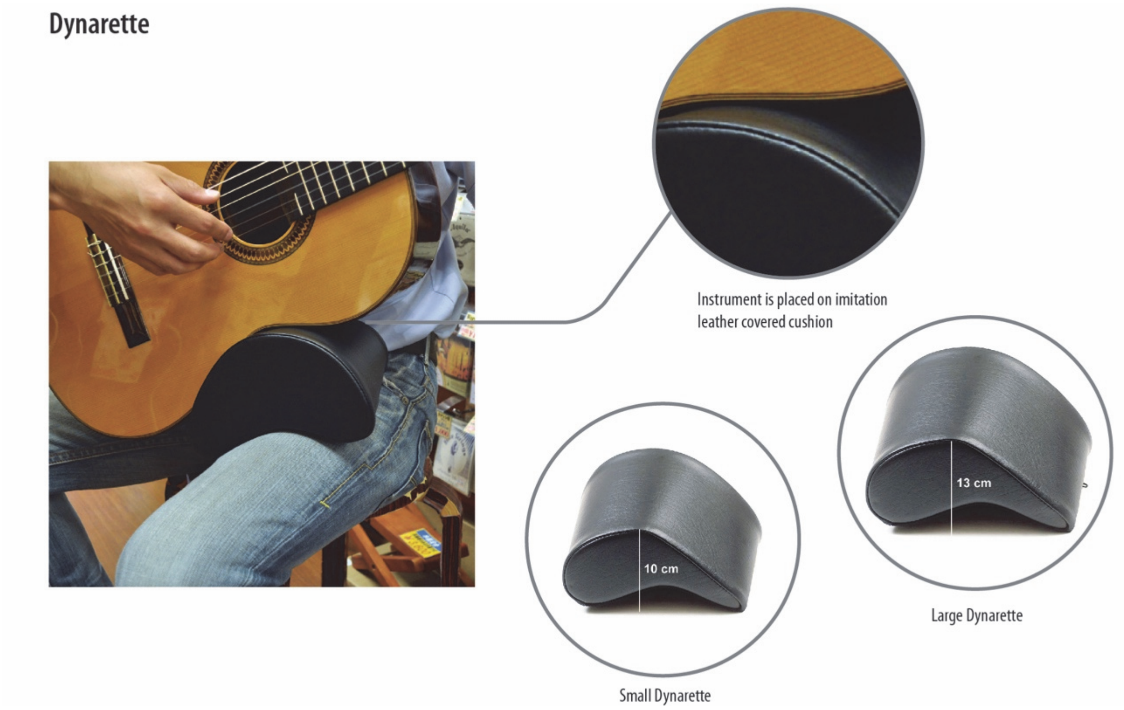

Figure 19 The Dynarette (Guitar player photo source: WEB 10)

A-Frame guitar support was designed by guitarist and innovator David Stevenson with Bob Driggers and is still in production with an estimated 20.000 units in total sold (David Stevenson, personal communication, September 3, 2016). The Western North Carolina based product's patent was granted in 1991. The motivation was to create a more versatile and inexpensive alternative to the Japanese Murata. A-Frame guitar support is claimed to be "*the most versatile guitar support*" on the market nowadays after over two decades (Sageworks, n.d.). The product, highly recommended by renowned guitar pedagogue Aaron Shearer, revolutionised the market due to its flexibility which allows for a greater variety of positioning than other guitar supports in the market. A-Frame can make adjustments to three separate aspects of positioning and then is locked to desired playing posture. These three adjustments are: (1) left or right adjustments, (2) angle adjustment (3) height adjustment. It fastens on via suction cups. It is attached to the guitar at two points. As seen in *Figure 21*, an A-shaped frame is used to stretch its stripe which is laid on the leg of the performer. *Figure 20* shows the different playing positions A-Frame could be used. The company introduced the A-Frame multi instrument (MI) support in 2015 (David Stevenson, personal communication, September 3, 2016), which is "*the first guitar support designed to be used on electric guitars*" (Sageworks, n.d.). The A-Frame MI is an interesting support because it can be attached and used on different instruments from electric guitars to banjos or mandolins (*Figure 22*). David Stevenson manufactured another guitar rest named X-Strap which was patented in 2015. The X-Strap is a unique double guitar strap that holds the guitar up over the shoulder and also pulls it tightly to the player's chest. Like the A-Frame, X-Strap also has three positioning angles for the neck of the guitar. Stevenson (September 3, 2016) believes that "*the classical guitar would benefit from being released from the chair*"; that is, if and when a player has the ability to express themselves with body movements, it adds to the expressionless of the music.

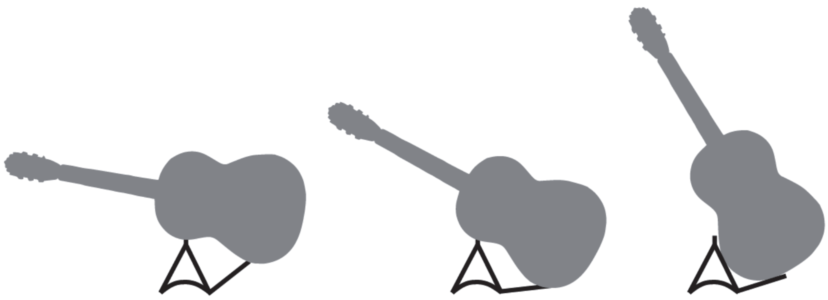

Figure 20 Different playing positions of A-Frame

Figure 21 A-Frame guitar rest playing position (WEB 11)

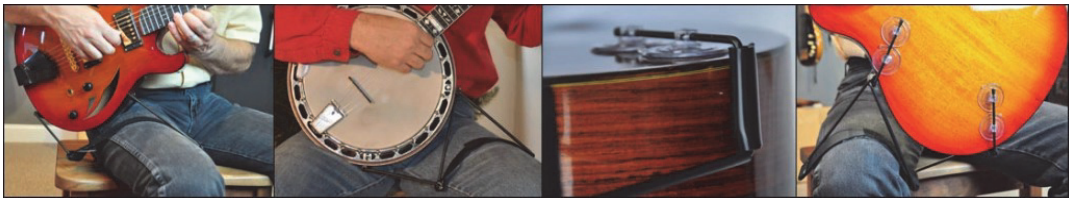

Figure 22 A-Frame MI (Multi Instrument) support (WEB 12)

The first aluminium alloy prototype of ErgoPlay professional was made in 1999, however, wooden models of the same size and function (then-named *the Guitar Rest*) made of oak and maple date back to 1985 (Johannes Teppert, personal communication, September 11, 2016). In 1999 ErgoPlay was advertised as an ergonomic rest for guitar and other stringed instruments, such as mandolin, bouzouki or ukulele. ErgoPlay claims that "*leisure time musicians and concert guitar players alike value this new wellness effect*" (ErgoPlay, n.d.) The company offers two models designed by classical guitarists Johannes Tappert and Michael Tröster and named after them. In addition to their first model *standard* ErgoPlay which is called *Tappert* (*Figure 23*), the company introduced a redesigned alternative with a few improvements to its basic design, including additional adjustments and suction cups. The new model has been advertised as the *special* model and it is called *Tröster* (*Figure 24*). It allows the performer to adjust the height on both ends, which is upper bout and lower bout of the guitar. Therefore, it gives more capability to adjust and fine tune the desired height. A smaller version of standard Tappert is on the market as *child model* and called *Tappert for Kids*.

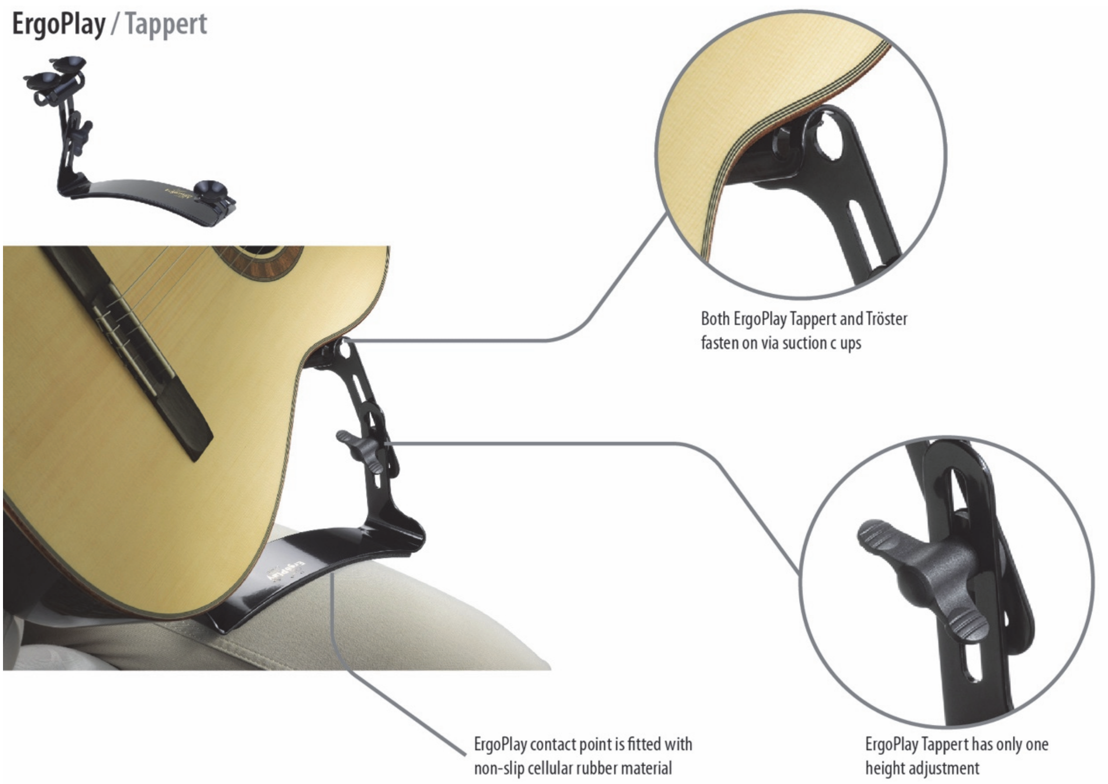

Figure 23 ErgoPlay Tappert (Image source: WEB 13)

ErgoPlay guitar rest is made with aluminium alloy. It is very sturdy and it contacts the performer body with cellular rubber grip that does not slide on trousers. It attaches by suction cups. There are many mixed views on suction cups. Beside their versatility to attach on the correct and desired point, they might take the French polish off when they are used on a handmade guitar featuring shellac finish. Being used by many artists justifies its claim to ensure a comfortable playing posture. As far as safety is concerned, ErgoPlay is considered one of the safest guitar rests in terms of unexpected detachment (Mathews, 2015; Werner, 2012). Although many concert performers complain that most guitar rests that incorporate suction cups unexpectedly detach from the instrument, ErgoPlay reportedly stays on the guitar and does not go off unintentionally. As a down side, the design does not let the performer to have the guitar low between the legs, as some players prefer.

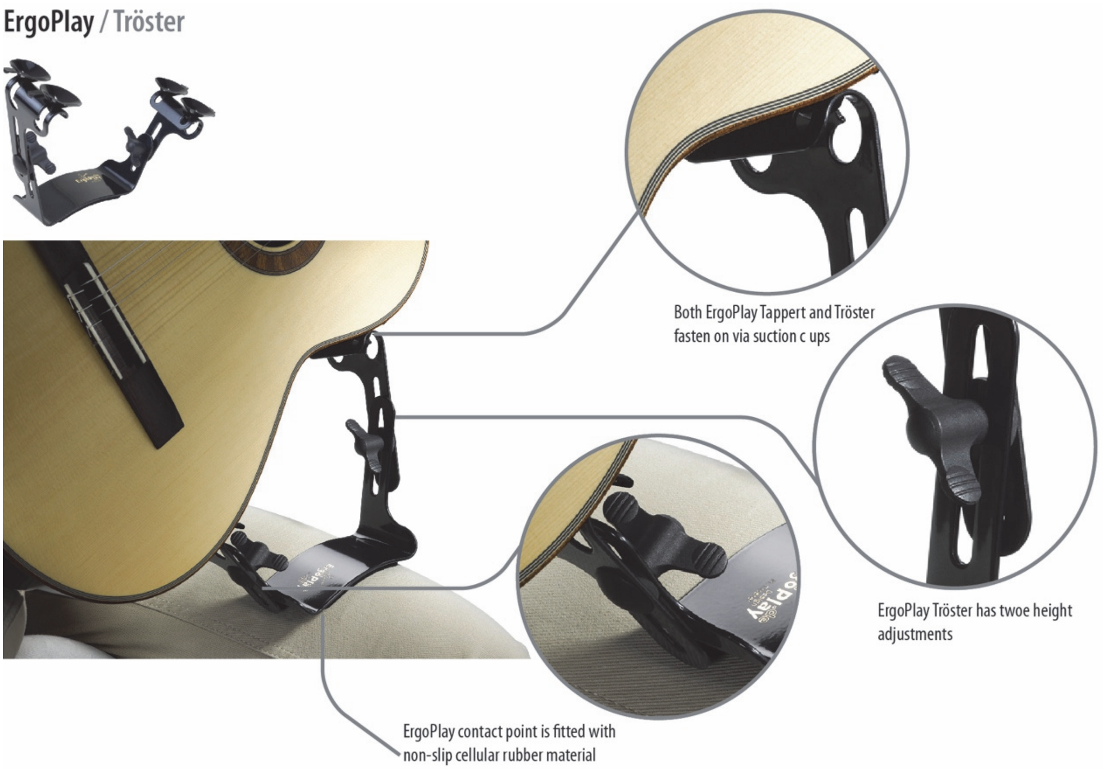

Figure 24 ErgoPlay Tröster (Image source: WEB 14)

Gitano guitar support has a very simple design to ensure the desired playing posture. *Figure 25* shows the exact dimensions of the Gitano, which is small enough to fit in a standard size trouser pocket (11,8 * 6,6 * 1,7 cm.). It is fixed on the guitar via suction cups, and it could be left attached when the guitar is stored in a gig bag. One problems mentioned by many performers is that suction cups might go off easily, which constraints the Gitano to the practise room instead of the concert venue, as it is not safe enough to use in live performances. It basically has two legs and a piece of stripe is stretched across. The stripe is the base of the support and it is laid on performer's leg.

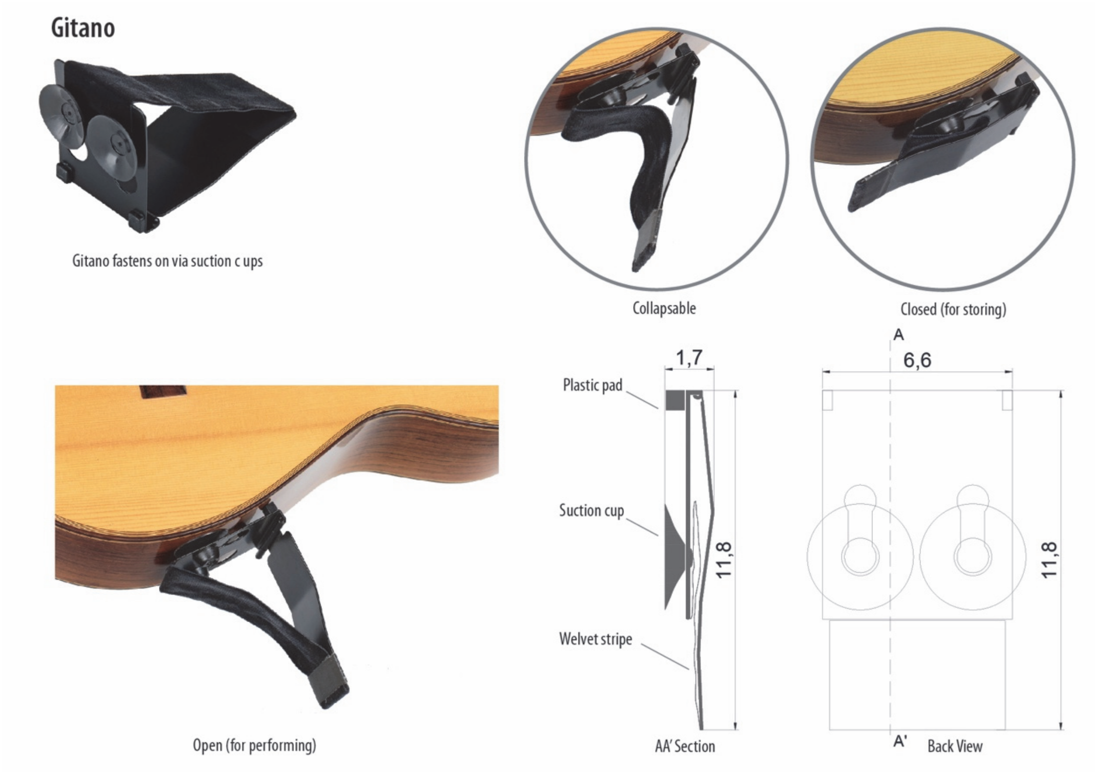

Figure 25 Gitano guitar support (Image source: WEB 15)

Oasis Quadrest is very similar to Gitano in principle but is a newer product. It was launched in 2012 (David Hepple, personal communication, September 3, 2016). It has the same simplicity in its minimal design. Unlike ErgoPlay, Barnett or Litcfield, which need to be adjusted using bolts and screws, Oasis -as well as Gitano- fastens on via suction cups and it is directly put on performer's leg. It has its own angle, which cannot be changed and it has a stripe made of chamois leather which conforms the performer's leg with some tension created between the two legs. Oasis has an interesting clamp which vacuums the air out and makes the suction safer and stronger. The mechanism is activated when the lever is pushed towards the leather stripe as shown in *Figure 26*. This moves the suction cup vacuuming the air out. The mechanism makes it quite stable on the guitar.

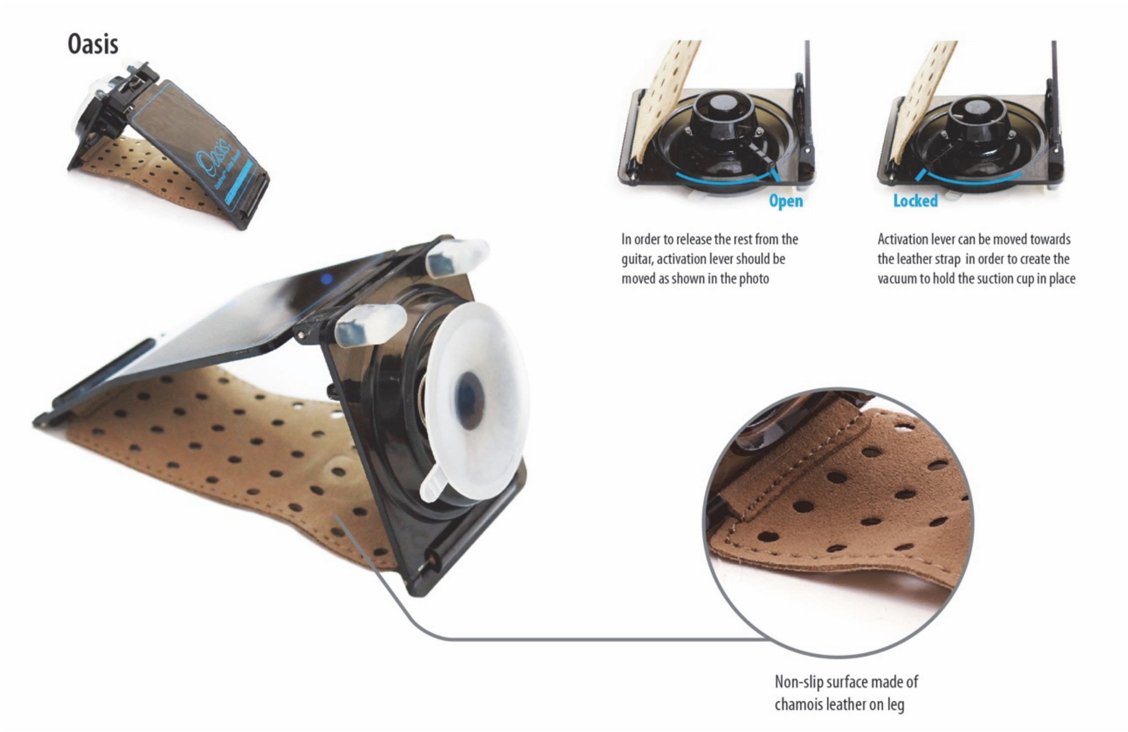

Figure 26 Oasis Quadrest guitar rest

The first iteration of the Barnett Guitar Support was launched in 2011, and has seen several iterations since then. Kris Barnett initially came up with the idea for using magnets on the guitar support and developed a model. Subsequent designs was a collaboration with his business partner Randy Meinert (Kris Barnett, personal communication, September 6, 2016). Barnett Guitar Support features magnets instead of clamps or suction cups (*Figure 27*) to attach the support onto the guitar. The company claims to ensure secure attachment and playing posture flexibility thanks to rare-earth magnets (Barnett, n.d.). The guitar support is fully adjustable including the bottom part of the rest which is used to change the angle on the bout of the performer. The product houses four discrete mechanisms which adjust instrument's angle, height, horizontal position and angle toward or away from the body. As can be seen in *Figure 28*, it gives many different posture alternatives to satisfy the performer's demand.

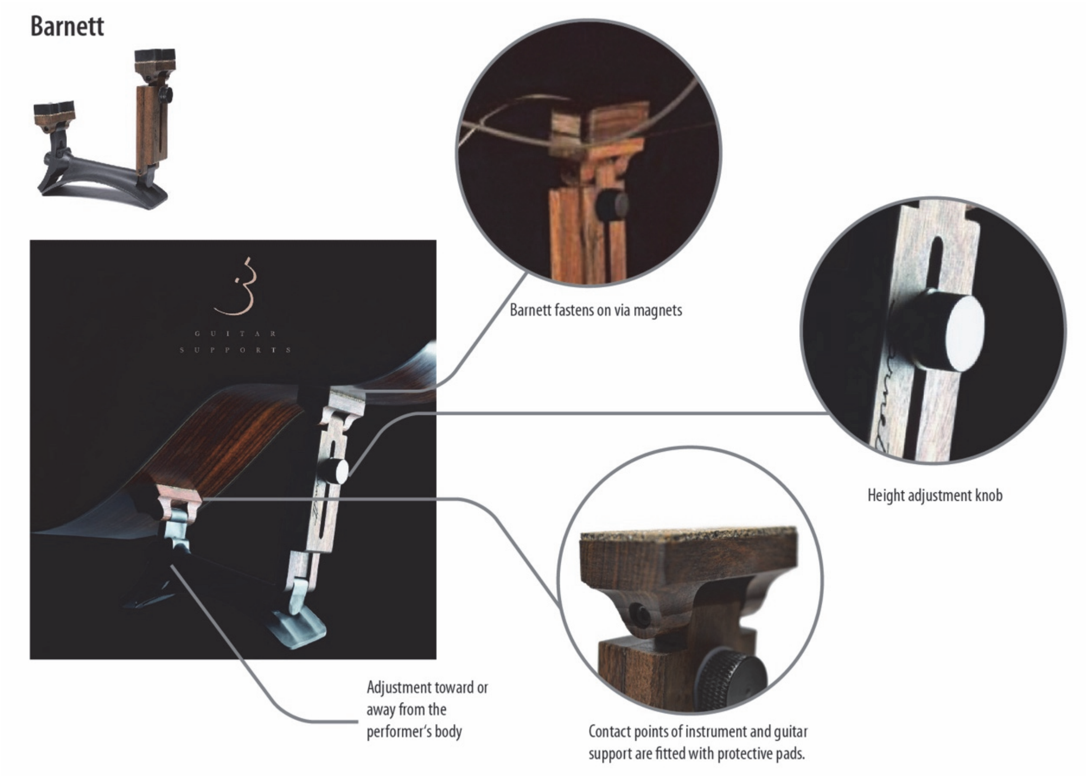

Figure 27 Barnett Guitar rest (Image source: WEB 16)

Unlike many other supports which are metallic, vinyl or plastic, in a sense out of place on the guitar, Barnett with its wood body seems to fit the theme that was going for with an acoustic instrument. In other words, it is more seamless as far as the looks is concerned. The base is made of well molded high density plastic and the leg-rest part is fitted with non-slip plate. The non-slip rest helps to keep the instrument safe on the thigh of the player. The end of the rosewood legs are covered with high quality rubber (protective pads) at the point they contact the instrument, which would otherwise damage the guitar's finish. Magnets are placed inside of the instrument. Unlike other guitar rests that are connected via suction cups, Barnett guitar rest is rated highly secure, live performance wise, by concertizing perforners such as William Kanengiser, Ben Verdery and Marek Pasieczny (Barnett, n.d.).

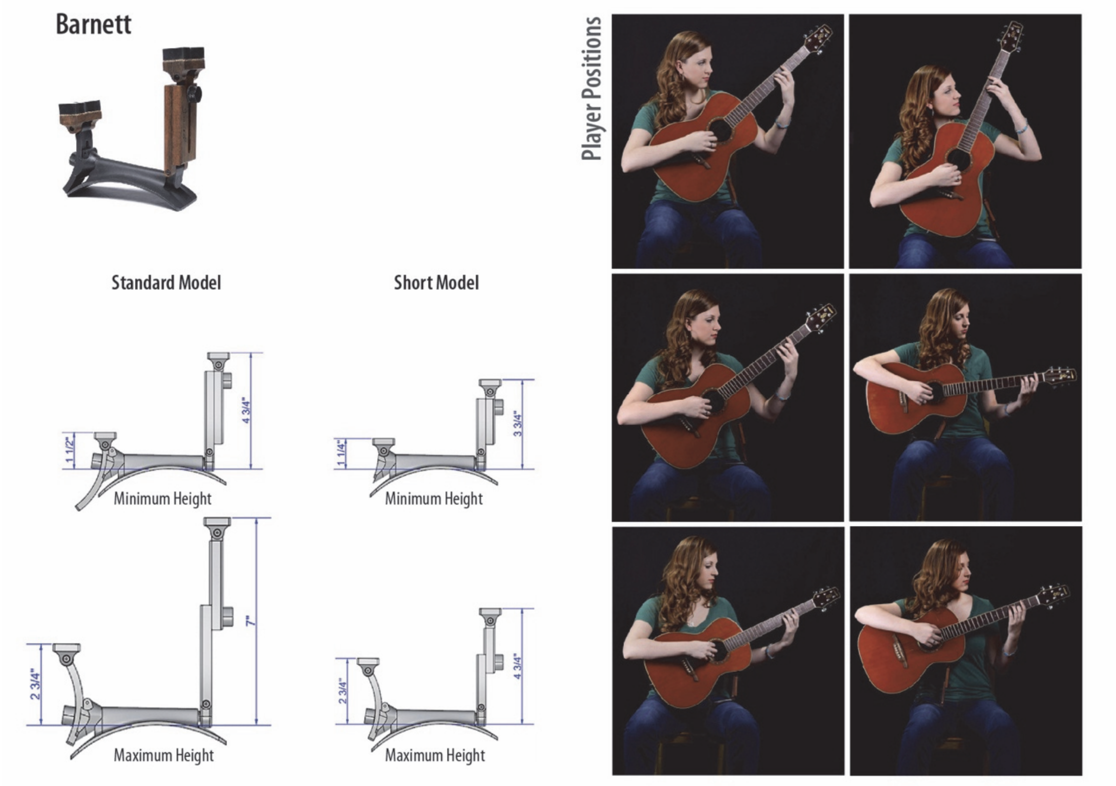

Figure 28 Barnett Guitar rest (Image source: WEB 17)

There are guitar straps produced for steel string guitars, electric guitars and nylon strung classical guitars. Among the ones produced for the classical guitar the Shearer Classic Guitar Strap is notably famous. It was designed and developed by guitar pedagogue Aaron Shearer, manufactured by Thomas Kikta and currently distributed by the Aaron Shearer Foundation after the renowned pedagogue's passing away in 2008. The strap is hang over shoulders (see *Figure 29*) and keeps the guitar in a desired positioning. It promotes back and shoulder alignment and provides freedom for both hands.

Figure 29 the Shearer Classic Guitar Strap (WEB 18)

2.2.4. Left and Right Hand Techniques and Their Evolution

A high degree of control over the acoustic output, which is required by experienced classical guitar players, is basically enabled by left hand (normally on the neck) and right hand (normally on the strings) technique. Heijink & Meulenbroek (2002) suggest that the left-hand complexity of classical guitar performers is determined depending on three biomechanical factors. Firstly, it is affected by the position of the hand on the neck of the guitar. The hand position on fretboard directly affects the angle of shoulder and elbow, and since wrist joint movement will eventually affect the finger span, this movement of hand makes a trigger effect and has an important issue on left-hand complexity. "*The cost functions show a minimum at about the middle of the angle range of the joint and the cost values increase to either of the extreme angles*" (Cruse, Wischmeyer, Brüwer, Brockfeld, & Dress, 1990, p. 519). Consequently, left-hand finger movement biomechanical complexity is greatly influenced by finger span and hand position on the neck. It is known that leftmost of the fretboard is too far from performer's body and the rightmost of the fretboard requires a performer to hunch over the guitar causing discomfort.

Secondly, it is affected by the fret interval sizes which vary from leftmost to rightmost on guitar fretboard (see Figure 30). Fret intervals get progressively smaller from the nut to the sound hole making them easier to navigate by fingers. On the other hand, required muscular force in order to press the strings on frets increase, as well, since the action height (string-fretboard distance) increases. In other words, pressing on strings with the left hand fingers gets more difficult while the left hand gets closer to the bridge because, in this case one needs to apply greater power to push the strings. This situation creates a balance of ease and difficulty within a cost-benefit relationship: necessary force increases while the distance for fingers decreases. Thus, the middle positions on the fretboard offer the most comfortable physical and cognitive ergonomics, whereas "*hand positions at either extreme of the guitar neck are presumed to be most complex*" (Heijink & Meulenbroek, 2002, p. 341).

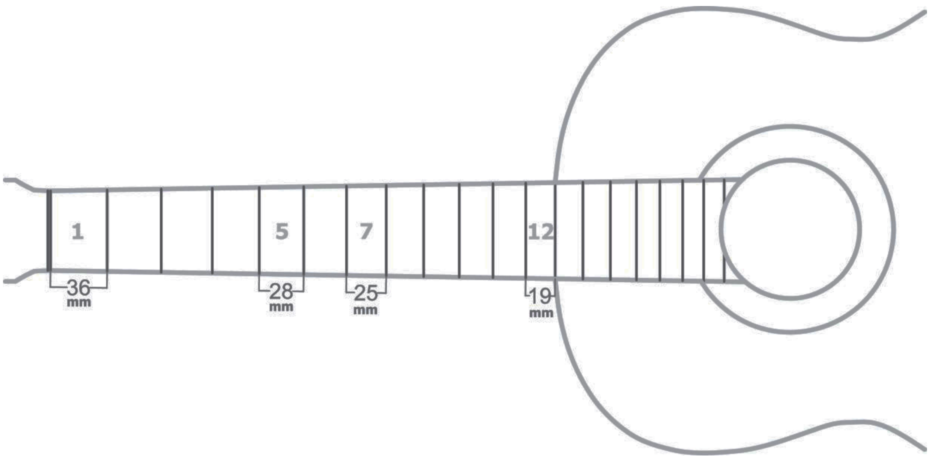

Figure 30 Average classical guitar fret dimensions

The third factor which affects the complexity is the hand repositioning within a musical passage or note sequence, because these notes need to be executed in line with the rhythmical structure of the musical piece. In this point, two transitions are relevant first of which is repositioning with finger movements without having to make an important move with the hand, and second is the transition where finger movements are not enough, therefore the hand is forced to make a move. Guitarists intend to overcome complexity which is caused by the second case with asynchrony (Rosenbaum et al., 1995). This could be summarised as playing the part prior to highly complex section faster than the music piece’s intended tempo so that they save up time, and this extra time is used to reposition and prepare the hand in the related position. Selection of optimal positions and relevant fingers require planning conceived during the study (when a performer decodes the musical notation), and upon practice, low-cost postures and series of postures become a habit in guitar performance. This habit consists of seeking for minimum spatial variability, finger span and movement series. Organisation of multi-joint arm movements is enabled by long term motor learning of physiological efficiency and development and improvement of precise movements (Furuya & Kinoshita, 2008).

Right hand technique has changed since Tárrega school performers. Tárrega's technique involves right hand thumb, index, middle and ring fingers, and left hand index, middle, ring and little fingers, unlike some performers prior to him who didn’t make use of the left hand's little finger. He codified two different angle attacks for the right hand, which still form the foundation of the classical guitar education. One is known as rest stroke (*apoyando*) in which the finger beats the string with greater force and the finger rests on the lower string, whereas the other attack angle, in the free stroke (*tirando*) the finger moves inward to the palm clearing the adjacent lower string with less strength and speed. His technique made use of the finger nail, as opposed to Fernando Sor or Dionisio Aguado who played with the flesh of the finger instead of the fingernail. Although Tárrega was forced to quit playing with fingernails due to weakening of his nails, he supported playing with nail in favour of greater projection for the most of his career.

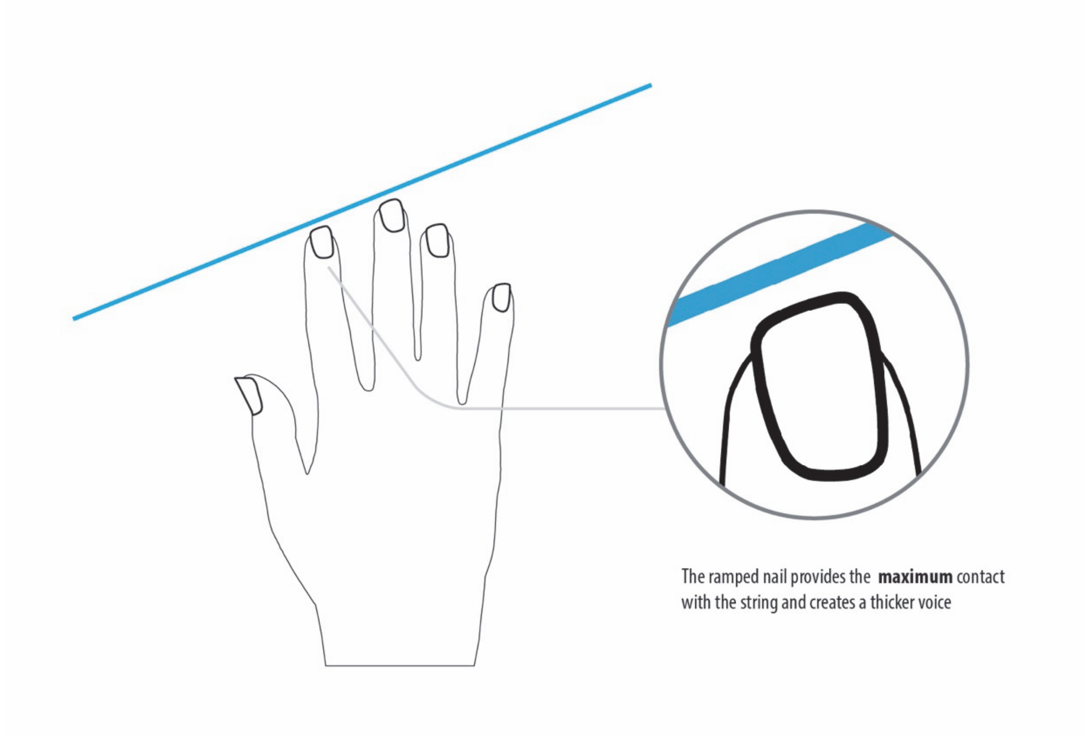

Figure 31 Ramped nail and maximised string contact

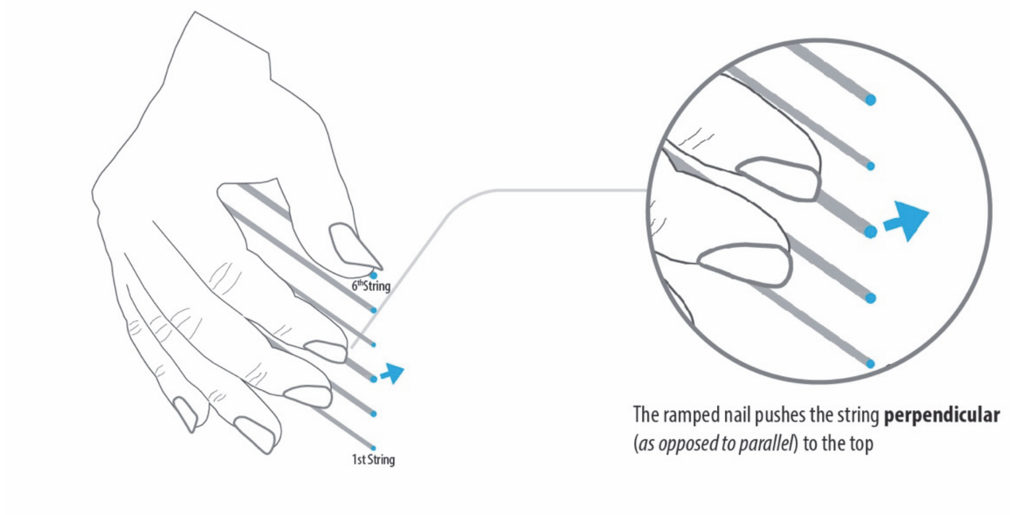

Figure 32 Ramp pushing the string into the guitar

Segovia, in line with Tárrega (*Figure 33* and *Figure 34*), is known to apply a perpendicular force to the strings. As seen in *Figure 33*, Segovia *warns* learners about a less acute right hand attack and he accepts it "*incorrect*" (Bobri, 1977). However, the wrist angle that Segovia accepts incorrect has become the current prevailing attack angle (Şaklar, 2001) although there are still performers playing with an acute wrist angle like Segovia school performers. Şaklar (2001) argues that there is a shift away from players performing with a perpendicular right hand technique to (most) contemporary performers who adopted a sort of parallel attack angle, and creates a fuller tone (Taylor, 1978) There are two important factors to create a fuller and thicker tone: attack angle and nail shape (Tennant, 1995) A less-acute or sort of parallel attack as seen in contemporary performers (*Figure 35*, *Figure 36* and *Figure 37*) creates a thicker sound with more body due to the instrument's acoustic principles. The other factor is the nail shape. Contact - release points and contact surface of the nail explains the logic. The majority of contemporary performers have adopted an ascending or descending ramped nail shape (Figure 30) to increase their nail-string contact area. When plucking surface is larger, the string is plucked with a greater energy that creates a thicker and fuller timbre. These performers file their nails in a way that creates either an ascending or a descending ramp as seen in *Figure 34*, *Figure 35* and *Figure 36*. Another advantage of a ramped nail is that it pushes the string perpendicularly, into the guitar, and the string has a vertical vibration (*Figure 32*) compared to the top -instead of a parallel vibration (Kanengiser, 2006). Since that movement vibrates the strings in a way that is into and out of the guitar top, it creates a warmer and thicker sound quality from the guitar. Segovia describes this tone as being *too muddy* and prefers a sharper and more penetrating tone (Bobri, 1977), thus adopts a perpendicular attack angle. Well-known method books, including Scott Tennant (1995), Frederic Hand (2004), William Kanengiser (2005) advocate a parallel attack.

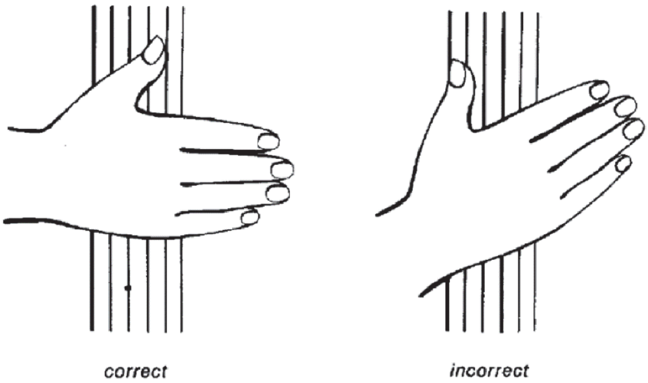

Figure 33 Segovia's Right Hand Attack (The Segovia Technique; Bobri, 1977, p. 39)

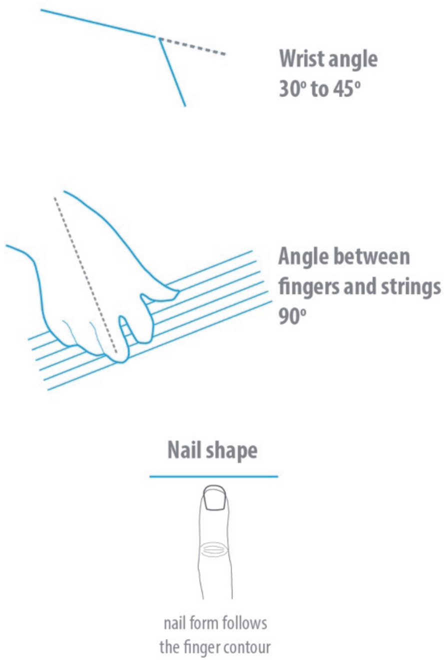

Figure 34 Francisco Tárrega right hand attack angle (FT's photo source: WEB 19)

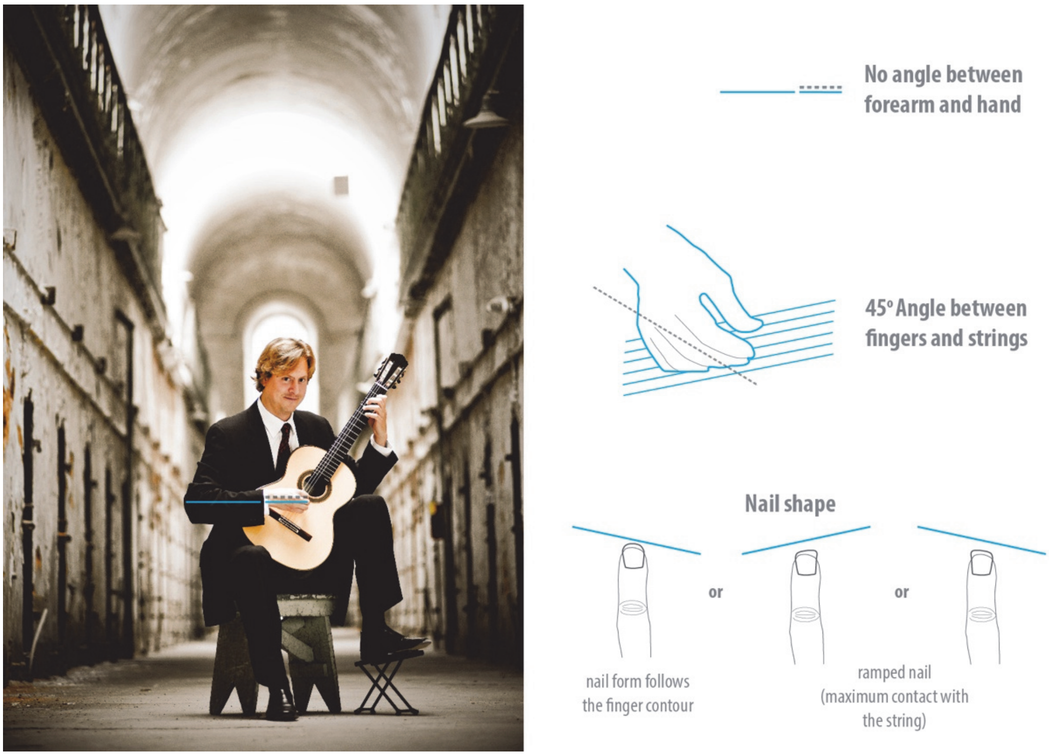

Figure 35 Contemporary classical guitar posture, Jason Vieaux (JV's photo source: WEB 20)

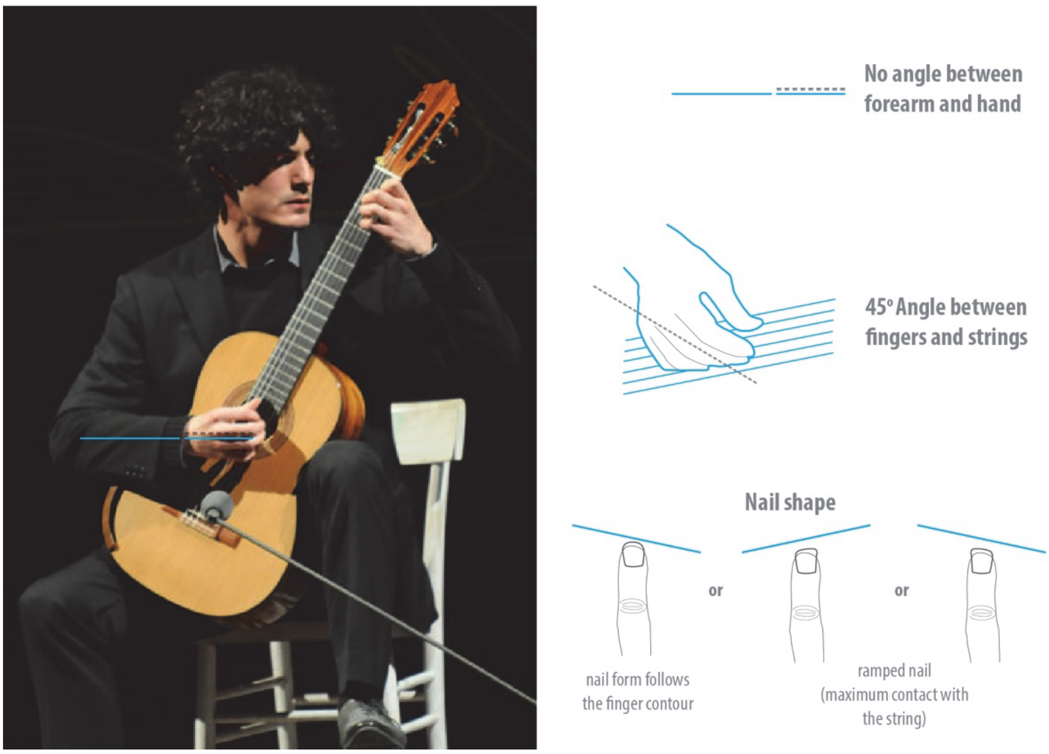

Figure 36 Contemporary classical guitar posture, Gabriel Bianco (GB's photo source: WEB 21)

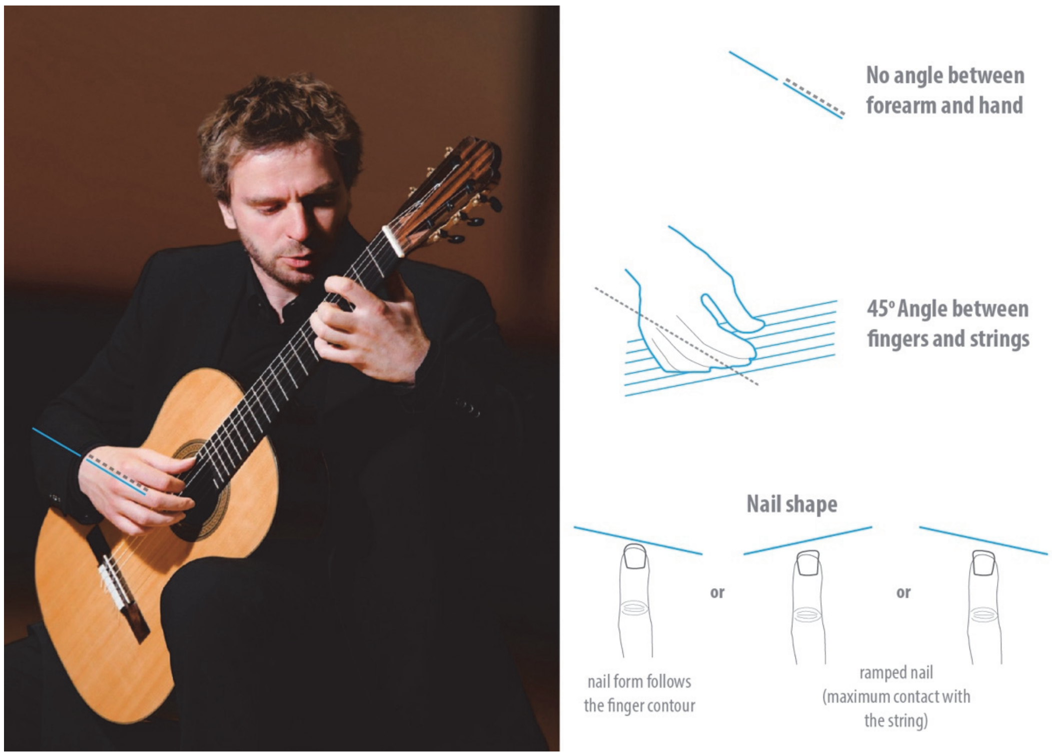

Figure 37 Contemporary classical guitar posture, Marcin Dylla (MD's photo source: WEB 22)

Figure 38 Practice Right (WEB 23)

Recent developments in instrumental instruction encouraged the use of educational tools, expending qualitative and quantitative aspect of these tools. They intend to teach the healthy posture or warm up the fingers before practice. Practice Right wrist alignment and position correction aid (*Figure 38*) is used to teach and habituate the correct right hand attack angle and intends to avoid carpal tunnel syndrome caused by repetitive stress injuries. It has adjustable wrist clips and can be used by adults of different body sizes. Practice Right has a model for kids and might as well be used by children. This tool simplifies learning and habituating the correct right hand technique motor movements without risking a bad posture or having no access to proper instruction.

Figure 39 Rosette Tremolo Mute Practice Tool (WEB 24)

Rosette Tremolo mute practice tool (*Figure 39*) roots from renowned guitar pedagogue Vladimir Bobri's idea for damping down the strings on classical guitar to help focus on right hand planting (placing fingers on strings before plucking them) and plucking. The tool simply stops the string vibration, so the guitar does not resonate but produces a pale but audible sound of strings and fingers contacting them, helping the performer hear their mistakes clearly and improve their touch and right hand nail shape in favour of a smoother technique. Practising with it is quite instructive as the student can focus purely on the right hand technique, aside from tonal concerns.

Figure 40 Planet Waves Dynaflex Gyro (WEB 25)

Planet Waves Dynaflex Gyro (*Figure 40*) and GHS Handmaster (*Figure 41*) exercisers are hand held devices which are used to build and condition wrists and forearm muscle groups. These tools are used to exercise playing-related muscles which in turn increase hand and finger movements and endurance. Dynaflex Gyro is built around rotating balls and helpful for keeping the playing muscles toned when a player cannot practise for a period or can be used for pre-concert warm up. GHS Handmaster is used to eliminate muscle imbalance from repetitive gripping and finger flexion.

Figure 41 GHS Handmaster (WEB 26)

2.2.5. Muscular Torque and Precision

Musical instrument instruments have a moral responsibility, beside their pedagogical responsibilities, to warn their students about risk factors and how to prevent them. The reason is, as it was mentioned in Section 2.2.2., concertizing classical guitar performers may develop Playing-Related Musculoskeletal Disorders as instrumental education includes many risks arising from overused force or simply extensive practice. Posture, left-right hand techniques and corporeal articulations have changed since Francisco Tárrega school performers, but guitarists still perform on Classical guitars manufactured within similar traditions and design considerations. Besides, as some interviewees argue, quantitative aspects of guitaristic execution have considerably improved (Kağan Korad, personal communication, March 16, 2016; Kürşad Terci, personal communication, December 25, 2015). The great masters of the 20th century, Andrés Segovia or Alirio Díaz would be good examples, were surpassed in terms of quantitative aspects of performative execution within their lifetime. It explains the change in educational methods, availability of practice tools and personal recording. This dramatic change in instrumental pedagogy snowballed into a common knowledge and considerations such as allowing practise periods of maximum 45 minutes or enormous care of the correct posture have helped to eliminate some of these issues recently. However, having an opportunity to be instructed by an experienced instructor is still not in the disposal of every student, and those who have not got that advantage may still suffer from injuries due to poor instruction or excessive practise hours. *Avoiding Piano Injury* is a piano technique biomechanical analysis procedure developed by Brenda Wristen (2000) can be the reflexion of it on other instruments. The aim of the procedure is to find out potentially harmful motions and introduce alternatives to these traditional instruction methods which rely on recommendations by formally educated teachers "*based on individual, subjective experiences*" (Wristen, 2000, p. 55).

Complex sensorimotor programming of fingers, hands, wrists and elbows is necessary to play any musical instrument. These motor programs need to be optimised in order to execute at high precision with minimal effort (Parlitz et al., 1998). This optimisation starts right at the beginning of the instrumental training and takes long years to habituate. Concertizing performers need to economise their use of muscular forces for their musculoskeletal well-being which justifies the necessity of working with a professional educator at the beginning of their musical career. This is a *habit* acquired relatively more easily at the beginning and the incorrect technique needs to be replaced and re-learned. Uneconomical torque problem could be observed in other instruments, like the piano or violin. For example, muscular force used uneconomically in piano playing is recognized as a *"risk factor for developing overuse injuries, tendinitis, or chronic pain syndromes*" (Fry as cited in Parlitz, Peschel & Altenmüller, 1998, p.1063). One frequent mistake of guitar performers, often mentioned by many experts through interviews, is the over-force they apply on frets with their left hand (Ender Bilge, personal communication, June 12, 2014; Ignacio Rodes, personal communication, February 3, 2015; Jose María Gallardo, personal communication, January 30, 2015). In this case, position changes explained in section become difficult and uncomfortable. There is a consensus in the literature and among performers and pedagogues that over-used muscular torque needs to be decreased and all muscle groups should be released from stress. This can be aided by designing a practice tools for this purpose. Performers need to learn how to undo the stress from the onset of their training.

Rhythmic structure of a musical piece Sternad, Dean and Newell (Sternad, Dean, & Newell, 2000, p. 266) points, is affected, and "*variability in the temporal structure of tapping movements is affected by the impact forces produced during the tapping actions*". It is in line with Minetti, Ardigo and McKee (2007) who argue that playing with higher muscular torque creates lowered keystroke speed or temporal coefficient variable. Similarly, Parlitz, Peschel & Altenmüller (1998) argue that an expert pianist relaxes their fingers after every keystroke, whereas a novice remains in a state of tension longer. Based on their findings, Parlitz, Peschel & Altenmüller (1998) claim that amateur players are often unconscious concerning the force they had been applying to their fingers, especially to the non-playing fingers.

The phenomenon Parlitz, Peschel & Altenmüller (1998) refer to as "*waste of force*", which eventually causes cramping is in line with the waste of force classical guitarists use on their left hand. Above mentioned over-used force decreases the fluidity and ceases to reach the real potential of the left hand as it feels like walking without elevating one’s feet from the ground. Waste of force and unnecessary energy consumption might be decreased by improving the movement control of the related fingers (Bingöl, 2013). This control starts with a weak torque to depress the string on a fret on the guitar neck, and the force is gradually increased until it reaches to the point enough to produce a clean tone from the string.

2.2.6. Ergonomics for Musical Instruments

Literature has a mention of ergonomics problems regarding musical instruments as an issue that could be solved to a degree by design alterations in form and materials (Bijsterveld & Schulp, 2004). Various musical instruments from viola to bassoon have been reported to develop PRMD (Winspur & Parry, 1998) and some luthiers attempted to solve these problems by producing ergonomically designed instruments. David Rivinus was concerned with repetitive motion injuries often associated with the large body of the viola, and designed ergonomic instrument alternatives against back, shoulder and left arm injuries, carpal tunnel syndrome or left hand tendinitis. Pellegrina is one of David Rivinus' alternatives which have been used by several orchestral players. For him, the traditional viola is "*several inches longer than it is humanly possible to handle*" (Rivinus, 2001). Rivinus accounts for his radical idea to gain space for creating hollow space, but different from the traditional viola, in order to create volume. He believes that manufacturing large and traditionally shaped instruments is not the right way to meet sonority demands (Rivinus, 2001). On the other hand, an undersized instrument that is characteristically weak would not solve any ergonomics-related issues. His design motive was to create more vibrating surface area and acoustic resonance space and still keep the scale (string length) short. According to Bijsterveld and Schulb (2004) these musicians who have switched to one of these ergonomically designed instruments from their traditional instruments wouldn’t have done so if they hadn’t been forced to retire due to pain.

Figure 42 Pellegrina, David L. Rivinus (WEB 27)

Pallegrina (*Figure 42*), has an asymmetrical design, which is a rarity as far as stringed instruments are concerted. However, its asymmetry is not very obtrusive, and it does not make it stand out in an orchestral setting. Another design alternative by Rivinus, the Riviola (*Figure 43*), was designed for players looking for a traditional instrument yet with an ergonomically conforming design. The Riviola represents a slight departure from viola making traditions; its lower right corner is smaller to allow for more bow clearance and its neck is out of centre. The design alteration is so slight that many performers do not notice the off-centre neck until these changes are pointed out to them (Rivinus, 2001).

Figure 43 Riviola, David L. Rivinus (WEB 28)

Nevertheless, the deviance from instrument making encompass potential problems including their timbral quality. Even if, Maarten Vonk (as cited in Bijsterveld and Schulb, 2004) states, they offer better timbral qualities, as long as they do not sound like regular instruments, they will most probably get rejected. "*The sound is the real tricky one. Because… there's a sound in their (people's) mind. And people have a really difficult time forgetting that sound. There is only one kind of viola. That's what they grew up with*" (Lipton as cited in Bijsterveld and Schulb, 2004, p.656). It is often stated that describing sound quality with numbers or even with words "*falls short of the experience of listening itself*" (M. French & Hosler, 2001, p. 47). However, listener remembers and looks for the sounds they are used to. Voice beauty and sound quality mean more for performers, therefore, they seek for an instrument which best projects the timbre quality they want to own.

Marmaras and Zarboutis (1997) claim to have carried out the "*first attempt to redesign the electric guitar, using ergonomic criteria*" (p. 59). Their ergonomic redesign of the electric guitar deals with ergonomic aspects of this instrument and player-instrument interaction including difficulties of beginners, disorders encountered by professional players and fatigue caused by extensive guitar playing. Marmaras and Zarboutis first defined the characteristics of the electric guitar that has a potential to cause fatigue or musculoskeletal disorder. As the authors state, they used direct observation to identify the way guitarists interact with their instruments. Based on their analyses, a set of ergonomic requirements were proposed related to the left hand posture and reach seen as F1 and F2 angles in *Figure 44*. These amendments were constrained by some requirements. They state that, in addition to preservation of the main features, technical and musical requirements were critically important to them and they were accepted as strong design constraints so as not to make drastic alterations.

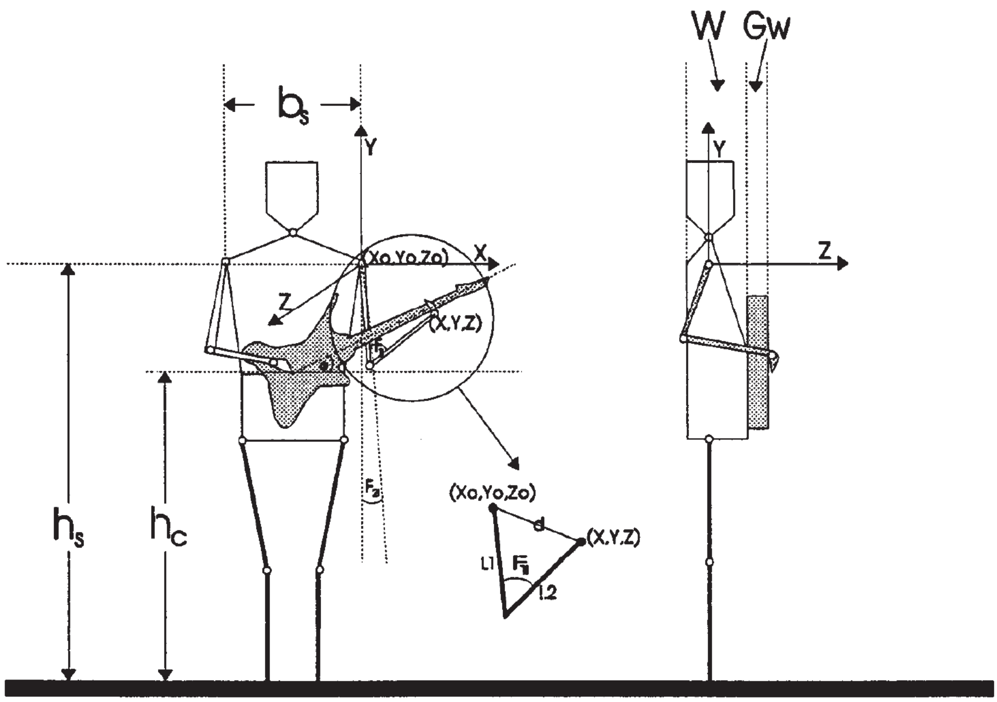

Figure 44 Geometric model used to calculate angles F1 and F2 (Source: Marmaras & Zarboutis, 1996, p. 67)

They intended to divide the electric guitar into three parts. Design proposals were produced for each section "*separately*" (Marmaras & Zarboutis, 1997, p. 62). These sections were (1) fingerboard, (2) body and (3) controls (levers and knobs). Based on the findings, they argue that the sustain and therefore sound quality of an instrument tend to increase as the fingerboard gets longer, however, making some positions difficult to reach at the same time as a downside. Consequently, a special computer program developed in Quick Basic and Microsoft Excel ware used to aid the calculation of "*comfort function values*" (p.62) to define the optimum fingerboard length. As will be seen in Chapter 4, the reverse relation between fingerboard length (referred to as *scale*) and comfort was mentioned by luthiers and computer aided modern methods are used to successfully measure the optimum length precisely, which otherwise requires a meticulous attention and hard work to complete successfully by ear and basic tools of luthiers.

Body design was realised in five steps which starts with a basic rectangle. At each step, they proposed to reshape one part of the body with usability and ergonomics in mind. Controls were replaced or redesigned to increase visibility, reach and accuracy. Some controls were placed on inclined surfaces, whereas, originally they are placed on flat surfaces. Eventually, they advised a cross-section as seen in *Figure 45* to aid reach and playability.

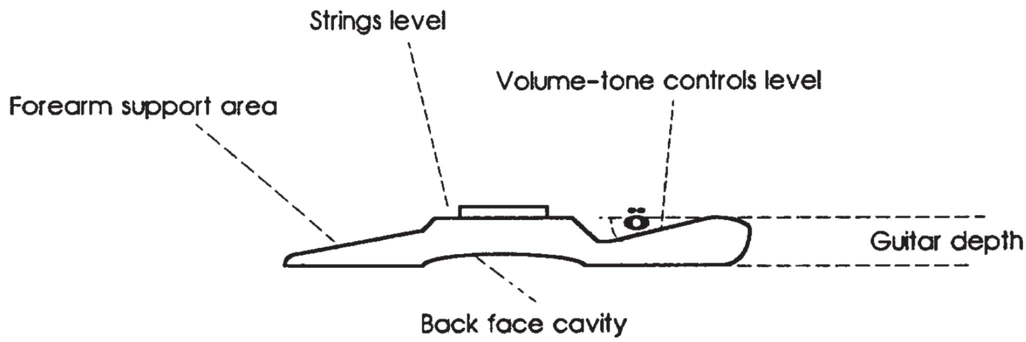

Figure 45 Cross_section of the Ergonomic Guitar Body (Source: Marmaras & Zarboutis, 1996, p. 64)

2.2.7. Audience Appreciation and Stage Presence

Performative qualities that make a performer considered worthy of a virtuoso status are compounded by intangible qualities of music and interpretation. It is claimed that, an important criteria is the existence of a qualified audience and their recognition; without such recognition, a virtuoso simply does not exist (Gooley, 2004; Howard, 2008). A virtuoso performer should cross limits, recreate new and more challenging ones and cross them, as well. Otherwise, they would disqualify. A virtuoso can push the limits towards either in qualitative or quantitative directions. Franz Liszt is an example to shifting and resetting both qualitatively and quantitatively (Gooley, 2004). In terms of quantitative aspects of his pianistic execution (i.e. beat per minute), Liszt was surpassed by younger contemporaries within his lifetime. However, "*none of his protégés and imitators came even close to him in extending the virtuoso's relevance qualitatively –beyond the sphere of music and into the social environments he entered*" (Gooley, 2004, p. 1). These social environments are a musicians interaction the musical world as both a musician and a public figure and significantly affect a virtuoso performer's presence on stage and recognition.

A musician is a product of their period and they pick up inspirations from their era. Musicians can help strengthen their fame and virtuosity qualitatively via dynamic and responsive contact to the social world as in the example of Liszt. "*Liszt became one of the most widely admired figures of his time not because his enormous musical talent made such popularity inevitable, but because his audiences made symbolic demands upon him that he was willing and able to fulfil*" (Gooley, 2004, p. 2). Howard agrees that audience appreciation is crucial for the recognition of virtuosity, and his metaphoric examples of virtuoso surgeon has one missing aspect, which disqualifies them from being a real virtuoso: *the absence of an audience*. Without such recognition, a virtuoso simply does not exist. In this sense, virtuosity is in the eye and ear of the beholder within a context of performance.

The virtuoso title is attributed to the performer by an educated listener (Howard, 2008; Ahmet Kanneci, personal communication, January 11, 2016). In other words, it is the audience who makes the assessment. However, research shows that an audience's appreciation towards technical precision and expressional behaviour is strongly influenced by performance manner in body movements, gestures and facial actions of musicians (Behne & Wöllner, 2011; Dahl & Friberg, 2007; Davidson, 1993, 2007, 2012; Huang & Krumhansl, 2011; MacRitchie, Buck, & Bailey, 2013; Thompson & Luck, 2011; Vines, Wanderley, Krumhansl, Nuzzo, & Levitin, 2004).

Especially Davidson (1993, 2007, 2012) gave notable examples in visual perception of performance manner, bodily movements and facial actions. Behne and Wollner (2011) carried out a study on different effects of seeing or hearing pianists, in which a pianist recorded works by Brahms and Chopin, and later further pianists acted as doubles and pretended to perform the same music pieces on dummy pianos over pre-recorded works with varying -from deadpan-neutral to exaggerated- gestures. All the performances were filmed and these videos were presented to a ninety three musician and non-musicians. Only one participant rated the videos across different pianists as *similar*. "*Even musically trained participants strongly believed that they perceived differences between performances*" (Behne & Wöllner, 2011, p. 324). The other participants, including musically trained ones, were effected by what they were shown instead of whet they heard. Another study to understand stage behaviour and visual effects on the appreciation of virtuosity was conducted by Huang and Krumhansl (2011). Twenty four musically trained and twenty four untrained participants were asked to rate the piano performances of compositions by Bach, Chopin and Copland. All of the pieces were recorded by the same pianist, however, the pianist was asked to act as double his recorded performance and pretend to perform with varying stage behaviours from minimal to exaggerated. Non-musicians rated differences across the stage behaviours but they did not notice a difference in the audio-only record. In contrast, musically trained participants perceived these differences under both audiovisual and audio-only conditions, and they rated minimal stage behaviour with the lowest ratings (Huang & Krumhansl, 2011).

Behne and Wölner (2011) argues that visual components have significant importance as well as auditory components in music perception. Musicians express through sound and bodily gestures. Some body movements do not necessarily produce sound and are intended for expressiveness often called *ancillary gestures* (Vines, Krumhansl, Wanderley, & Levitin, 2006). On the other hand, some of these gestures have great importance over tone quality and expressiveness. They bring intrinsic musical qualities of body movements to music (Davidson & Malloch, 2009). This can be exemplified by two virtuoso guitar performers who produce different timbral qualities on the same instrument. This basically depends on their posture, touch and the quality of strumming and plucking.

The visual information is especially important for non-musicians. A recent study with 30 participants carried out by Vines et al. (2006) has shown that visual-only, auditory-only and audio-visual performances are perceived very differently, that is, seeing a performer affects the perception of listeners. Vines et al. (2004) argue that visual information enables the creation of a new dimension related to perceived tension rather than only improving the auditory experience. Dahl and Friberg (2007) supplies further insight on how seeing different parts of the performer's body (hands, hands and face, whole body etc.) might evoke different perceptions. The designer of A-Frame ergonomic guitar rests believes that the classical guitar should benefit from being released from the chair (David Stevenson, personal communication, September 3, 2016). Having the ability of performers to express their feelings with a bit of body movement not only frees the player by reducing body tension, it helps to express the music and it invites the listener in. Reaching the audience members who are not players or who aren't familiar with the repertoire can be difficult with a quiet instrument and a player who barely moves (David Stevenson, personal communication, September 3, 2016).

2.2.8. Flow

Mihaly Csikszentmihalyi (1975) introduced the notion of *flow* about intrinsic motivation of those who take part in painting, sports, dance, performing arts and music. He argues that creative people can find pleasure and satisfaction in certain activities that bring them about "*a state of heightened focus and immersion in activities such as art, play and work*" (Csikszentmihalyi, 1975, p. 43). Depending on the context, it might be a state of mind or a physical experience. During the course of flow, the subject feels that s/he is totally involved in what they are doing. Csikszentmihalyi explains that the state of mind had the same characteristics among all participants: they described it as having clear goals, immediate feedback to the action, and a balance of challenges and skills (Csikszentmihalyi, 2004).

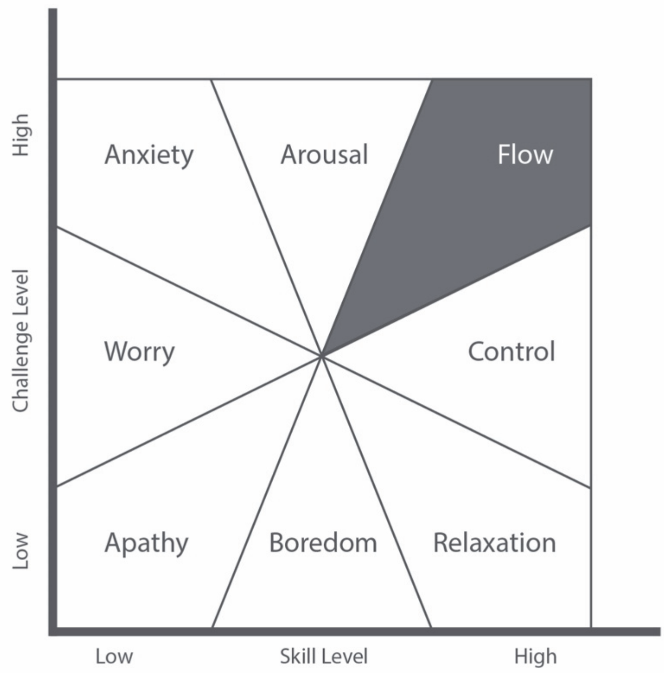

Figure 46 Flow model of Csikszentmihalyi: Mental state in terms of challenge level and skill level (Csikszentmihalyi, 1997)

As can be understood from the *Figure 46*, experiencing flow requires a lifelong commitment to practise as it requires advanced skills. According to Csikszentmihalyi, flow is the reward which makes them think that spending their lives -in most cases without expecting either fame or fortune- is worth and meaningful. This excerpt below from a notable American composer's interview with Csikszentmihalyi from the 1970s explains the flow experience well (Csikszentmihalyi, 2004).

> *"You are in an ecstatic state to such a point that you feel as though you almost don't exist. I have experienced this time and again. My hand seems devoid of myself, and I have nothing to do with what is happening. I just sit there watching it in a state of awe and wonderment. And (the music) just flows out of itself"* (anonymous composer).

The presence of flow might explain why and how musicians play emotionally and expressively at a very high performance level in their live concerts, with apparently no detrimental troubles related with their nervous systems. The responses of audiences in live concert settings, the design of the stage, the resonance of their instruments and the overall atmosphere even boost their performative skills. *Figure 47* gives a mental view of the interaction between a performer, instrument and audience. The notion of flow suggests that the technical skills of virtuoso performers is not a fixed term. If a performer possesses advanced skill, in an appropriate atmosphere they can experience the flow, which makes them perform beyond their normal performative skills.

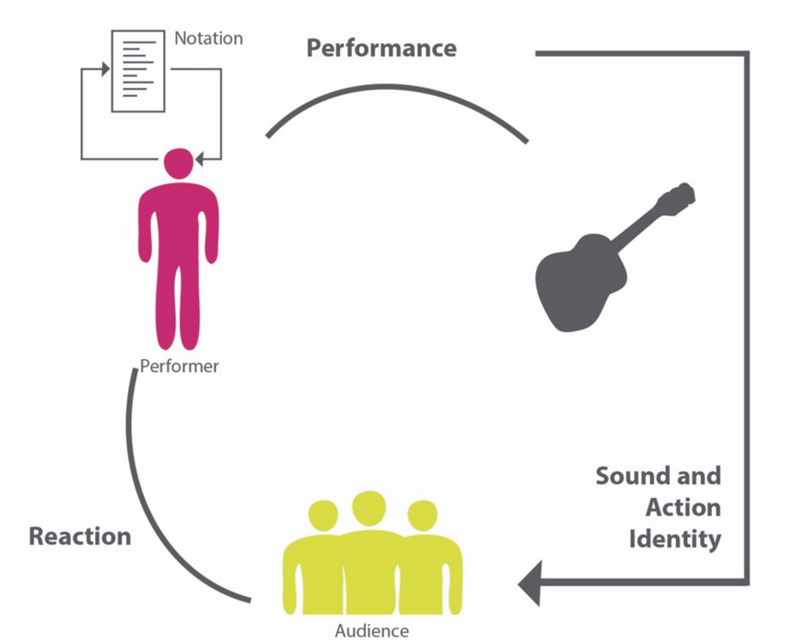

Figure 47 Mental view of the interaction between a performer, instrument and audience

CHAPTER 3

BOUNDARIES OF DESIGN NOVELTY

This chapter aims to review the benchmarks of the Classical guitar development. Some of the guitars exemplified in this chapter are convention-bound instruments, while an important number of luthiers have recently realised much refinement in their innovation-induced experiments. Patterns indicate that they fall into roughly four categories. The first category consists of traditionally manufactured instruments that are based on the so-called standard Torres guitar form and made by one of the exponents of traditional guitar making conventions. Hermann Hauser and Ramírez (both José and Manuel) would be the most obvious examples of this group. Secondly, some guitars are made using conventional methods and materials, but they feature some novel design ideas realised using traditional materials to boost various aspects like volume, projection, playability and ergonomics. Examples are the Manuel Contreras double top or Miguel Rodríguez reverse bracing. These novel features are exclusively invisible on the exterior. The third group of guitars include contemporary design alternatives like composite top or lattice braced guitars. Contrary to what is often believed, there are many examples of innovative design alternatives even in such a tradition-bound field. Although on first inspection most of these guitars seem like the guitar archetype and partly made with traditional materials, they differ from the Torres design in many ways regarding their sound production methods and ergonomics. The guitars that belong to the third group are still considered Classical guitars and are extensively played by a vast number of virtuosi all over the world. Only an educated eye can tell a few subtle differences of the third group instruments from purely traditional guitars. The fourth cluster encompasses some instruments, which may or may not seem like a Classical guitar, like the Brahms guitar or the True Temperament frets, obviously differing from, or a deviation of, the Classical guitar design. Therefore, one would be uncertain, by the way they look, whether they should be accepted as Classical guitars or not. This group consists of guitar examples or guitar parts which for some people would not be accepted as Classical guitars. The aim of this chapter is to draw perspectives as to how design has taken its turn in designing for performability and how far it can go but still stay within acceptable boundaries of what 'defines' a Classical guitar. The chapter also covers a comparison of luthier instruments and industrially made guitars produced in comparatively shorter production cycles in bulk quantities. Although factory guitars are usually considered to be inferior quality, some high-tech methods have appeared to facilitate the manufacturing of luthier instruments since the end of the 1990s. The instruments mentioned in this chapter are, in fact, not factory guitars. The technologies mentioned above are designed to manufacture some guitar parts using high technology. Their innovators claim that these technologies considerably facilitate the production quality of luthier instruments. The circumstances of the application of those advanced technologies create confusing signals, because factory manufacturing is always accepted inferior to handmade custom production in lutherie. But, in this case, these technologies are covered under a controversial –and slightly paradoxical– section title: *Mass Manufactured Concert Guitars*.

A side-by-side comparison study of different Classical concert guitars made by the same maker would reveal subtle differences in proportion, size and thickness from one instrument to another (Sloane, 1976). That is, each instrument in the high-end instruments segment is bespoke and has different attributes. This is in line with the empirical study conducted with luthier participants, and explains why these famed luthiers work without certain guitar molds; it gives them virtually limitless opportunities to create their unique *plantillas* (outline, layout, in particular guitar sound box plan). In fact, molds do make a luthier's work easier and less time consuming. It also explains the reason behind unique dimensions and design differences between, say, Manuel Contreras and Paulino Bernabe, or fairly less obvious dimensional variations on many instruments made by the same luthier through their career. Usually, makers do not handle the guitar making as a production defined by definitive judgements and unchangeable rules. They tend to develop, listen/try, judge and change. An interesting observation Huber mentions is successful in describing Classical guitar makers in comparison to violin makers: "*Unlike violin makers, guitar makers rarely make copies of historical instruments in order to learn a style or particular system of making… [i]nstead they tend to concentrate on successful contemporary instruments without giving too much thought to their origins*" (1994, p. 14). Therefore, comparing the Classical guitar development with more conservative instruments would be sufficiently misleading and incorrect; because the guitar development was definitely not a "*unified march toward the modern form*" (French, 2012, p. 14). Although there are widely-accepted methods for crafting musical instruments that are surrounded by relatively more conservative circles, like violins or cellos, there is no single way to design and make a Classical guitar. The most commonly used construction methods, the French, Spanish and Vienna construction methods, have different approaches. The Spanish construction manufactures the neck first and attaches the top, back and sides to the neck, whereas the French method starts with the sound box and attaches the neck later to the sound box (Bogdanovich, 2007; Ejder Pamukçu, personal communication, June 10, 2014; Hermann Hauser, personal communication, July 22, 2015). Together, these initial observations concerning the guitar making industry point to a certain degree of flexibility and room for novelty in guitar design activity.

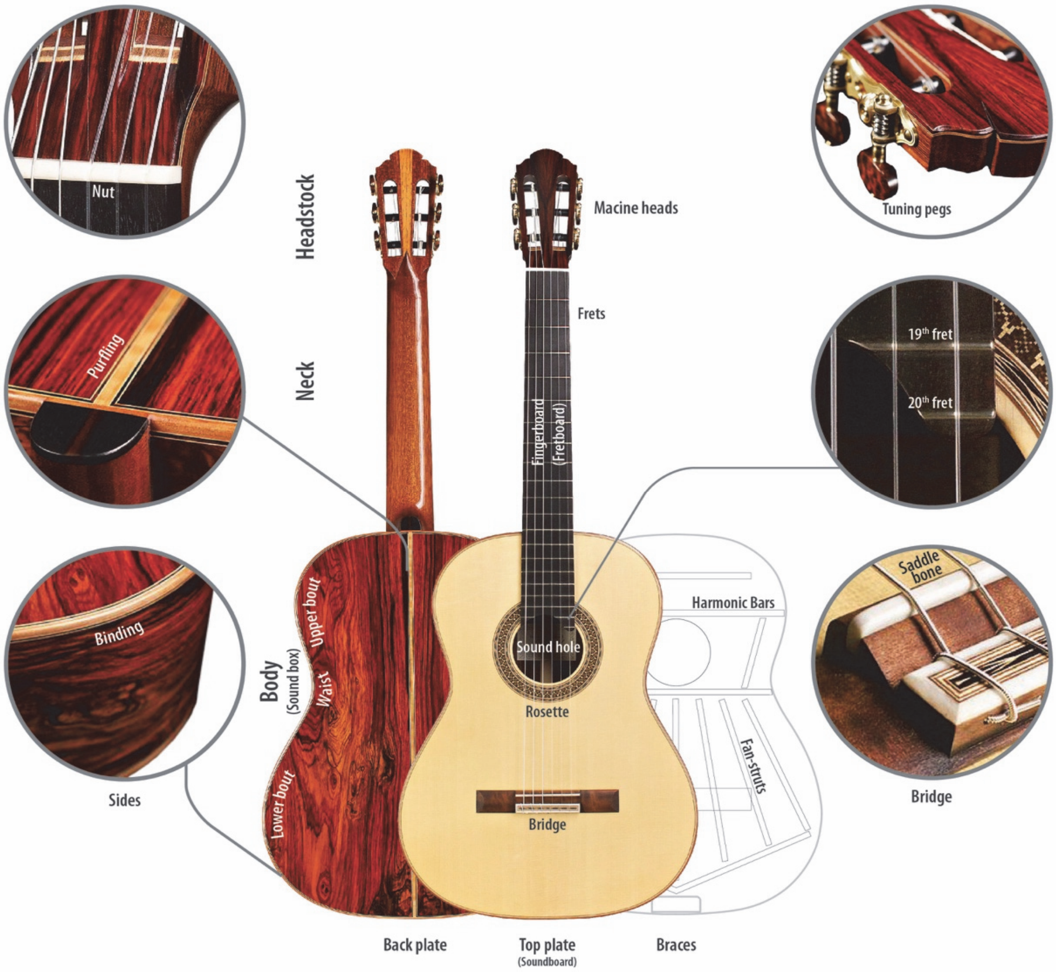

Figure 48 Guitar Parts, guitar made by Sebastian Stenzel, image courtesy of Guitar Salon International (collage and annotations by the author)

A Classical guitar is basically made up of a neck and body (see *Figure 48*) and has a quite simple but refined structure for carrying the string load (R. M. French, 2009). High-end Classical guitars have traditionally been made with spruce tops, Brazilian or Indian rosewood back and sides. Cypress and Mahogany back and sides can be found on Flamenco guitars or inferior quality instruments. In fact, the Flamenco guitar was originally associated with the blue collared working class and historically belonged to the countryside. Eventually, it was considered inferior to the Classical guitar. They are still –even those top quality Flamenco guitars– made with inferior quality woods like Cypress. The remaining parts are usually made from a range of woods of different densities like different species of mahogany for the neck, ebony for the fretboard, and various woods for decorative and constructional purposes like snakewood, maple and balsa. Initially, European spruce was the primary wood for soundboards, but nowadays Sitka and Engelmann spruce is widely used (R. M. French, 2009) in addition to the rapid increase in the usage of Canadian red cedar made popular by José Ramírez III (Wade, 2001).

Although there is a tendency to associate the beginning of the modern Classical guitar with Antonio de Torres Jurado (1817-1892) (Bruné, 1997), many contemporary makers do not describe this "*founder of the Classical guitar*" (Courtnall, 1993, p. 29) as a major inspiration for their design. This claim can be supported by a vast number of on-going work and novelty concerning some parts of the Classical guitar such as the soundboard, neck, bridge and machine heads. In the present day, many observable attempts indicate that the design "*has not yet reached perfection*" (Morrish, 2002, p. 7) and it is evident that there is room for improvement.

3.1. Evolution of the Classical Guitar

In broad terms, the modern Classical guitar design and construction finds its roots in the foundation formed by Antonio Torres between the 1850s and 1870s (Martin, 1998). Torres made his first guitar in the 1840s, and by 1854 he was a full time guitar maker based in Seville, Spain (Martin, 1998). As a central figure, the life of Antonio Torres, the luthier who gave the Classical guitar its final form (Romanillos, 1997), like any important historical figure, has attracted an important amount of mythology which hinders the important contribution he has done to the modern Classical guitar (Morrish, 2002; Romanillos, 1997). A large part of his manufacture is not clearly available for a re-evaluation today. Until recently, his work and life had been covered with uncertainty, until Spanish luthier José Romanillos initiated a research into Torres-made instruments and the famous luthier's life. By documenting some sixty five Torres-made guitars (Romanillos, 1997), he managed to trace and examine, and then put together an important body of knowledge including the master's contribution to the Classical guitar lutherie.

Figure 49 A four-course Renaissance Guitar illustrated on the title page of a guitar music collection by Guillaume Morlaye in 1552 (Tyler & Sparks, 2002, p. 15)

Figure 50 A five-course Baroque Guitar manufactured by Domenico Sellas in 1670, Venice (Tyler & Sparks, 2002, p. 113)

Early examples of instruments that would be considered to be a *guitar* today date back to the Renaissance (NB. guitar-like string instruments would go much further than the Renaissance) and the famous violin maker Antonio Stradivari is known to have manufactured guitars (Faber, 2006). That is, guitars had existed before Torres. These early instruments appeared in many different forms and sizes with various stringing and tuning arrangements (Tyler & Sparks, 2002). For instance, the Renaissance guitar –typically four-course– (as seen in *Figure 49*) with a thin and long neck, flat top and back plates (French, 2012) and the Baroque guitar –usually five-course– (as seen in Figure 50) which seems like a scaled, thinner and very elaborately ornamented version of the modern Classical guitar (Usher, 1956) are two examples amongst many. It can be understood from these figures that Torres did not actually *design* the guitar; his instruments featured certain design elements, which had been introduced by his predecessors, and improvements over those of his predecessors (Chapman, 2003). He made a strikingly fundamental influence to standardise those slight differences amongst different primitive guitars and allegedly put the *last* touches (Summerfield, 2002).

> *"[H]e created by far the most important and influential model for the modern guitar; he too had access to traditions, models, and an existing technology to build upon… [and] the work of Sanguino, Benedid, Pagés, Récio, Guiterrez, or Soto and Solares did not escape his attention" (Huber, 1994).*

Although pre-Torres guitars often have elaborately crafted decorations and normally have smaller bodies (Martin, 1998), Antonio de Torres always preferred to manufacture his instruments as functioning tools to make music with, rather than a beautiful object that is appealing to the eye as well as the ear. Only a minority of his output displays special marquetry and elaborate ornamenting. His famous instrument *La Leona* from 1856 (Romanillos, 1997) –now owned by Wulfin Lieske– is considered to have brought together many different parts that the modern Classical guitar has in the present day. It indicates that the modern Classical guitar form was essentially present (French, 2012), and the typical Classical guitar today has a great amount of resemblance to the ones made by Torres in the late 19th century.

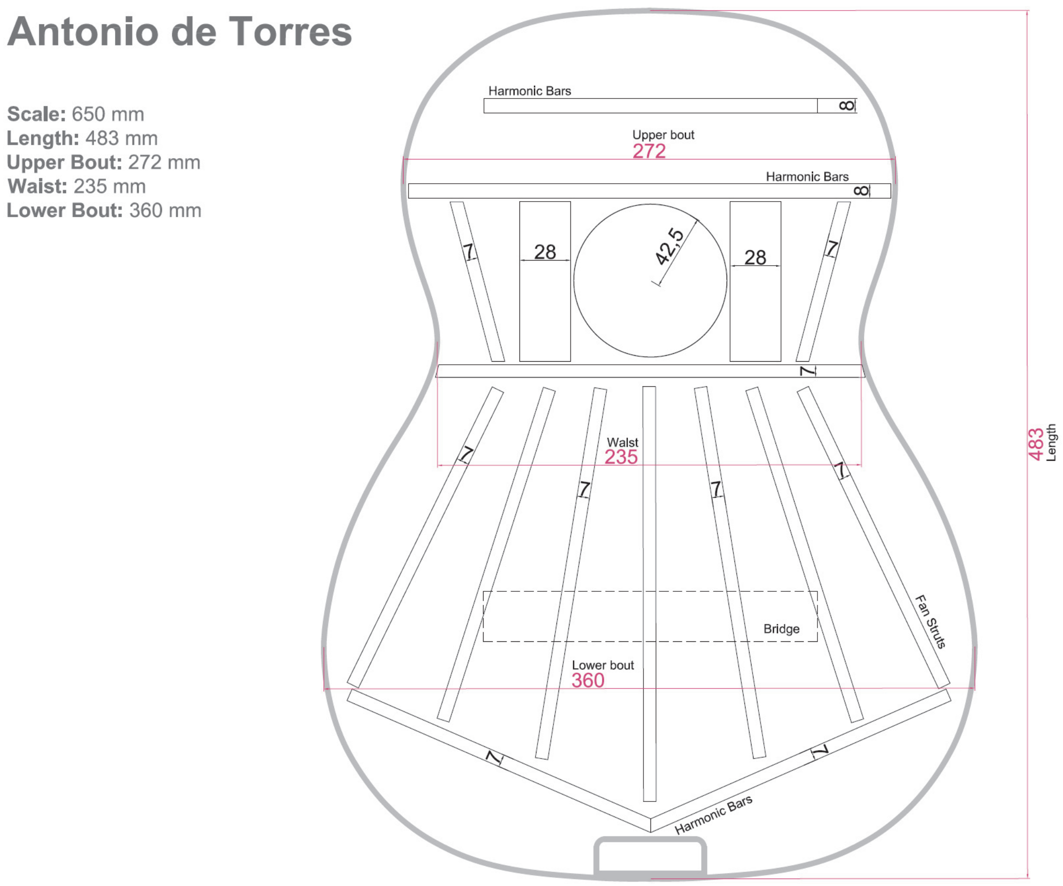

Figure 51 Antonio de Torres guitar interior bracing
Re-drawn based on the calculations of Courtnall (1993, p. 37)

Although Torres "*is not the originator of fan bracing*" (French, 2009, p. 2), he is especially known for his contribution to develop the seven fan-strut architecture (*Figure 51*) which became the "*hallmark of the modern strutting design*" (Courtnall, 1993, p. 29) and was considered the bracing standard for more than a century that is still reproduced as the most standardised form of soundboard bracing. However, it did not become a construction standard, in the sense that a Stradivari violin is the current violin making standard. Different makers created their unique fan-strutting patterns in the following decades. The Torres guitar is slightly smaller than regular contemporary guitars today but is still bigger than its predecessors (French, 2009). His unique fan-bracing is fundamentally influential for that. In other words, Torres changed the engineering of the instrument, as well as its looks. He managed to produce state of the art, balanced and powerful instruments which were ahead of their time. Torres-made instruments, especially from his first production phase, 1852-69 which includes his famous 1856 La Leona, are in great demand today – rather than his second phase, 1875-92 (Courtnall, 1993).

A few decades after Antonio de Torres, another Spaniard José Ramírez I (1858-1923), along with his younger brother Manuel Ramírez (1864-1916), established their style by adding some idiosyncrasies to Torres fan-strutting (Morrish, 2002). Initial attempts to manufacture guitars with a bigger sound and better projection fall in this period. It was the first decades of the 20th century, when Andrés Segovia (1893-1987) helped establish his chosen instrument's place as a Classical music concert instrument and put the Classical guitar where it deserves to be: the concert venue. Segovia was always in close contact with luthiers in search of more powerful instruments. His collaboration to make the first successful nylon strings with a Danish born American luthier Albert Agustine, who flied to New York in 1928 to pursue his career as a luthier, was inspired by Segovia's desire to have more powerful instruments for large recital halls. Another reason that forced Segovia towards nylon strings was the fact that he, due to the World War II by that time, did not have access to his favourite German made gut strings for his Hauser guitar. As a matter of fact, Segovia somehow succeeded to draw luthiers' attention to manufacture powerful instruments which can project better and he attracted many luthiers for this ideal –indeed with the help of his flesh and nail plucking technique. Before Segovia's influence, even the legendary Stradivari[4] family made very pretty and small Baroque guitars (Usher, 1956) –at least two (R. M. French, 2012)– probably for girls from the high society who did not really know how to play (Nupen, 1967). Following Segovia's successful career as a concert artist performing in large venues, three luthiers made three iconic guitars, all of which are now in exhibit in the MET museum, and eventually succeeded in paving the way towards building more powerful "traditional" guitars before non-conventional contemporary guitars came into existence. The first instrument that should be mentioned here is the

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[4] A Stradivarius is a string instrument (violin, viola, cello or other string instruments) manufactured by members of the Italian family Stradivari whose most significant member Antonio Stradivari (1644-1737) is considered one of the most significant artisans in string instrument lutherie.

famous 1912 Manuel Ramírez guitar, which was in fact made by a Ramírez co-worker and one of the most influential makers of the 20th century, Santos Hernández (Courtnall, 1993) and presented to the young Segovia when he was still 19 (Summerfield, 2002). Segovia gave concerts on that iconic guitar for 25 years (Nupen, 1967). Secondly, Hermann Hauser Sr. (1882-1952) made a guitar for Segovia in 1937 (see the following pages) which became the most replicated instrument of the 20th century. The third instrument to be mentioned is the José Ramírez III 665 mm. scaled guitar which he first developed in the 1960s (see the following pages) which made a profound influence on guitar construction onwards. The Ramírez III guitar exhibited in the MET museum is a 1967-made instrument.

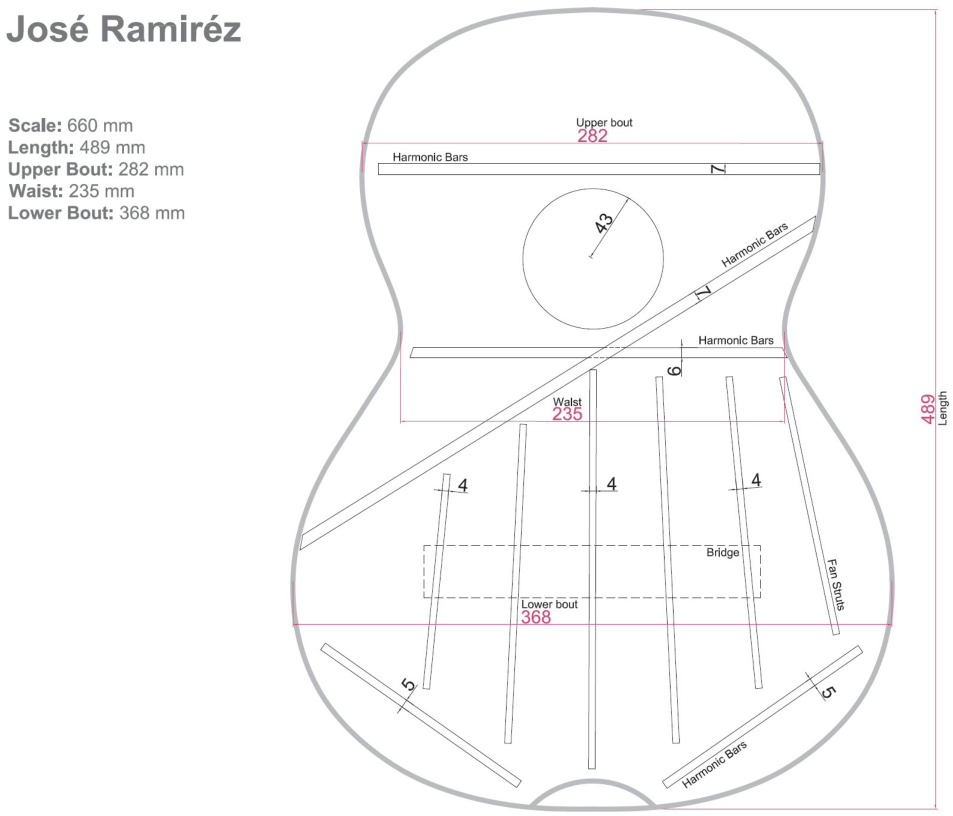

Figure 52 José Ramírez guitar interior bracing
Re-drawn based on the calculations of Antes (1986, p. PL28)

The Ramirez family (in addition to José Ramirez I and Manuel Ramírez chronologically José Ramírez II 1885-1957, José Ramírez III 1922-1995, José Ramírez IV 1953-2000 and Amalia Ramírez 1955) along with their co-workers, particularly Santos Hernández (1874-1943), manufactured their guitars with arched soundboards and supported them with an angled harmonic bar (Courtnall, 1993). The harmonic bar, as seen in *Figure 52*, greatly improved the soundboard's strength-to-mass ratio which ensures a lot of strength and brought the Ramírez guitars to the attention of Madrid music communities. Powerful guitars were to their liking and Madrid school players praised the sound power after Andrés Segovia giving concerts in large halls.

The Ramiréz family, and Josè Ramiréz III in specific, is known for their curiosity to further improve their guitars' sonic resources by manipulating their dimensions, materials and connection details and proposing novel solutions. José Ramírez III, with Segovia's attention back after roughly twenty years with his Hauser guitar, developed a new model in the 1960s, a rather longer and larger instrument which suited the legendary performer's large hands. Following this instrument, Segovia performed on several guitars of this type by the same maker. The 1967 José Ramírez III remains a remarkably successful guitar model, and serious performers who could play comfortably on a long scale and higher action guitar played instruments of this type (Huber, 1994). The Ramírez of the 1960s was especially designed for recital halls rather than small gatherings or home use. To achieve this, the contribution of Ramírez was "*a lengthened neck designed for high tension nylon strings, and the use of cedar for the top which produced a very powerful tone*" (Huber, 1994, p. 11). Another important quality of Ramíez III was his success to refine old innovations and define new standards (Wade, 2001). Considering nearly fifteen thousand José Ramirez III model instruments around the world today, built between the 1960s and 1987 (Huber, 1994), the workshop can be said to have established certain standards and precisely manufactured a consistent high quality. In that sense, Ramírez III succeeded a high degree of control over material selection, production and a workshop model where a luthier in chief directs master artisans. This workshop model that successfully managed to maximise the production per artisan was in fact associated with Japanese production such as Masaru Kohno in the 1960s rather than the Ramírez of Spain: it was not characteristic of Spanish production by that time.

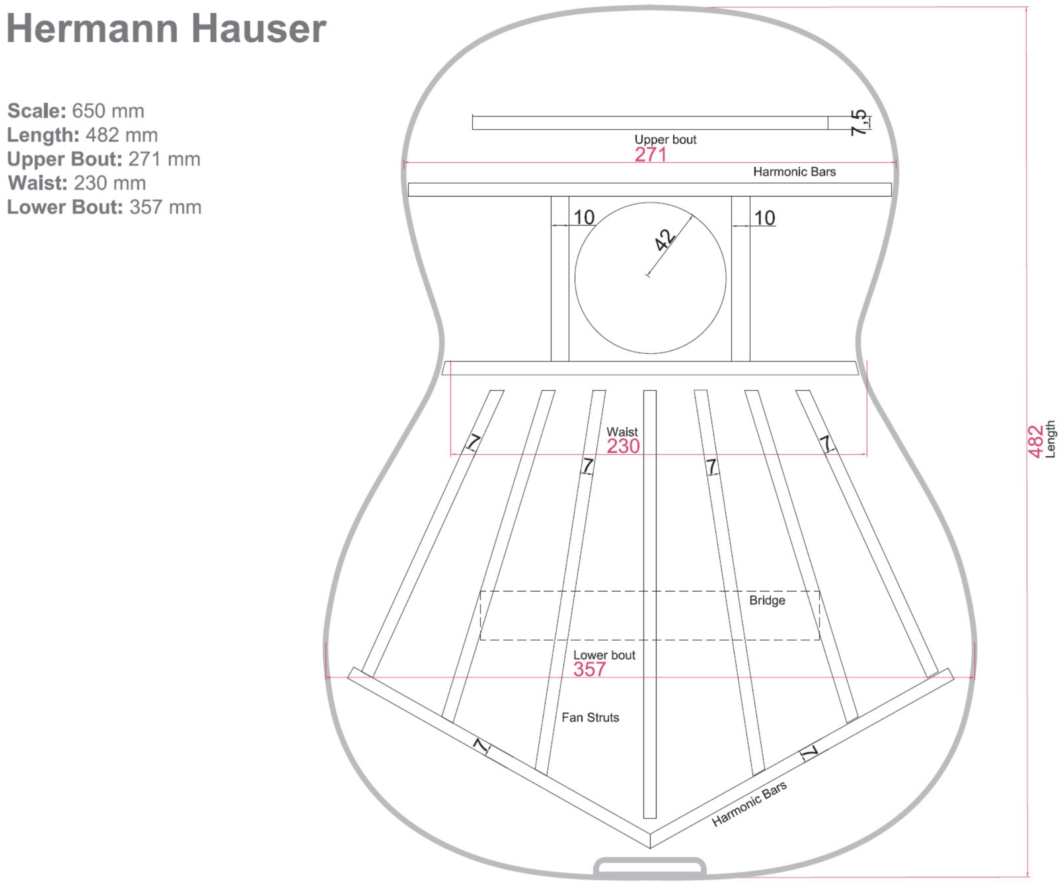

Figure 53 Hermann Hauser guitar interior bracing
Re-drawn based on the calculations of Courtnall (1993, p. 66)

The first serious *foreign* challenge against the Ramírez workshop was Hermann Hauser I. The German luthier improved his skill by investigating Torres, Ramírez and Hernández-made guitars, thus was very much influenced by Spanish making traditions (Martin, 1998; Summerfield, 2002) and Andrés Segovia himself through their conversations (Courtnall, 1993). Inspired by Spanish traditions and Segovia, this particular 1937 guitar was such a well-manufactured instrument that Hermann Hauser I convinced Andrés Segovia to swap his 1912 Ramírez. The 1937 Hermann Hauser is accepted as *the greatest guitar of our epoch* by many (Segovia as cited in Bruné, 2003). Hermann Hauser was active and growing his reputation in Germany as a maker of fine concert guitars after José and Manuel Ramiréz passed away in the 1920s, so did their famed pupils Enrique Garcia and Francisco Simplicio in 1922 and 1933 respectively. The decline of famed guitar makers in Spain was an advantage for

Hauser, because, "*Santos Hernández was virtually the only great guitar maker*" of that time (Courtnall, 1993, p. 61). Hauser guitars, in line with Torres, show that a relatively smaller guitar body can indeed project equally well (Romanillos, 1997). The way a Classical guitar is designed should enable it to be strong enough to withstand the tensile stress of the strings, player's body forces and environmental loads like humidity and heat, and be "*light enough to radiate sound*" (R. M. French, 2009, p. 43). Hauser guitars are minimal in every sense and just enough material has been used in the manufacture process. Therefore, they are very lightweight, approximately 1.35 kg (Morrish, 2002; Roberts, n.d.-b, n.d.-c), allegedly rooting from the stereotypic term "*German precision*" in the engineering of guitars. These guitars are described balanced and responsive with a bright sound. Some great masters of the 20th century believe that these iconic guitars are the best instruments of the century. For instance, Julian Bream described the Hauser of Segovia as the best sounding guitar he had ever encountered (Sherry, 1981).

The top tonewood is unquestionably the most fundamental part of a Classical guitar. Simply increasing its size would increase the sound power and sustain. However, instruments with a bigger body tend to sound bass, which can be paralleled by the difference between a violin and a cello. Several luthiers in Madrid experimented with double or triple body parts and modified shapes in an effort to increase the sound volume. These makers, unlike contemporary luthiers, did not leave guitar making traditions; they rather experimented using conventional materials and methods. However, it should be noted that "*Manuel Contreras has probably gone furthest*" (Huber, 1994, p. 27) and is still accepted as one of the most experimental guitar makers of Spain (Summerfield, 2002). The early 1970s are the years when Manuel Contrares started his experiments that would lead to some novel and unconventional design ideas to obtain greater volume and projection from the Classical guitar (Pohren, 2005). Most of his ideas were compatible (save the Carlevaro model) with the traditional appearance of the Classical guitar. His most notable innovations include *doble tapa* –double top– (*Figure 54*), resonator (*Figure 55*), curved bracing (*Figure 56*a), the Carlevaro model (see Section 3.2 and *Figure*

68) and floating top (*Figure 69*) among others (Martin, 1998). Nevertheless, his Carlevaro model did not evoke much attraction with its larger body. Although his double-top, resonator, floating top and Carlevaro model are quite *futuristic*, they are still considered conventional instruments. Their design ideas are in general invisible on the exterior and are in harmony with the Classical guitar traditions. It makes Contreras guitars much sought after while still considered traditional but novel instruments (Cumpiano & Natelson, 1994).

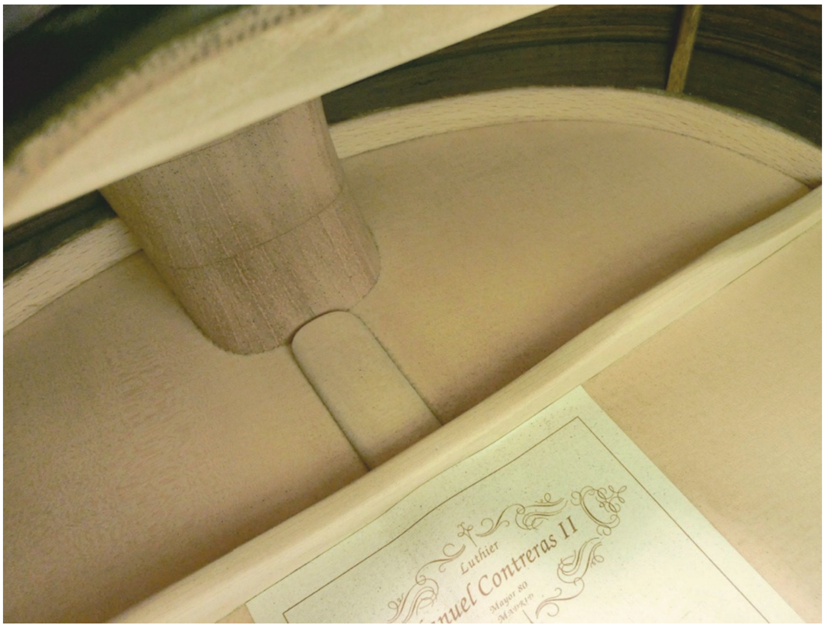

Figure 54 Manuel Contreras double--top: an additional soundboard attached to the back of the instrument (Martinez, 2014a, pp. 10-11)

The *doble tapa* (double top) construction was designed based on an idea of Celedonio Romero in 1974 (over a decade earlier than Gernot Wagner and Matthias Dammann contemporary double tops) and is still used in numerous Contreras guitars such as *25º Aniversario* and *10º Aniversario* models in addition to the *Doble Tapa* model. Unlike the contemporary Wagner and Dammann double top, Contreras double top incorporates a second soundboard connected to the back, rather than the top soundboard. *Figure 54* shows the second spruce soundboard attached to the inside of the back of the guitar. After numerous experiments with different thicknesses and various bracing designs, Manuel Contreras tried to add a second soundboard to the inside of the Brazilian rosewood back. Since this process does not require any advanced "foreign" materials (i.e. carbon or Nomex) it still sounded like a traditional instrument (Cumpiano & Natelson, 1994). Contreras would laminate a hard wood (rosewood) with a softer and more flexible one (cedar or spruce). "*Manuel Contreras eventually concluded, after countless tests, that this system delivered better results if the guitar's top and the second, internal top were made of the same wood… [therefore] guitars made of red cedar also have bracing and the inner soundboard of red cedar*" (Martinez, 2014a, p. 10).

Figure 55 Manuel Contreras Resonator design (Image source: Martinez, 2014a, p. 12)

In the mid-1980s, Manuel Contreras, in cooperation with Pablo Contreras, came up with the Resonator concept. Central to this idea was to separate the guitar's vibrating body from the performer's body as much as possible to eliminate the dampening of the human body. The first resonators were detachable to be able to remove or attach the resonator when needed. Over the span of years, the father and son decided to build the resonator as an on-board attachment. Besides these major design innovations coming from traditional makers like Contreras, there are a few minor touches, from similarly traditional luthiers, like Miguel Rodríguez reverse bracing and José Ramírez double back. The reverse bracing development of the 1970s, which is attributed to Miguel Rodríguez (Romero, 2016), consists of inverted fans that cluster up towards the bottom end of the guitar (see Figure 56b). In addition, José Ramírez manufactured a visually identical alternative of their regular model with an extra rosewood back plate attached to the sides (Huber, 1994) which is termed *double-back*.

Figure 56 (a) Curved Bracing ghost view [left], Manuel Contreras guitar (Martinez, 2014a, p. 9) / (b) Reverse Bracing, 5 fan-strut bracing [right], Miguel Rodríguez reproduction, Pepe Romero, Jr. (WEB 29)

To sum up the guitar construction prior to the introduction of contemporary instruments, a great many makers, starting from the first decades of the 20th century up until the writing time of this research, have struggled to meet the demands of the market, thus have committed to participate in various experiments in a pursuit to come up with a "*better*" guitar design. In the first half of the 20th century, a few luthiers manufactured the so-called iconic guitars which became successful in setting the standards of guitar making traditions. These makers were followed most notably by Miguel Rodríguez (1888-1975), Ignacio Fleta (1897-1977), Robert Bouchet (1898-1986), Daniel Friedrich (1932). The most widely preferred Ramírez alternative, a Barcelona based maker Ignacio Fleta was brought to attention by the prominent guitarist John Williams, who more recently replaced his traditional guitar with an Australian made lattice guitar manufactured by Greg Smallman. These makers who manufactured using conventional methods were followed by some luthiers harnessing high-tech advanced materials such as Greg Smallman (1947), Gernot Wagner (1948) and Matthias Dammann (1956). The 1970s and 1980s encouraged a more scientific approach to innovate and design Classical guitars. Since then, the Classical guitar design has witnessed two major developments (the lattice bracing and double/composite top) and several relatively minor fractions in guitar design. Patented or unpatented, numerous design implementations have been proposed, some of which entered production, and quite a large amount did not catch on. The two recent major developments in soundboard bracing have made a stronger effect on lutherie traditions which is "*more profound than those contributed by any other modern maker*" (Morrish 2002).

A scientific study carried out by physical chemist and acoustical theorist Michael Kasha (1920-2013) who researched into physical structure and acoustics of the Classical guitar (see Figure 57). He applied modern physics and acoustic theory in order to manufacture a radical re-design of the Classical guitar with a master builder Richard Schneider and this collaboration brought in an unusual bracing design. Richard Schneider became a foremost exponent of Kasha's radical soundboard bracing design, and "*[i]n the following years Schneider introduced many of his own innovations including vibrating softwood backs, ... and a new position for the sound hole*" (Summerfield, 2002). But, besides a loud volume, their research neglects essential qualities of the Classical guitar manufacture, such as tonal character and colour. Kasha and Schneider guitars have a quite distinct voice which does not appeal to many Classical guitarists today, and very few guitarists (i.e. Kurt Rodarmer) play Kasha and Schneider guitars.

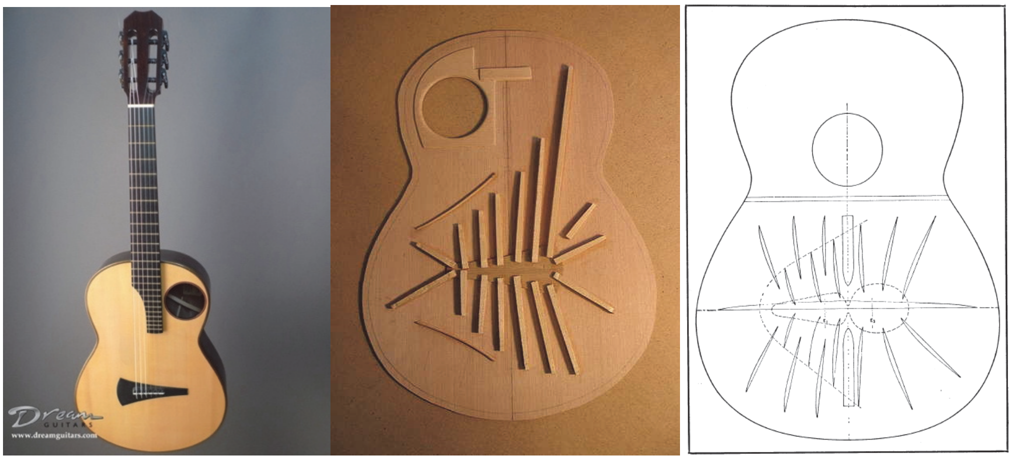

Figure 57 Michael Kasha guitar with a relocated soundhole by Schneider [left] bracing system [right] Sources: WEB 30 [left] and Perlmeter (1970) [right]

Although Simon Marty has been through a similar approach to sound, he reached a more musical product from his empirical research. He was interested in guitar lutherie as a player to explore new design alternatives to improve its performance and began building guitars in 1982. Having science majors in physics and mathematics, and a doctorate in electrical engineering, he found his inspiration in guitar science. In 1984, Marty was granted an Australian Government fund to explore and further develop his innovative concepts in guitar lutherie (Marty, n.d.). His scientific research included some advanced methods such as laser holography, frequency response testing, timbre element analysis computer modelling and computer finite-elements analysis to study soundboard vibrations intended for a re-evaluation of the Classical guitar bracing (Atherton, 2014). He carried out detailed investigations concerning the physics and construction stringed instruments and applied his findings to guitar design and construction (Marty, n.d.). Marty found out the limitations of the traditional fan-bracing and came up with a new concept (see Figure 58), which he names radial bracing (Rossing, 2010). His radially designed braces are made of carbon fibre composites. His research resulted in loud and well-balanced guitars that are currently played by notable performers including Sharon Isbin, Jérémy Jouve, Martha Masters and Scott Tennant.

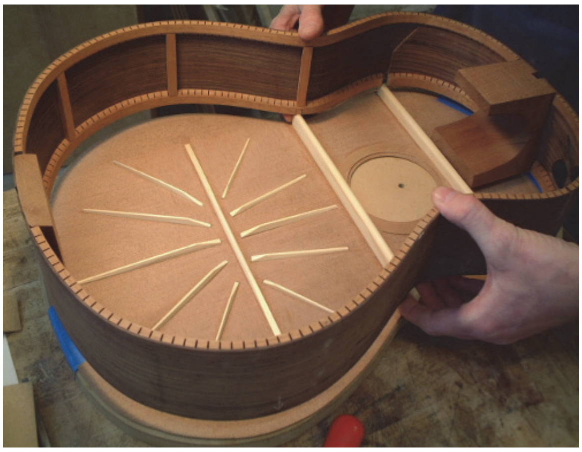

Figure 58 Symmetrical radial bracing -the bracing is of European Spruce- [Source: Randy Reynolds (luthier), WEB 31]

Informed by their scientific analyses and methods, some makers were able to come up with some novel ideas which harness advanced materials and technologies. Greg Smallman and Matthias Dammann are the first names that usually come to mind, having introduced the lattice bracing and the double-top (aka “composite top” or “sandwich top”) construction respectively. These methods aimed to increase the soundboard’s efficiency without having to increase the overall guitar size. Eventually they have succeeded to produce greater loudness from their guitars.

Greg Smallman's lattice bracing in the 1980s was one of the first major attempts that sought to achieve louder volume from the classical guitar and had a profound effect on lutherie traditions. He is acknowledged as the founder of the criss-cross lattice bracing and produces a small output, roughly four guitars a year (Summerfield, 2002). With his sons' (Damon and Kym Smallman) contribution after the 2000s, his output may have raised a few more guitars a year. An ultra-thin tonewood which vibrates more efficiently than thicker tonewoods can explain the main argument of his design philosophy. Since this ultra-thin top is fragile and cannot be supported enough by traditional fan-struts, Smallman replaced the traditional fan-struts and devised an elaborate and strong strutting system, the so-called *criss-cross lattice* bracing system, which supports the top tonewood without hindering its flexibility. Greg Smallman explains that the top acts sort of like a drum diaphragm: energy of strings when plucked is sent to the top and with this energy the top is excited like the diaphragm of a drum. A phenomenally thin flexible tonewood could be exited with less energy, and therefore, the guitar’s top moves up and down causing a bigger rippling motion across the sound box. In other words, the threshold to active the tonewood is decreased thanks to his design proposal. Smallman's lattice braces incorporate various materials from balsa to some advanced materials such as carbon fibre reinforcement (see Figure 59). In other words, he aimed to increase the stiffness-to-mass ratio of the soundboard. A Smallman soundboard is exceptionally thin and light, it is almost like someone's skin, soft and flexible (Thomas, 1993), and since it is supported by a tough bracing system and heavy back and sides it does not crack or displace.

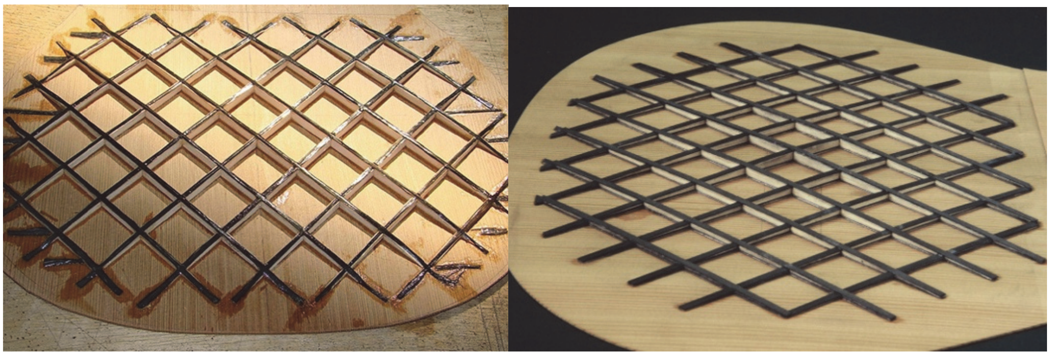

Figure 59 Carbon supported lattice bracing (WEB 32 [left], WEB 33 [right])

The light top soundboard, so to speak the vibrating mass, permits an increase in sound radiation and boosts the projection of the instrument with a balanced tone through all registers. Backs and sides of a Smallman guitar are usually much heavier than a standard guitar and their backs have a curvy shape. The curve permits Smallman to discard strutting the back plate: his guitars and other luthiers' guitars in the same design do not have back plate braces. Whereas a standard Classical guitar weighs around 1400 and 1600 grams, a Smallman is usually around 2200 and 2400 grams (Morrish, 2002) but there are heavier Smallmans that weight over 3100 grams (Roberts, n.d.-a). Central to Greg Smallman's heavy back and sides is to decrease the amount of energy absorbed by them. In fact, this technique was explored quite thoroughly by the French maker Daniel Friedrich (1932) and it is applied by some makers including one of the interviewees of this thesis study, Andrés Marvi. He explained that he uses double back and sides in order to decrease the absorption; in any case the back and sides absorb some energy, but when it is a tough box with double back and sides and a vibrating top, the absorption decreases (AM). In turn, it enables a higher volume, better projection, faster response and longer sustain. Many controversial opinions exist about contemporary guitars in general and Greg Smallman guitars specifically. Bernard Richardson, a guitar acoustics expert, agrees that Smallman has employed very sensible engineering to reduce the mass compared to stiffness; and this is actually what players need, but he accepts that the Smallman tone is not entirely to his taste (Richardson, 1994). Guitarist and concert instrument dealer Raymond Ursell explains his doubts about some listeners who seem rather critical about Smallman-type guitars (Ursell as cited in Morrish, 2002). Julian Byzantine too mentions about Smallman guitars that they may not have the intimate beauty which appeals to some players (Byzantine, 1988).

Figure 60 Carbon fibre composites [left] Sheet and [middle] Rod materials (WEB 34), [right] Carbon support used in back and sides (WEB 35)

Double top refers to a relatively new way of manufacturing the Classical guitar soundboard that emerged after the 1980s and is alternatively termed composite top or sandwich top. Following its success in Classical guitar construction, steel string guitar application is relatively new (Dunwell, 2008) and this ushers in new application possibilities on various other instruments. Although it is termed “double top”, some of them in fact house three layers: the outer skin, the inner skin and a middle core (see Figure 63). Some luthiers started to advertise their double tops as “triple top”; for cosmetic reasons they added a 3rd wood layer that summed the layering (including the Nomex®) to 4 layers, but the 3rd wood layer does not have another function apart from veiling the soundboard’s layering. Hence, those guitars will be categorised under double top guitars. In addition to sandwich top tonewood, there are some luthiers experimenting with composite construction backs (Mueller, 2012) which can be seen in Figure 60.

Many luthiers have adopted the double top construction technique in the present day, but the double top development is often attributed to Matthias Dammann and Gernot Wagner. Here it should be noted that, although Matthias Dammann’s name has been identified with the double top contraction, Dammann adopted his friend and colleague Wagner's idea and produced the first double top guitar and his success, along with David Russell's fame as a renowned performer, helped popularise this radical soundboard design (Kelly, n.d.). Dammann and Wagner experimented with a material called Nomex®, which is a lightweight kevlar-polymer honeycomb product, and originally designed for use in the aviation industry and fireproof clothing (Dunwell, 2008; H. F. Mark, 2013). Nomex® is a registered trademark for meta-aramid material introduced by an Americam company DuPont in the 1960s (H. F. Mark, 2013). This material is sandwiched between very thin inner and outer skins (usually cedar, spruce, redwood or a combination of two species one for each inner and outer skins) to make the soundboard. It appears that the outer skin’s wood is the main determinant of the character of the timbre we hear from that particular instrument (Mueller, 2012). Nomex® and tonewood are laminated together using epoxy or polyurethane glue (Dominelli, n.d.). The amount of glue used and its application technique is a determining factor, because this unrecoverable application has significant input to define tonal qualities of the top soundboard (Dunwell & O'Brien, 2008). Therefore, it should be an extremely controlled process and each and every piece should be weighted carefully using a precise scale; and their weights should be recorded before and after the gluing process. It should be noted that these pieces are between 50 and 150 grams each, hence they should be weighted very precisely. The necessary amount of glue is calculated accordingly. The glue should constitute a nice and small fillet between the walls of the honeycomb and inner or outer skins as can be seen in Figure 61 (NB. Image on the left shows the Nomex layer and inner wooden skin, but outer wooden skin is excluded from the drawing to improve clarity). Dunwell & O'Brien calculates the required amount of glue as 0.14 to 0.16 gr/square inch (2008). Their construction model, which is based on Hermann Hauser's famous 1937 guitar, has a top tonewood surface of around 241 square inches. Therefore they calculate the necessary glue amount as 33.7 to 38.6 grams. Every component is measured first without glue, and then with glue to double check whether the top place has enough glue.

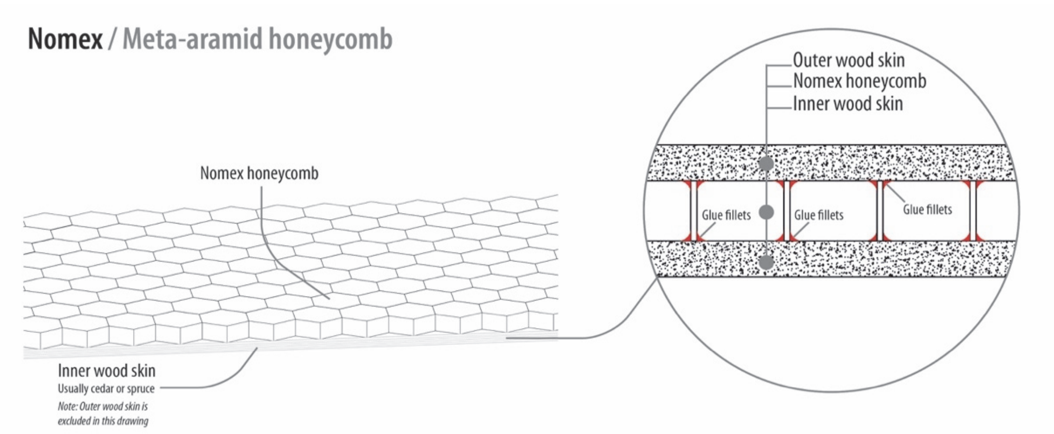

Figure 61 Nomex - Wood skin section and glue fillets

Double top guitars do make one thing possible: a combination of spruce and cedar. This has been an important *first decision* since cedar started to be widely used by José Ramirez III for the first time (Huber, 1994). That is, performers became faced with the dilemma of selecting cedar or spruce after him. In double top manufacture, both spruce and cedar can be used on the same guitar, one inside and the other outside. According to the famed luthier Kenny Hill, if the cedar plate is used on the outside, the guitar gives out a more of a cedar sounding mixture; or vice versa (Hill, n.d.).

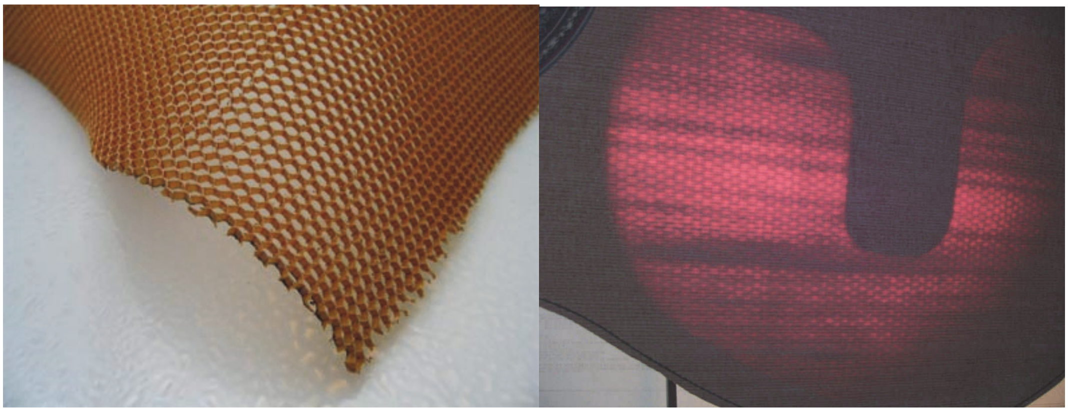

Figure 62 Nomex® [left] is a lightweigh honeycomb fiber developed by Dupont Chemical (WEB 36) / Double top guitar soundboard [right] under 100 W light bulb (WEB 37)

The most important advantage of the composite construction is its weight; it weights roughly 25% less than an equivalent traditional soundboards (Dunwell, 2008; Mueller, 2012). That means a greater ability to respond to the vibration of the strings (Dunwell & O'Brien, 2008; Mueller, 2012). Less internal friction is another reason that improves the volume and response (Reynolds, n.d.). Composite tops flex in a different way than traditional tops plates. It acts like the grain of the wood has disappeared, which in turn improves its response (Dunwell & O'Brien, 2008). However, this may also change the precise places of nodes, thus should result in a deviation in its timbral character. Double top soundboard construction does not oblige a particular bracing system (Mueller, 2012); some luthiers even choose to opt for no (Dunwell, 2008). As can be seen in *Figure 63* double top guitars produced with lattice bracing or fan struts exist, and it is a luthier's preference or experience that different combinations of hybrid bracing systems is a possibility. The 3rd photo from the left shows symmetrical fan braces of a rather traditionally strutted double top guitar, whereas the 4th photo is a double top guitar of David Pelter with lattice bracing. Figure 64 (1st and 2nd images from the left) shows the extra small layer in the periphery which is used to cover the layering of double (or triple) top guitars. The aim is to ensure a clean edge which does not reveal the layering.

Figure 63 Double top layers and strutting
(Image source [left to right]: (1) WEB 38, (2 & 3) WEB 39, (4) WEB 40)

The inner and outer skins are 0.6 mm each (Hill, n.d.; Reynolds, n.d.). They are glued to honeycomb whose wall thickness, material thickness and cell sizes vary, but most usual honeycombs have 1/4″, 1/8″ or 3/16″ (0.6, 0.3 and 0.47 mm respectively) cell diameter sizes (Dunwell, 2008; Reynolds, n.d.). The thickness of Nomex® can be modified with sanding down and usually around 0.8 to 1.2 mm, so that the total thickness of a double top soundboard is around 2.6 mm at the centre and 2 mm at the perimeter (Reynolds, n.d.).

Figure 64 Double top construction phrases (WEB 41)

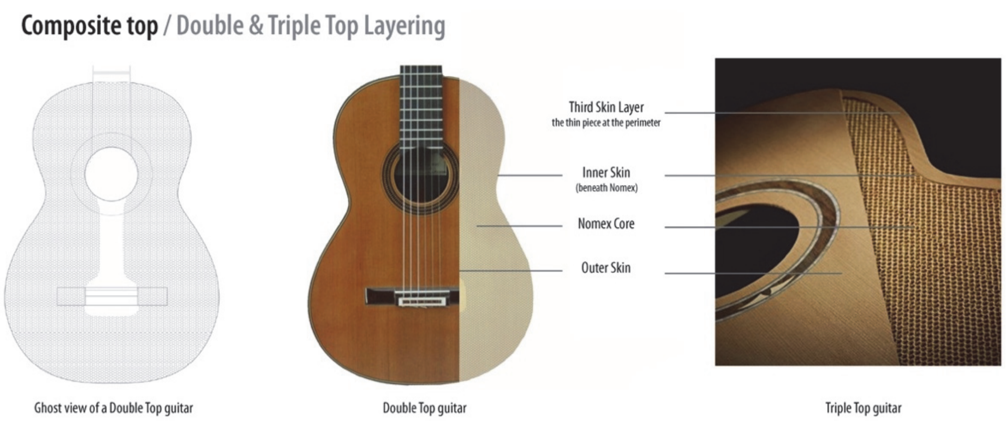

Figure 65 Double (Composite) Top –aka Triple Top- layers and Ghost View (Image Source: [Middle]: WEB 42 / [Right]: Ortega Nemesis Series Classical Guitar, WEB 43)

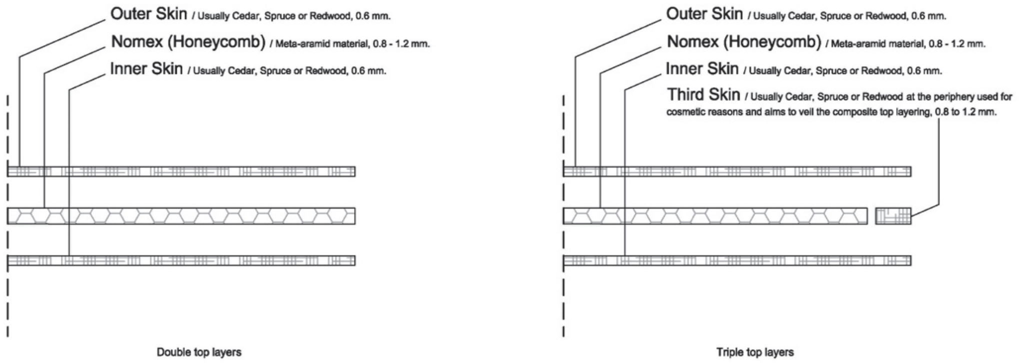

Figure 66 Double (Composite) Top –aka Triple Top- layering

As it has already been stated in this chapter that, apart from two major design novelties in the 20th century (the double top and lattice bracing developments) there are numerous design changes which are comparatively rather minor. In short, these developments encompass Manuel Contreras double-top. Different from the contemporary double-tops, these instruments do not incorporate advanced materials. The double-back design of José Ramirez can be another example. The resonator of Manuel Contreras and reverse bracing can be other examples of this type of design novelty. The common ground between these design alternatives is that these design implementations are exclusively invisible; that is these guitars look like straight guitars and these differences cannot be noticed (except the Resonator design) by listeners.

Figure 67 Examples of above mentioned luthiers from the famous Russell Cleveland Collection (courtesy of Guitar Salon International, WEB 44) José Ramírez made for Andrés Segovia, Hermann Hauser made for Julian Bream, Greg Smallman made for Benjamin Verdery

3.2. Contemporary Guitar Design and Boundaries of the Profession

There is enough evidence to believe that the musical instrument retail market is conservative by nature; performers are reluctant towards innovation and tend to stick with what is considered conventional. Nonetheless, relative to other concert or orchestral instruments, the Classical guitar might be an exception as there have been considerably more, in lutherie terms, novel ideas associated with Classical guitar manufacture. Some of these novel design implementations have caught on. Most recent developments in guitar design have shown that these makers utilise "*scientific data as their major source rather than any historical or intuitive preferences*" (Courtnall, 1993, p. 29) which causes them to discard some conventions at times in order to fulfil their ideals. This section gives an overview of these extraordinarily designed instruments in order to evaluate how much flexibility there is in the musical instrument market that can tolerate a potential design implementation through this PhD study.

Figure 68 Theo Scharpach the Concertura Double Soundhole [left] (Source: WEB 45) / Manuel Contreras Carlevaro model [centre and –ghost view– right] (Martinez, 2014a, pp. 12-13)

Classical guitar making traditions have supplied us with a sufficient amount of standardisation that we can recognise and conceive a universal Classical guitar form with reasonable certainty. This does not necessarily mean that the same exact form and size need to be shared among all guitars. Theo Scharpach, one of the leading exponents of contemporary Classical guitar manufacture, has successfully introduced his Concertura model in the 1980s (*Figure 68*). His guitars are considered among those highest ranked elite models and played by many virtuosi performers including Carlos Bonell, Enno Voorhorst, Ahmet Kanneci, Soner Egesel, and his steel strung and arch-top guitars are played by performers including Al Di Meola and Philippe Catherine. His approach is quite innovative and his production might be placed on the boundary of the traditions of making, as his guitars look so unusual that one would be unsure whether it is a Classical guitar or an arch-top or swing guitar. On the other hand, his instruments are still considered Classical guitars and find a place in Classical guitar performers' collections. Different from the infamous cutaway Classical guitars, his instruments seem to have a similar inner volume, as they feature semi-cutaway body-neck connection. They are well-known for their playability, and the semi cut-away form helps them without compromising the qualities which are expected from a classical guitar.

Manuel Contreras *Carlevaro* model was built by the famous Spanish luthier in 1983 for the famed performer Abel Carlevaro (1916-2001) based on the Uruguayan guitarist and pedagogue's own ideas. As can be seen in *Figure 68*, Carlevaro imagined a guitar without a conventional soundhole (to gain soundboard space), and the bass side of the body is straight rather than curved. In addition, the soundboard needed to vibrate separately and free from the back and sides. Contreras, to realise these criteria, suggested a complex system to unlink the top soundboard from the back and sides in 1983 (Martinez, 2014a). His design (floating top) has a separation around 10-15 mm from the sides (see Figure 69) which enables the top to float freely. This instrument, inspired by the grand piano concept, has a larger soundboard and a bigger hollow body, which gives the instrument a bass tone (Martin, 1998). In terms of tonal character, this model has the typical Contreras sound from its period, with a noticeably enhanced volume and projection (Morrish, 2002). Another deviation from the Contreras tone is a strengthening of the mid-range. Abel Carlovaro is known for his fresh ideas regarding the sitting position and posture. It is wise to suggested that this guitar was designed to meet the Uruguayan performer's sitting and posture criteria. However, this instrument is not given much recognition. Manuel Contreras manufactured a few Carlevaro models in the 1980s with slight changes such as modified bracing (Martinez, 2014a). After his death in 1994, his son Pablo Manuel Contreras (1957-2011) took over the Contreras legacy but this model was discontinued in the Contreras catalogue listings. Carlevaro model is a very rare model in the musical instrument market, mainly because very few of them were ever built.

Figure 69 Floating top, soundboard and sides wooden peg connections (Martinez, 2014a, p. 12)

The scalloped fingerboard is a very distinct looking fingerboard design mostly used by a few electric guitarists like John McLaughlin, Yngwie Malmsteen and Ritchie Blackmore. In contrast to its fame in the present day, scalloped fretboard have a long history expanding to ages before the invention of guitar (O'Dette & Carter, 2012). Some Eastern instrument like the Veena has long had scalloped fingerboards (Divekar & Tribhuwan, 2001). In European lute manufacture, there were examples of lutes with scalloped fingerboards (Usher, 1956) presumably with the Eastern music influence. However, Classical guitarists prefer to stay away from this development presumably because of the complications it would create due to a weakening in the neck structure (personal observation). Another reason why electric guitar players use it but classical guitarists not is that it facilitates bending at a certain level. That is, a performer can bend the strings by pushing perpendicularly down into the fingerboard, and not side-to-side as on a regular guitar. Yngwie

Malmsteen, a dedicated user of scalloped fingerboards, performs on this type of fingerboards due to its ability to make string bends easier.

Figure 70 A scalloped Fender Stratocaster electric guitar fretboard (WEB 46)

Figure 71 Smaro Gregoriadou, Scalloped guitar and the resonator underneath (WEB 47)

Smaro Gregoriadou is a very rare example of Classical guitar players who play on scalloped fingerboards. Apart from the scalloped fingerboard, she uses extraordinary tools (like the resonator guitar rest on her leg in *Figure 71*) and string tunings. Her unusual methods and instruments bring out a personal tone-colour to her performances. Her unusual tools and instruments include "r*ight-hand or back pedal mechanisms, scalloped fingerboards, and unconventional resonators, such as the multi-timbre rectangular guitar, the minimal guitar with carton or plastic resonators, and the air-pedal guitar*" (Gregoriadou, 2016). Her methodology finds its roots in her teacher Yorgos Kertsopoulos's approach (Kertsopoulos, 1994). This methodology, termed "*Kertsopoulos Aesthetics*", focuses on "*reviving/redesigning the historical forms and sound traditions of the instrument, while expanding the highly advanced guitar-building standards of today regarding modern repertory*" (Gregoriadou, 2016).

Figure 72 Two Microtonal guitars featuring movable frets, [left] Daniel Friedrich, 1976 (Martinez, 2013, p. 29) / [right] Walter Vogt 1988 (WEB 48)

The meantone (or microtonal) temperament has been quite popular for the last two decades, but in fact, was introduced in the 16th century in an attempt to offer perfect major thirds (Martinez, 2013). More recently, a few makers including the legendary French luthier Daniel Friedrich (1976, No. 437) and Walter Vogt (1988) constructed microtonal guitars with movable frets (see *Figure 72*). The inspiration behind these guitars featuring movable frets is creating instruments capable of achieving exactly correct frequencies across the whole fretboard.

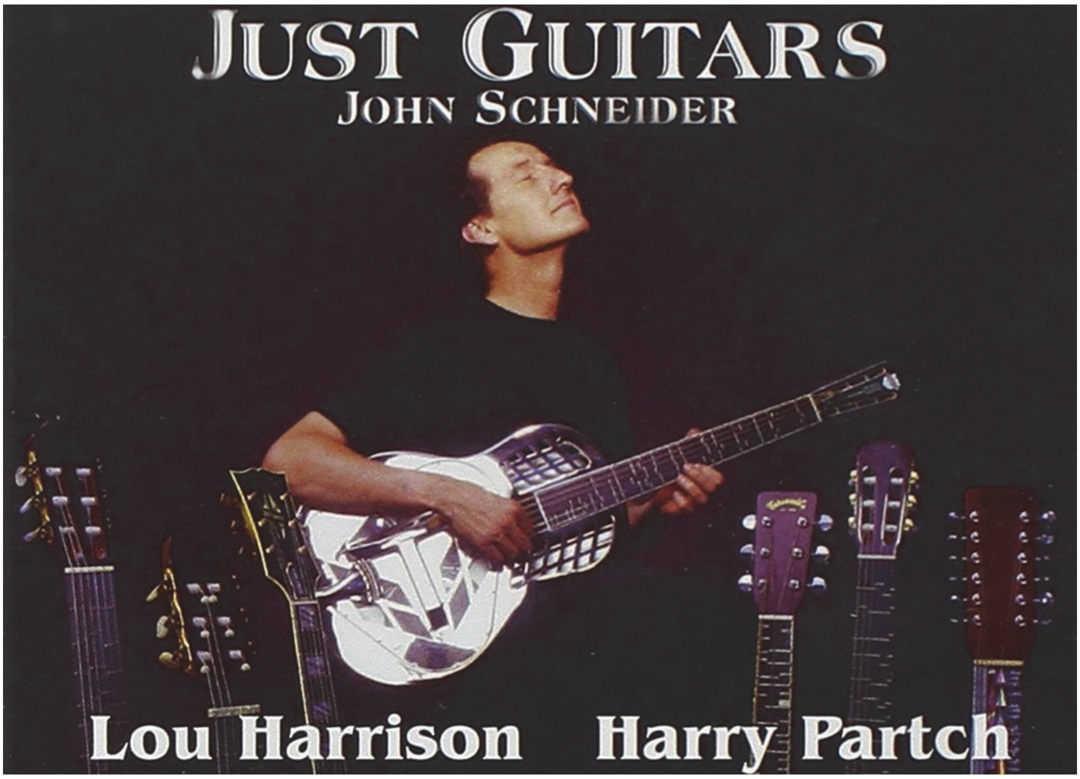

Figure 73 John Schneider album cover (Just Guitars, 2003) with his microtonal (or meantone) guitars, (WEB 49)

Some guitarists, notably John Schneider, perform on *just guitars*, microtonal guitars or guitars with movable fingerboards to be able to play microtonal music or for different kinds of tuning. Regular guitars feature equally tempered, or equally spaced, notes which sound out of tune to a number of musicians (personal observation). Schneider argues that a standard guitar's most intervals have been "*tweaked in such a way that notes can do double duty*" (Schneider & Collett, 2017). Friedrich made his 1976 microtonal guitar in order to be able to tune the guitar very precisely. It should be noted that Friedrich did not invent it, what he did was actually "*mimicking a tuning that harpsichordists used from the Renaissance until the time of Bach*" (Schneider & Collett, 2017). And lutes from the old days feature tightened up frets made of gut strings rather than hammered metal frets in order to be able to tweak them, sometimes in non-vertical (i.e. diagonal) directions. Manufacturing microtonal instruments, or the True Temperament fret systems (see Section 3.3), Schneider argues, is actually like "*coming back to something that we left back in the 18th century*" (Schneider & Collett, 2017).

Figure 74 Armrest design by Greg Smallman, guitar made in 2003 (WEB 50)

Besides major design implementations, numerous minor design features have been proposed to increase the physical comfort and the sound quality of Classical guitars. Australian makers, notably Greg Smallman, made the armrest a distinctive trade mark of Australian-made guitars as seen in *Figure 74*. The armrest has mainly three purposes: physical comfort, decreasing or preventing the top soundboard dampening by the right arm of the player (especially important when ultra-thin topped lattice guitars are concerned) and eliminating the potential damage caused by sweat of the arm on the top soundboard. Additionally, Rafał Turkowiak's innovative approach including a fairly-less obvious armrest, acoustic tubes placed in the neck, the wave resonator and his unique bridge should be mentioned (*Figure 75*).

Figure 75 Rafał Turkowiak armrest, acoustic tubes, drilled bridge and wave resonator (WEB 51)

The unconventional design of the Brahms guitar seen in *Figure 76* finds its roots in a collaborative work by David Jose Rubio and Paul Galbraith (Shaw, 2008; M. Woodhouse, n.d.). The famed luthier Jose Rubio is a maker who produces high quality lutes, harpsichords, violins, violas, cellos as well as Classical guitars for renowned performers including Julian Bream, Sergio and Odair Assad, Stéfano Grondona, Carlos Bonell and Jason Vieaux. The main motive for the Brahms guitar is to enhance the facilities of instrument to play Brahms compositions and facilitate a player's left hand stretch. Guitarists Paul Galbraith explains that the idea is rooting from his Brahms Variations Op. 21A guitar arrangements (Shaw, 2008). He was worried by a certain incompleteness in the bass section which caused enormous stretches. The innovative approach of Scottish virtuoso Paul Galbraith inspired Rubio to develop this concept (Shaw, 2008).

Figure 76 Brahms Guitar, David Jose Rubio (WEB 52)

What Brahms guitar offers beyond existing guitars with its additional bass strings is that Rubio and Galbraith added a treble string placed above the 1st string (high E) tuned to a high A –a fourth above the high E string (Galbraith, 1996). In short, Rubio and Galbraith added an extra bass and an extra treble strings. Although there had been guitars with additional bass strings, the additional treble string was quite novel by that time. The aim of the additional treble string was to balance the additional bass string as these two additional strings together would surround the traditional six strings (Galbraith, 1996). The design implementation utilizes a radically conceptualised radial fret system which seemingly requires a smaller stretch and offers high performability in difficult positions. The Brahms guitar is held upright like a cello and supported by a metal endpin. The instrument is mounted on a resonator box which increases its volume. David Rubio's design became successful in the sense that Galbraith has performed on this non-conventional looking instrument in an attempt to improve his chosen instrument's capabilities. It made a considerable amount of repertoire written for other instrument available to guitarists besides allowing guitarists to realise more complete and comfortable versions of Brahms transcription (Galbraith, 1996; Rubio, n.d.). Rubio took some inspiration from the Renaissance instruments Orphereon and Pandora for the staggered length of the strings (Rubio, n.d.). This instrument does not feature strings of uniform length; it has a slanting bridge and nut. Therefore, the string length increases from trebles to basses with fret intervals opening up in line with the strings lengths (see Figure 77). The varying string length was limited to the maximum angle to which the bridge could be inclined without stopping the soundboard from vibrating freely, and the maximum amount of fret fanning splay that could be managed by the guitarist. The 1st string has a vibrating length of 63 cm whereas this length goes up to 66 cm for the 8th string (Rubio, n.d.). These considerations have been important determinants to define the soundboard area, and thus, the final guitar shape.

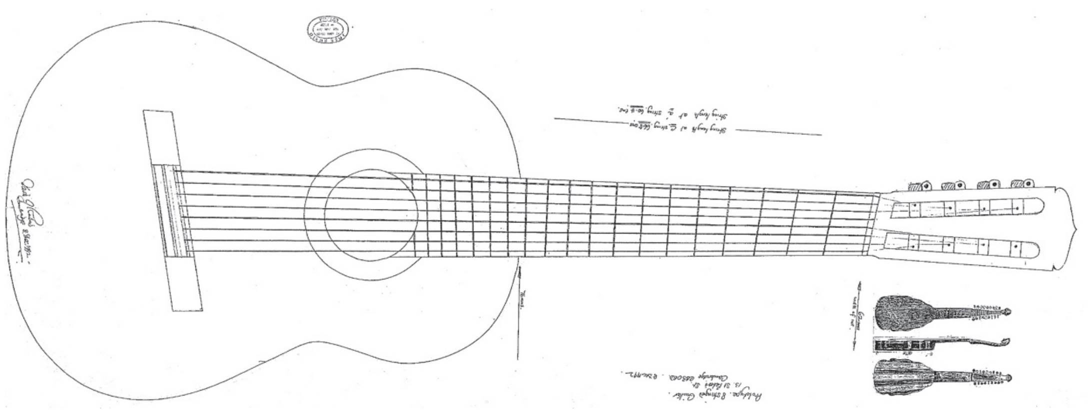

Figure 77 David Rubio, Brahms Guitar (Source: Galbraith, 1996)

Paul Galbraith thinks that some fine adjustments concerning the width of the strings and the overall width of the neck made the Brahms guitar feel very natural to play: "*the finished look and ergonomics of Rubio's guitar [is] totally integrated and somehow timelessly Classical*" (Galbraith, 1996). Although Galbraith, as a guitarist, finds this instrument very promising and has made a successful career on it, the Brahms guitar did not exceed beyond fairly small musical circles. There are luthiers still manufacturing the Brahms guitar, one of which is the British luthier Martin Woodhouse, but the production is very limited. Woodhouse, who had advice and instruction from Jose Rubio and inherited many of his tools and guitar wood, says that he has made around forty Brahms guitars since Jose Rubio's death in 2000 (M. Woodhouse, n.d.). That is, only a few players like Paul Galbraith and Joseph

Ehrenpreis, were not able to take the instrument into the mainstream. Furthermore, whether this instrument should be classified as a Classical guitar or not is still somewhat ambiguous; it is rather akin to the cello of the string instrument family. Therefore, it is an example in this PhD study, which exceeds the boundaries of guitar making traditions, and it should be learnt from this example that, accepted design changes in the Classical guitar are those that do not suggest obtrusive parts or features and those that appear like traditional instruments.

3.3. The Guitar Industry and Mass Manufactured Concert Guitars

Fine concert instruments are not expected to come from high-tech assembly lines of factories. The captivating charm and intimacy of luthier-made instruments make it such a pleasure that requires the "*skill of a single man*" which is precluded from factory guitars considering the "*sheer economics and mechanics of mass production and mass distribution*" (Sloane, 1976, p. 14). Since there are differences across tonewoods even between the same species grown in the same climate, the skill of a *single man* is required to treat varying wood densities, thicknesses and grain structures differently. A luthier aims to satisfy a delicate equilibrium amongst a plethora of variations and this requires a painstaking effort which cannot be fulfilled by machines. However, evident proliferation in computer controlled systems at the dawn of the 21st century has shown that computer controlled tools can assist luthiers which would yield their productivity and production quality. For instance, high-end concert guitars take many labour hours to build, and there are different figures as to how many guitars per year a master luthier can construct. In line with Greg Smallman's limited output per year already mentioned in this chapter, Hermann Hauser states to spend 240 labour hours for a guitar –which is roughly eight guitars a year– (Martinez, 2014b). Likewise, Daniel Friedrich produces 10-12 guitars annually (Martinez, 2013). Some American, Japanese and Chinese workshops identified the demand very well and they established their speciality in producing high quality instruments at a faster pace.

By the early 1970s, Martin[5] *had reached their limit of modernization, when their average production time per guitar dropped considerably below twenty man hours for the first time in their long history. It should be pointed out for comparison that the average guitar factory at that time required less than five man hours of production time per guitar in the west and less than two hours in Japan (Huber, 1994, p. 70).*

Three technological solutions can be given to exemplify how technology-based design can facilitate luthiers without compromising quality, and to clarify the technological input and industrial means of production to manufacture concert quality instruments. First of all, computer aided fret locations should be mentioned to understand why and how computers started to be used by some luthiers in the 1990s to calculate fret positions. Even though some luthiers consult computers for fret locations, many luthiers would disagree the correctness of computers due to the mathematically incalculable nature of fret positions. A more recent development is the True Temperament fret system which is a mass produced solution that significantly decreases the time spent for fine tuning the fretboard. True temperament is especially important as it is a design implementation aimed to increase playability and drop the manufacture time. Finally, a more complete and advanced system, the Plek Station, will be explained to understand how design and engineering can almost replace a master builder in some parts, if not the whole instrument. The Plek station can satisfy a higher precision than a master builder can ever do, as well as reducing the labour hours dramatically. Therefore, some famed luthiers get the Plek service for their instruments' setup and fretwork (Theo Scharpach, personal communication, January 21, 2016).

A master builder is expected to construct flawless instrument without the advantage of technology. Fret positions are conventionally defined by luthiers depending on two inputs. Firstly, (i) calculated measurement is based on the chromatic twelve note system which was settled by Johann Sebastian Bach (Lehman, 2005; Spitta, 1992).

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[5] *American guitar maker workshop C. F. Martin & Co. founded in 1833*

Depending on that, the fret placements are calculated and can be seen from fret distance tables (i.e. for 65 cm scale length the first fret should be 36.5 mm, second fret 70.7 mm etc. from the nut). However, there are still ways to improve concert Classical guitar construction methods even on a theoretical foundation level (Stenzel, 1997). Some concert guitars lack intonation, while some others may be improved by an optimised action height where good design can interfere to facilitate the painstaking hard work. Computer software which aim to do the calculation has long existed, probably since the 1990s. However, string amplitudes make it obligatory to compensate the extra length, and many luthiers do not trust computers in this task (Ejder Pamukçu, personal communication, June 10, 2014; Hermann Hauser, personal communication, July 22, 2015). Therefore, as a second input (ii) luthiers consult their hearing ability to compensate string amplitudes. Since different action heights will require different compensations, luthiers make, listen, judge and change fret positions, and through years they create their own locations. As an example, Hermann Hauser guitar string lengths are 64.8 cm for the first string and 64.9 cm for the second string, instead of the standard 65 cm (Hermann Hauser, personal communication, July 22, 2015). Despite a handful of curious new developments using advanced materials or conventional methods in guitar lutherie, the fretboard has interestingly remained unchanged. Hardly any development has been proposed except some computer software which help calculate fret positions although there are many signs that guitarists and luthiers have encountered intonation problems. This problem is evident in direct dealings with luthiers and players as well as the literature (Bartolini & Bartolini, 1982; Byers, 1995; Gilbert, 1984). Stenzel writes in irony:

> *"Only a few years ago, I have advised customers who complained about the bad intonation of their (in conventional terms correctly adjusted) guitar to switch to playing the violin. What a sad conclusion for a guitar maker." (Stenzel, 1997, p. 1)*

Conventional fretboard construction is based on dividing the scale length into fret intervals. A highly skilled master builder is able to (up to a certain point) take into consideration the tension increase when a string is pressed down on a fret. The only available tool to tamper is the string length by moving the bridge or manipulating the saddle bone for compensation as seen in *Figure 78*.

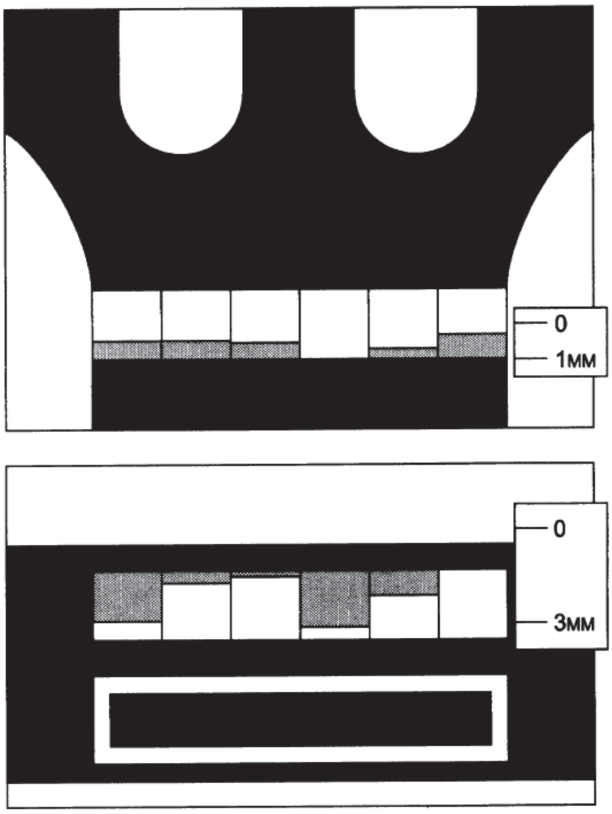


Figure 78 Nut (upper image) and bridge saddle (below image) compensation shown diagrammatically and exaggerated for clarity (Byers, 1995, p. 10)

Unfortunately, this is not an adequate measure for correcting all of the fret across the neck: "*the conventional method of compensation ensures a sufficient exactness at the top of the fingerboard and around the twelfth fret, but does not constitute the entire solution to the compensation problem*" (Stenzel, 1997, p. 2). In order to really solve this problem, each fret position should be calculated individually depending on factors (i) individual fret-string distance, (ii) material and (iii) thickness of the string. Ernst Frisch dedicated a research study on the above mentioned problems to improve guitar intonation as well as other fretted string instruments (Stenzel, 1997). The renowned Classical guitar luthier Sebastian Stenzel worked with Frisch to verify his proposal and obtained the right of using his method on a number of his guitars he built since the 1990s. Frisch decided not to publish his dissertation, and today, we know about his study through Stenzel. They presented this method together in a workshop in Germany.

Frisch developed computer software to determine a string-specific parameter which defines fret location corrections based on all of the related variables such as scale length, action height, string thickness and material: these variables are entered in the software to understand the specific behaviour of each string individually. Eventually, the software calculates "*the corrected fret positions, the required compensation at the bridge, and finally a complete height profile of the finger-board*" (Stenzel, 1997, p. 3). This method offers a special advantage to correct the fingerboard based on selected string sets and different player techniques. That is, the software is capable of considering the individual technical aspects of a particular performer and define the corrected fret positions accordingly.

Figure 79 True Temperament fretting system, [upper photo] electric guitar (WEB 53) / [lower photo] steel strung acoustic guitar (WEB 54)

A very unique design alternative, the True Temperament fretting system, incorporates a radically organised fretboard which makes use of non-linear metal frets. The claim is that the *true temperament* can precisely tune a guitar across all registers along the whole neck. Anders Thidell, the designer of this fretting alternative, calculated all placements for all of the strings and the results pointed to non-linear fret forms as seen in *Figure 79* whereas the standard chromatic twelve note system traditionally uses a divisor constant to determine fret locations which is known as the *rule of 18*. The string length divided by the constant –17.817152 is equal to the 12th root of 2 (Thidell, 2013)– gives the first fret position. Later the first fret length is subtracted and the remaining is divided by the same constant which gives the second fret position. Remaining frets are calculated using the same method. This mathematical model is considered ill-defined and "*oversimplified*" by numerous luthiers and musicians (True Temperament, n.d.); "*It ignores virtually every physical parameter which governs the behaviour of vibrating strings, except one – speaking length. Tension and mass are not even considered*" (True Temperament, n.d.). In this model, different strings are considered the same and perfect, therefore, thickness, action height and tension differences are ignored. String diameters vary considerably depending on materials and construction type (i.e. steel-wound, nylon, carbon etc.). Therefore, their responses differ in numerous ways when fretted. When a string is pressed down on a fret, the string length and tension change; and this change varies across the neck. The change of length (because the string is stretched when pressed on a fret) increases the tension, thus increasing the frequency which sharpens the produced note. High-end guitar fretboards are tweaked by master luthiers who work in millimetre precision to compensate different string amplitudes. But, the fretwork takes long hours per instrument, and industrially manufactured factory guitars cannot get this process. Keeping in consideration that professional luthiers often mention 16 to 20 hours (roughly two days) for the fretwork only, whereas entire high-end factory guitars are made in fewer than 20 hours (Huber, 1994), the guitar industry had a demand to find ways to facilitate the fretwork using high-tech machinery and decrease the skilled craftsperson skill that undergo the fretwork.

The designer of the True Temperament fret system and some electric guitar star virtuosi claim that the guitars with a regular fretboard can never be tuned properly no matter how great the crafting skill of the maker is (Thidell, 2013; Vai, 2008). A regular guitar correctly tuned either to open strings or to the 5^{th} or 7^{th} frets can only be in tune in the chord it was tuned for. In other words, when a guitar is tuned to a particular chord, and another chord is played, it will usually be slightly out of tune. "*It is just the nature of the way notes work, and their overtones*" (Vai, 2008). That is, one should not expect to play two different chords and hear them in tune for both chords. Thanks to the True Temperament, "*for the first time in history*" a guitar can be truly tuned (Eklundh, 2014). Some electric guitar virtuosi claim that now we can really do it on a True Temperament guitar "*specifically because these people who engineered the difference between the distance of the notes on the guitar ... [i]n order for the guitar to be in tune for all of these chords… And it really works. I am shocked*" (Vai, 2008). The manufacturer claims that "*[t]he only way to fully compensate for all these parameters [i.e. action height, string amplitudes] is to adjust each and every string-to-fret contact point on the fingerboard separately, until each and every note plays the target frequency exactly*" (True Temperament, n.d.).

True Temperament frets are cast to be produced in bulk and do not require a craftsperson to dedicate days to manufacture these frets, therefore it is considered an industrial design solution to the problem. These frets are precision cast in nickel-free silicon bronze for low friction and corrosion resistance (True Temperament, n.d.).

The third method which is visually akin to traditional construction methods is the Plek Station. High-end guitars of some renowned luthiers, i.e. Theo Scharpach, is inspected and perfected using the Plek station. Although it is not new that fret positions are calculated by computers, the Plek Station is beyond a computer, it is a fully automated station that inspects and cuts fingerboards and frets.

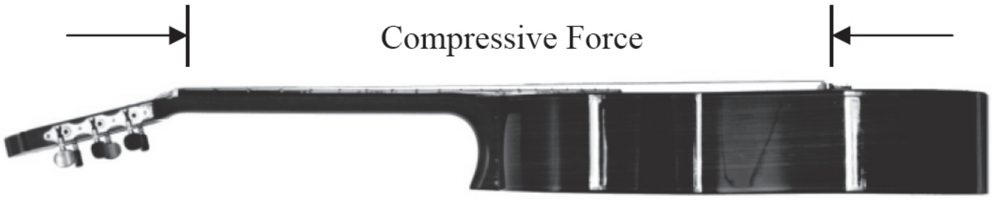


Figure 80 String tension and its compressive force (R. M. French, 2009, p. 43)

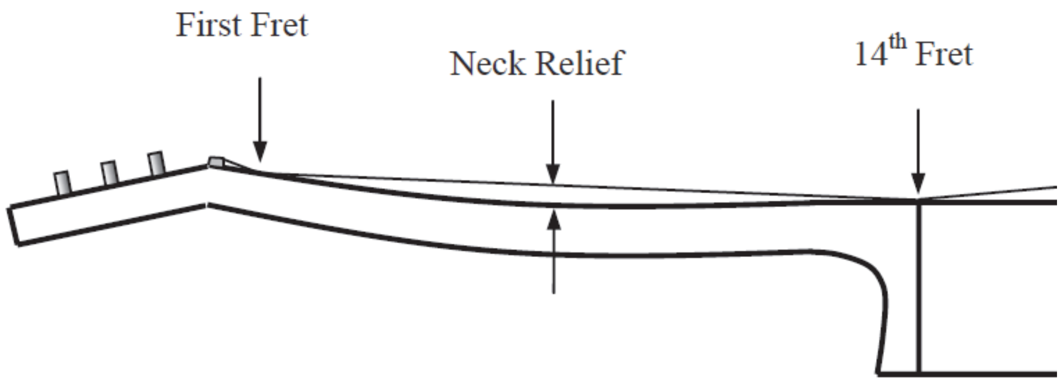


Figure 81 Neck relief –or the C shape– intended to decrease the string buzz: see Section 5.3.1 for the Fret Buzz Removal design (R. M. French, 2009, p. 52)

Different playing styles and techniques of players, as well as approaches to the string, are accepted as a challenge that needs to be met when finishing the string setup. The string tension creates a compressive force (R. M. French, 2009) as seen in *Figure 80*, and different performers, due to having different attack styles, all move the string differently. One common problem that players encounter is the localised buzzing. The parts of the string that have larger oscillations will eventually tend to rattle on some frets depending on their heights. Traditionally, luthiers attempt to resolve it by levelling higher fret tops and then putting a relief or a curvature (see Figure 81) –often termed C shape– on the neck so that they would not buzz on a particular fret, which is higher comparatively.

The main reason why conventional neck relief and the neck-body connection angle do not stop string buzzes is the natural oscillation of the string that we are able to understand only via slow-motion high resolution cameras. The C shaped neck would technically allow the string to make the largest movement in the centre and the smallest at the edges. An important problem is the nature of string vibrations: in fact, the string doesn't move like that (Hoover, 2014). Plek Open String Box (Figure 82) incorporates a strobe blinder which has shown that:

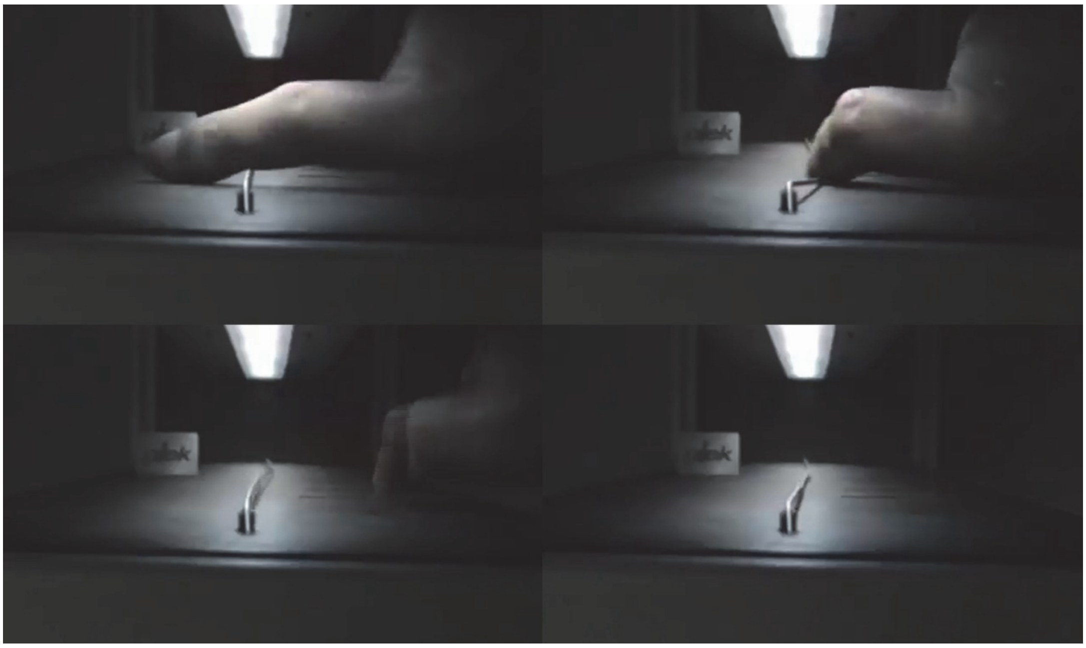


Figure 82 Plek Open String Box, strobe blinder (Hoover, 2014)

> *"[The string] does not move the most in the middle. In fact, when you plucked a string with your right hand, it sends a bundle of energy up towards the nut. And that bundle of energy is moving the most as it approaches the end of the fingerboard, not the centre. So right above the soundhole to the body of the guitar, where the neck joins the body is the most movement, and this is the place where you need the most room between the string and the top of the fret." (Hoover, 2014).*

Figure 83 Plek station view of what Ski Slope or Rock and Roll Fret Work looks like

The description proposes that a properly finished fingerboard should actually look like what a player would not want to have. This fingerboard form was termed *ski slope* by Richard Hoover (Hoover, 2014). In other words, a nice action height requires a fingerboard to encompass a C shape curvature from the nut towards the 14th fret which drops thereafter (Figure 83). However, since the measurements of the bump and curvature are small, the neck still looks straight. Steve Klein developed a concept to solve this problem which he called *rock and roll fret job* where he tried to get the strings as low as possible without any buzzing. His concept is noteworthy because he realised this process by hand before precision machinery and CNC's (Hoover, 2014). The Plek station (*Figure 84*) came into existence as an aid for luthiers to make this painstaking fretwork easier.

> *"Plek is many things to many different people. We like to think of it as a question: 'What makes for the best possible playability in a guitar?' which we have turned into a machine." (Plek Brochure, 2016)*

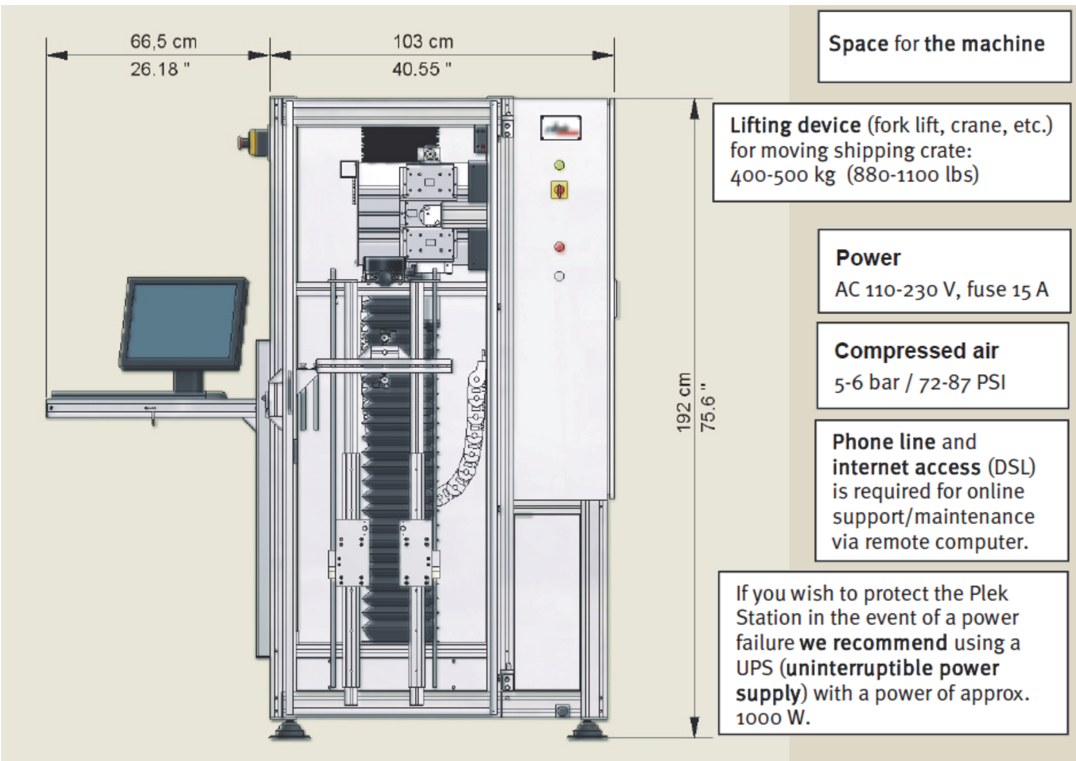


Figure 84 Plek Station parts (Plek Manual, 2016, p. 7)

The fretwork is known to be one of the most difficult parts of guitar making, requiring very advanced luthier skills. The brand claims to have transformed "*the craft of guitar and bass setup into a 21st century cutting edge precision technology process*" (Plek Brochure, 2016). According to the company catalogue, the station operator can be trained in two or three days. The Plek company still wishes to keep the quality of a master builder's touch, but aiding his job: "*What has been done only based on artisan knowledge and experience over centuries can now be achieved with an accuracy and correctness unfeasible ever before without losing the human touch*" (Plek Catalog, 2013). The Plek machine is a manifestation of craftsperson skill and it is a noteworthy example of a mechanised approach to manufacturing concert grade instruments. The Plek machine, produced by A+D Gitarrentechnologie GmBH in Berlin, was invented by a guitarist-engineer Gerd Anke, who over the years found many problems with guitar setups (Cesaroni, 2010). Anke founded the company Plek (previously Plektron until 1993) with Michael Dubach in 1990. It is basically a computer attached to a couple of cutting devices (i.e. a computer numerically controlled - CNC - machining station), and can create very precise fretwork. This computer controlled device basically works with three tools, as seen in Figure 85 to work guitars under simulated conditions: (i) scanning module (sensor finger), (ii) fret cutter head and (iii) high frequency spindle. The scanning sensor (instrument diagnosis) acquires all the data related to the neck by touching the frets, fretboard and strings (apart from the wood and metal parts, it also strikes the strings from which the name is derived, "plek" from *plectrum*).

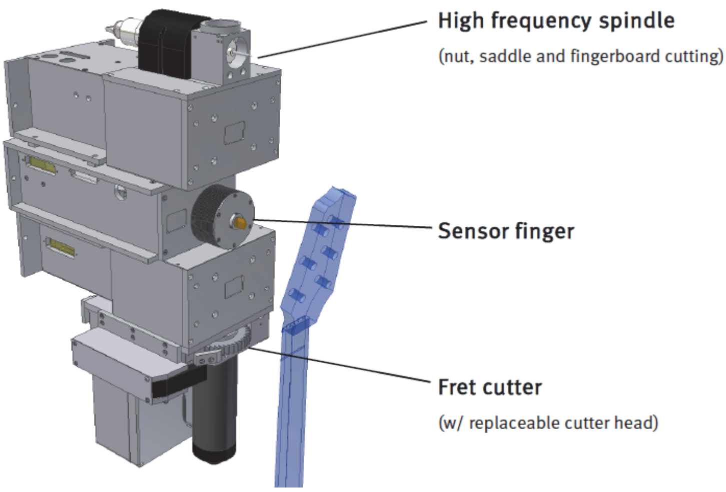


Figure 85 The Plek station modules (Plek Manual, 2016, p. 2)

The first part of the process is the instrument diagnosis in which the Plek sensor finger goes through and registers the locations of all the frets as well as their height and radius. Combined with a high-resolution magnetic linear encoder, this sensor is capable of measuring all the relevant parameters of a guitar's playability: action height, fretboard relief, fretboard contour, fret height, fret spacing and nut details. In short, the scanning process maps the physical fretboard into a 3D digital model as seen in *Figure 86*. The scanning phase creates graphic images with extensive dimensional data of the above mentioned parameters. The scanning module makes it possible to view and choose various aspects of the neck and frets.

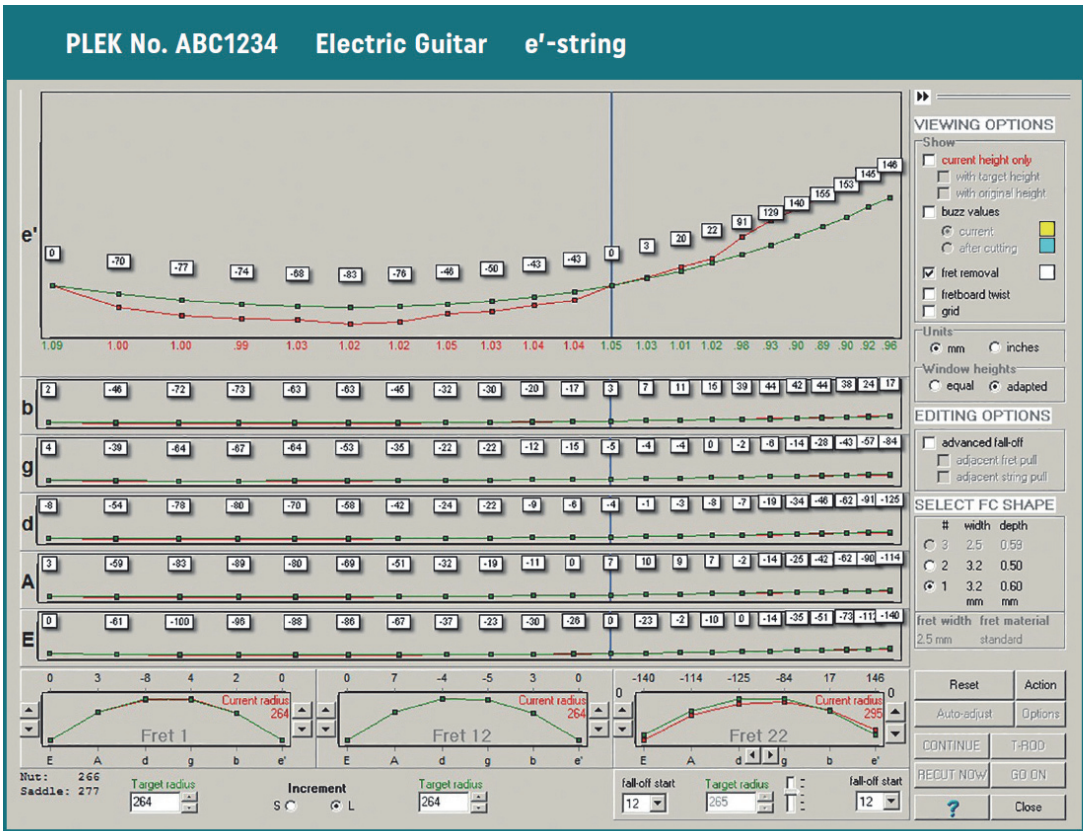


Figure 86 Plek scan results [from top to down] 1st to 6th strings-fret geometry (Plek Brochure, 2017, p. 9)

The Plek station can scan an instrument with and without string tension, and then level the frets based on the change. The first scanning process is realised under string tension, therefore the guitar is strung (or the string simulator is used) and tuned to pitch, so that any bending or relief in the fingerboard caused by the tension will be identified by the sensor. After the initial scan, the second scan is carried out in the absence of string tension. By doing that, the computer measures the differences in the fingerboard geometry and thus fret top positions caused by the tension difference. The Plek station uses this intelligence to determine the string tension exertion, even when the guitar is not strung up anymore; therefore, it is no matter whether the instrument is strung up or not (Grom, 2010). This is the strong side of the Plek station; fret cutting would be impossible to carry out on a stringed guitar. This determination makes it technologically possible.

Figure 87 Plek rotary cutter (Hoover, 2014)

After the neck geometry is scanned and modelled by the computer, the operator –or luthier– makes the required changes depending on the existing 3D neck model in order to get the desired neck form and action height. In other words, there is still room for the skill and knowledge of a master luthier. After the luthier puts their final touches –by manipulating the 3D model using basic point-vertex relationships– the Plek machine starts cutting the luthier's intended fret form and height. After a fine sanding, the guitar is placed in the Plek station for a post-scan under simulated string tension (or externally using the STS device: exterior string tension simulation device as seen in Figure 88), to be sure that the calculation of the neck exertion was correctly estimated. If the luthier wants to change the radius of frets, a specially manufactured carbide cutting wheel is used. It is a rotary cutter (Figure 87) with concave teeth to give the desired radius to frets. The Plek station can also change the fret radius along the neck at three different frets and can give radiuses of various diameters. Finally, the instrument has the perfect geometry on the neck and all the geometry of saddle and nut as well as their depth is done precisely. The saddle and nut slots are cut by a high-frequency motor spindle (HFS). The Plek station can also correct the intonation between individual frets by re-shaping the fret tops.

Figure 88 50 kg applied force using exterior STS (String Tension Simulator) Hoover, 2014

The utmost benefit of using the Plek station over doing precise luthier tasks by hand is the machine's accuracy: the Plek station can cut to a 100th of a millimetre and scans to a 1000th of a millimetre[6] (Chandler, 2016; Plek Brochure, 2016). The machine makes it possible to look at a guitar fingerboard and frets "*in microscopic detail*" (Plek Brochure, 2016, p. 5) even a human hair can be detected by its scanner (see Figure 89). Although the original goal of the Plek is to eliminate fret buzzes, there are many luthiers and players who believe that Plekked instruments actually sound better since the whole neck is precisely calculated to have the optimum form, and thus, the player has a better note-to-noise ratio (Gibson USA, 2009). The company claims that their way of working is in line with traditions: "*We respect tradition… [w]e also understand musicians because most of us are musicians ourselves*" (Plek Catalog, 2013, p. 2). However, the Plek Station, just like any technological *improvement* in lutherie, is often encountered with inertia from luthiers. Joe Glaser, one of the first adapters of the station, accepts being sceptical about it at the beginning (J. Glaser, 2016). He says that he was a "*technology denier*"

[6] *Scanner sensor finger accuracy +/- 0.005 mm, fret cutting accuracy +/- 0,01 mm, nut & saddle cutting accuracy +/- 0.05 mm (Plek Brochure, 2016, p. 18)*

but upon witnessing the first scan results, he realised that it was a "*critical way of seeing what is really going on with the instruments*" (J. Glaser, 2016).

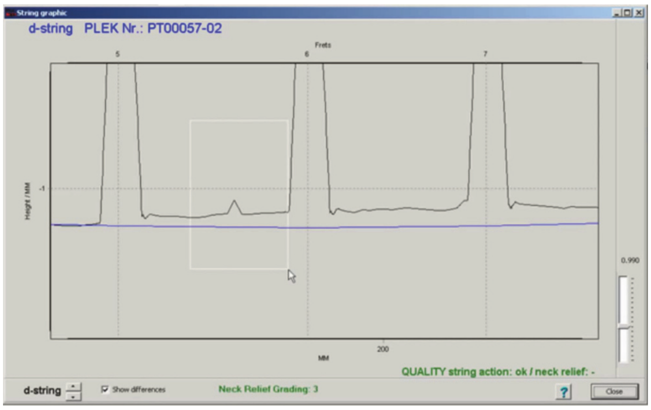


Figure 89 Human hair (constrained by the white rectangle) taped onto the fingerboard detected by the Plek scanner (Anke & Glaser, 2011)

Although the Plek station was a fret cutting tool only in the 1990s, being through a dynamic and fruitful design and R&D work by luthiers and developers, it has evolved into a much smarter tool. Currently, it is accepted as a different way of understanding and improving instruments at a much faster speed. Time consuming and skill dependent luthier jobs can be carried out in jufst a few minutes. Figure 90 shows the workflow of different stages of the Plek station. It should be noted that the whole process takes 19 minutes, 45 seconds including scans and nut cutting, whereas it usually takes roughly two days by hand (Andrés Marvi, personal communication, August 8, 2014; Theo Scharpach, personal communication, January 21, 2016). Coming from a traditional background, its designers have made it an evolutionary tool, or rather "*an information source and a knowledge base and it has been a great revolution*" (J. Glaser, 2016) that is used by some of the highest grade contemporary guitar maker workshops including Martin, Gibson, Fender and Takamine.

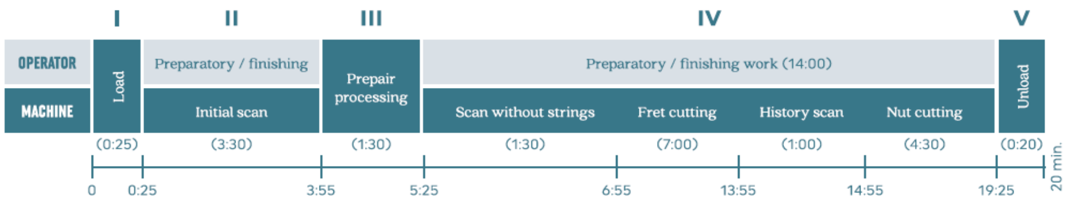


Figure 90 Plek station workflow (Plek Brochure, 2017, p. 14)

CHAPTER 4

ANALYSIS AND RESULTS OF PERFORMABILITY

Classical guitar lutherie showed great achievements and came a long way in the 20th century. Whilst many refinements have been accomplished, some grey areas still remain in guitar lutherie. The grey areas occur in realms where tacit knowing is a principal part of one's expertise. Uncovering "*secrets*" of such tacit knowing should happen in uncanny fields of implicitly grasped knowledge developed among various professions such as composition, performance and lutherie. Direct dealings with them throughout interviews have shown that some professionals prefer to take this instrument for granted and do not wish to improve it. Furthermore, some would be discouraged by the idea of trying to push the limits of the Classical guitar to another step. This chapter brings together answers to the questions "*what are the constraints of the guitar*", "*how can a musical instrument facilitate performers*" and "*what is the possible input of industrial design in this experience*". The chapter intends to deconstruct, compare and contrast the nature of performability from the perspective of many different professionals. The aim is to elaborate a qualitative analysis of the concept of "*performability*" by examining its characteristics from perspectives of a wide range of stakeholders in musical composition, performance and lutherie. It seeks to understand the playability and performability concepts; find differences, similarities and common points, and eventually aims to characterise the relationship between product design and performability for the first time. In other words, the intent is to understand and theorise the user (performer) and product (concert guitar) interaction, that becomes the manifestation of virtuosity through playing, and to unravel the dimensions of performability.

The art of crafting Classical guitars often includes a great deal of tacit knowledge. Like many artists, musicians and composers, as well as luthiers, tend to communicate important concepts using somewhat obscure vocabulary, abstract terminology, metaphors and subtle semantics. Therefore, the body of knowledge associated with lutherie can be obtained only from experts. Hence, a series of interviews was realised with luthiers, performers and composers to bring insight to elevate the performability and raise product qualities of musical instruments in general, and the classical guitar in particular. Interviews were not merely based around talk. Instead, interviews were generally realised in their *native* environments, which might be an atelier for luthiers, a practice room for performers or a studio or office for composers. Interviewees were also asked to *show, play* or *make* using their tools, be it an instrument, piece of paper or wood. However, five participants needed to be interviewed out of their normal context due to practical reasons. Content of interview questions and the questioning style were determined by key concepts that emerged from the literature review. Questions and points covered in the interviews seem, argumentatively, to relate to phenomena which fall into an intersection of Classical guitar lutherie and product design.

Interviews were realised in three subgroups chronologically with luthiers, performers and composers -with only a few exceptions due to practical and logistic necessities. The reasons to do an interview within another subgroup were none other than time allocations and geographic location of a particular participant. Apart from these few exceptions, interviews were held discretely and separately in clusters in order to see the unique comprehension of each group towards the subject matter of this thesis study. Interviews and findings from completed interviews were a *journey* in which the acquired experience from a completed interview helped to re-imagine the oncoming interviews, and re-learn and re-shape the following interviews. As the interview sessions continued and findings from the following interviews flowed, the understanding of the research was fine-tuned. Concepts became clearer during the journey, especially design for playability, virtuosity and "*performability*". During the course of the interviews the "*performability*" concept was coined and termed. New sub-terms complementing virtuosity also emerged from the interview series such as *heightened state of performance*, *high level of performance*, *technical mastery* or *superiority in musical performance and expression*. In short, the interview stage of the research was shaped through this *journey*. In addition, since some luthiers and performers stated opposing and controversial views on contemporary instruments, a number of questions emerged to understand their sensitivity about this deviation. Chronologically, instrument makers are followed by those who play, and then who write for it. However, there was some flexibility as to where the study would go. Content analysis of interview sessions one-after-the-other defined the route of the coming stages. For instance, the left hand overuse of muscular torque on the fretboard was asked after the initial interviews, since its importance was not clear prior to the initial interviews. Please see Appendix H for coding and clustering across participant groups from different phases of the study to have a *visualisation* the 'journey'.

Music critics and students were initially considered as separate interview groups. A number of critics were approached for their thoughts on the research project; however, they were not convinced that they would be of help concerning the subject matter. They are observers of the live experience of playing, as well as recorded material, and they make performance evaluations of musicians. At first, it was thought that they could detect the relation between a musician and an instrument. However, they are not well-informed about the product qualities of concert instruments. In this sense, they are result-oriented and are expected to evaluate and critic the final product, which fundamentally relies on creative and performative qualities of individuals. In short, musical instrument product qualities do not take part in the centre of attraction for them. Eventually, after a few music critics approached for interview, this group was excluded from the interview series. Classical guitar students, another initially intended interview sub-group, were also excluded from the interviews due to their lack of experience in high-end concert instruments, and consulted to try the left thumb pressure tool (see Section 5.2.1. Left-thumb Tool).

Participants were expected to talk about their personal experiences and opinions, and put forward their first-hand ideas. In the analysis of transcripts, redundancy of occurrences of a concept, theme or argument by a particular participant is allowed to be counted only once per participant. In other words, when one participant mentioned the same point multiple times, the repeated occurrences were discarded due to the fact that they have mentioned it multiple times and this would unreasonably increase particular themes and concepts. In most cases, different stakeholders talked first-hand about their experiences. At times, they talked as a representative of their group and this was allowed in the coding process; meaning, these ideas were given codes and sub-codes and counted. There were rare instances of them talking on behalf of other groups (e.g. composers 'putting themselves in the shoes' of luthiers). Such instances were not assigned codes or sub-codes during the coding process, because the main goal of the study was acquiring their own experiences or their group's view on the subject matter directly.

Interviewed luthiers were selected from the top makers of traditional and/or non-conventional Classical guitars. Some of the participants make contemporary guitars such as double tops or lattice braced guitars, and some of them manufacture within traditional conventions. These makers are luthiers whose instruments are used by internationally famed concert performers. The Spanish city of Granada was very convenient due to its surprisingly high concentration of master guitar builders - probably the highest around the world (personal observation)- in contrast to its small physical size. High calibre classical guitar virtuosi, concert performers and educators were selected for interview to generate a variety in responses for performer interviews. Another criterion was their chosen instrument; the variety in participants' concert instruments covers a wide range from contemporary instruments to traditional guitars. Interviewed composers are either guitarist composer, or orchestral composers writing for orchestra and classical orchestral instruments, as well as the classical guitar, because it is believed that these multi-facetted orchestral composers and guitarist-composers will bring a wide spectrum of answers to the study. In addition, some of the composer participants can be described as "*new music*" composers and have a contemporary approach to sound and timbre. From this point forward, interviewed participants will be referred to by abbreviations made with their name and surname initials[7]. All participants and their stylistic approaches are described in the Appendix section.

The interviews were semi-structured, because this interview type, as opposed to structured interviews, gives an opportunity to hear the ideas of respondents at a lengthy amount of time with their own words. Semi-structured interviews allow each participant to communicate their style using sometimes different words for similar concepts and aims to deal with the subject in its entirety. Interviews were not realised on a fixed questions-answers basis. The semi-structure would rather draw a general framework in order to shape the basic outlines of the work. In addition, they are supposed to leave a margin for unexpected points. On the other hand, semi-structured interviews do not let the detail nuances to disappear.

Interviews (except Paulino Bernabé) were filmed and/or recorded with permission of the interviewees. Six interviews were conducted in Spanish. The interviews in Spanish language were translated to English by a native Spanish speaker, Laura Díaz Montes. During the interviews in Spanish, the answers of respondents were translated to a basic level of refinement in English, to facilitate immediate understanding for the researcher. The full translation was carried out after the interview was over. The translator contributed to these interviews' data analysis phase, as well and aided the coding process by elaborating word-games and double meanings of participants. Respondents (except Daniel López) were given a guideline on the interview topics (see Appendix E, F and G) 2 to 7 days ahead of the meeting, so that they could have an idea about the subject matters. Daniel López could not be given the information before the interview, due to university policies of Rodolfo Halffter Conservatory (Conservatorio Profesional de Música Rodolfo Halffter). His contact address was not available to us and our meeting was fixed by the university

[7] *AE: Ana Espinosa Rodríguez, AK: Ahmet Kanneci, AM: Andrés Marvi, CD: Carlo Domeniconi, CL: Casimiro Lozano, CS: Ceyhun Şaklar, DL: Daniel López, EB: Ender Bilge, EBa: Ertuğrul Bayraktar, EP: Ejder Pamukçu, EK: Ertuğ Korkmaz, FK: Füsun Köksal, HH: Hermann Hauser, HM: Heike Matthiesen, IR: Ignacio Rodes, JM: Jose María Gallardo, KK: Kağan Korad, KT: Kürşad Terci, MD: Marcos Díaz, OH: Oscar Herrero, OT: Onur Türkmen, PB: Paulino Bernabé, SE: Soner Egesel, TE: Turgay Erdener, TS: Theo Scharpach*

secretary. No response was necessary from the interview participants, therefore, none gave a feedback whether they read or did not read. However, during the interviews, it was clear from their answers that participants had indeed read, incubated and even found resources about the points mentioned in the interview guide. The interview recordings and videos of the twenty-five participants were transcribed into a 115-page manuscript (see Appendix D).

4.1. Analysis Methods

The manuscript was analysed with qualitative data analysis methods using Atlas.ti software. Atlas.ti software, like other qualitative data analysis software of the same kind, depends on the principles of Grounded Theory and utilises *groundedness* and *density* concepts. The theory introduced a systematic methodology by conceptualising data bits as codes (B. S. Glaser & Strauss, 1971). In the content analysis, ideas and themes are linked or related in an argumentative manner. In the interview manuscript, according to the intentions of answers and comments, sentences, phrases, words –and sometimes gestures– were assigned *codes*; and then *code families* were created from related codes. The codes are usually keywords which summarise a participant's views and ideas, in other words, the mental key structure of an interview. For instance, the *Tension* was related with (1) *Bracing System and Material*, (2) *Neck Material and Thickness*, (3) *Soundboard and String Relation*, (4) *The Feel of Hard or Soft*, (5) *Top Tension* and (6) *Top Thickness*. These six codes were collected under the code family '*Tension'*. Similar codes and code families were brought together within multiple options for connectives – such as "*is associated with*", "*is part of*", "*cause of*", "*contradicts*" and "*is property of*", therby creating associations and links across codes and/or code families. The structure of the code families, codes and links among them, depict the structure of the interview outcomes and shows the hierarchy between important and less important themes and concepts related with performability, playability and virtuosity.

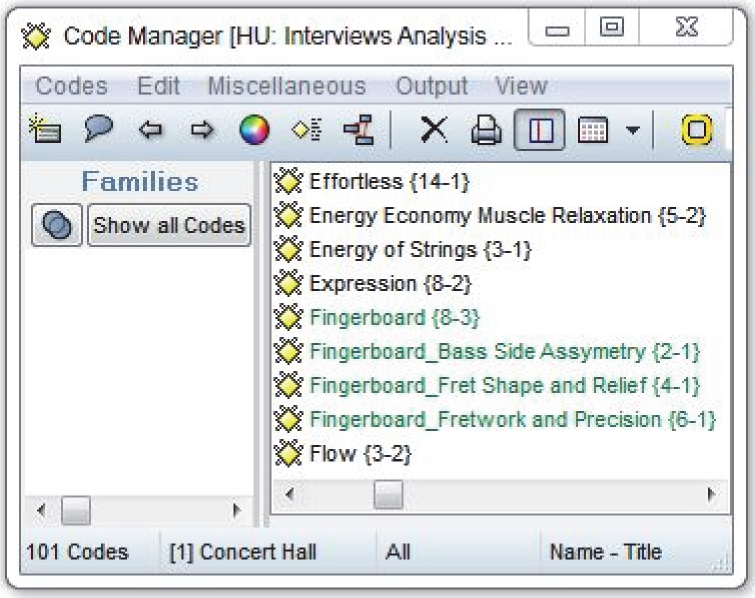


Figure 91 Atlas.ti Code Manager Window

Figure 91 shows the Atlas.ti software Code Manager with codes and code families. Five single codes (Effortless, Energy Economy Muscle Relaxation, Energy of Strings, Expression and Flow), one code family in green colour (Fingerboard), and its sub-codes in green colour (Bass Side Asymmetry, Fret Shape and Relief, Fretwork and Precision) can be seen in the Code Manager. Numbers in brackets show the *groundedness* and *density* respectively. For instance, *Fingerboard (8-3)* means that this concept's groundedness is equal to 8, and its density is 3. Groundedness is the number of quotations where the term *Fingerboard* is mentioned. In other words, eight participants directly mentioned this concept. Density stands for the linkages among codes and code families. In this example it means that participants mentioned about three concepts concerning the Fingerboard –which are (1) Bass Side Asymmetry, (2) Fret Shape and Relief and (3) Fretwork and Precision. In short, the groundedness of a concept shows the frequency of a term mentioned in the interviews whereas the density shows how many connections were made across codes in a family or among other codes. An excerpt from the interview with Theo Scharpach and the deconstruction of the passage is given below as an example:

"Every string has a different vibration. So the first string has a completely different vibration as the sixth string. Then the neck has a curve to follow the vibration of the string. It is a very complex way to do it. Fingerboard work takes 2 days. I make very slightly rounded fingerboards. And to the basses, it makes a turn going down, because I want almost the same string height on the first string as on the sixth string. So, if I had a 3 mm. action height on the first string, then my bass may not be more than 4 mm. Because, otherwise, the height on the bridge would be twice as high on the bass string as on the first string. And my bass string already has more energy than the first string. I'll have the height on the bridge only 1 or 1.5 mm. more than the first string. So I have to work on the fretboard, that's something a lot of Spanish makers do, as well. You can see that the fingerboard on the bass side drops off a little bit."

Theo Scharpach is giving a detailed description of his fingerboard work and how it affects the playability. In order to code a passage like this, code and code family hierarchy should be made up in simple terminology, preferably as short as a few words. This passage could be coded as "*Fingerboard – Bass Side Asymmetry*" because asymmetrical surface of the fingerboard is the main theme of this passage, and as a design input, it makes a guitar more playable according to Scharpach. Theo Scharpach and other participants talk about other features, as well, regarding the fingerboard such as *Fret Shape and Relief* and *Fretwork and Precision*. Their common ground is the Fingerboard, thus they can be grouped under the *Fingerboard* code family:

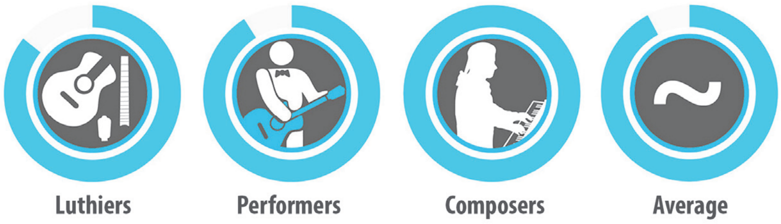
Fingerboard (x: 8 - y: 3) - ***Code***
(mentioned by participants A, B, C, D, E, F, G, H= 8)

Fingerboard – Bass Side Asymmetry (x: 2 – y: 1) – ***Subcode***
(mentioned by participants A, B= 2)

Fingerboard – Fret Shape and Relief (x: 4 – y: 1) - ***Subcode***
(mentioned by participants B, C, D, E= 4)

Fingerboard – Fretwork and Precision (x: 6 – y: 1) - ***Subcode***
(mentioned by participants A, C, E, F, G, H= 6)

In the passage above "*x*" is the *groundedness*, that is, how many participants mentioned that phenomenon; and "*y*" is the *density*, meaning how many links it has. In this example Fingerboard code family has 3 links (*Bass Side Asymmetry*, *Fret Shape and Relief*, *Fretwork and Precision)*. Please note that Fingerboard code groundedness is equal to 8 –and definitely not 12 (=2+4+6), because each participant is counted once. Fingerboard sub-codes have a total groundedness of 12, however, since they are allowed to be counted once, the groundedness of the code family is equal to eight (A+B+C+D+E+F+G+H= 8). Expert groups have uneven numbers (7 luthiers, 11 performers, 7 composers), which may lead to complications in making groundedness comparisons across stakeholder groups. For instance, stating that "*four participants acknowledge the top soundboard geometry as an important quality of performability*" is misleading in the sense that the *groundedness* value ("*x*" in the passage above) four is '*more than half*' for luthiers and composers (as each subgroups has seven participants), whereas it is '*less than half*' considering performers (as there are eleven performer participants). Hence, these groundedness values were evened out so that they could be expressed in relative terms, thus comparison amongst them would be easier to grasp. 10 was chosen as the common denominator, and the data was normalised (see *Figure 92*). Decimal denominator is supposed to make the comparison of different sample sizes easier to grasp and cognitively more meaningful. From this point forward, referred participant numbers will be followed by their *normalised value*, abbreviated with "*v*" (i.e. 4 luthiers -out of 7- is equal to v=5.7 -out of 10) on a scale of 0 to 10; that is, normalised value v=0 means "*no participant mentioned*", whereas v=10 means "*all participants mentioned*". Additionally, infographics, radar charts and tables are used to simplify the comparison for readers. The infographics symbolise luthiers, performers, composers and their average values (see below).



After all the coding and analyses, as a verification and clarification process, one representative of each group was consulted to comment on the initial Venn diagrams and intensity graphics (see Appendix H) which had been prepared based on the findings of the interviews to make sure whether they would agree, or saw mis-concluded and erroneous points and had further commentary. Eventually, some codes, code families and graphics were updated. Based on the feedback and advise of the groups representatives, there are instances of codes that were combined, discarded, renamed or added. Additionally, relationships between some codes and code families were changed or updated (i.e. from '*is part of*' to '*is associated with*'). *Figure 92* shows the finalised code groundedness intensities of each group and the average groundedness in shades of blue. In addition, the average groundedness intensity is graded out of 10. The figure gives clues regarding the consensus or priorities of each participant group. The average intensities are sorted high to low on a scale of zero to ten. It can be understood from the figure that the highest seven codes were brought forward by *all three* participant groups, which indicates these codes as substantial shared qualities for guitar manufacture and crafting in design for performability.

4.2. Common Ground among Participant Groups

The interview data revealed some themes or points that were brought forward by all parties, of which some were repeated frequently, meaning they were considered within the analysis procedure as the most important aspects of design for performability. It can be drawn from *Figure 92* that some themes were proposed by one group, or two, but not by all groups. The themes shared by all groups is explained in this section. If a theme is shared by one participant group, it will be mentioned in one of the sections 4.3, 4.4 or 4.5. If a theme is mentioned by two groups, it will be mentioned in the corresponding participant group which has the higher intensity. Having said that, some themes emerged in the interviews are not included in any of these sections i.e. "*Aging and Longevity*" or "*Psychological Reasons and Attachment*". Although it is certain that aging of tonewood is crucial, or psychological reasons play an important role, themes like these were not considered worthy of mention, because they fundamentally have no direct relation with design activity.

The main focus of luthiers was playability, product and design qualities of concert instruments. They were "*product*" oriented and voiced a sort of performative quality which depends on both player and instrument. Performers mainly mentioned design qualities of products and personal skill development techniques of players and tools designed to aid their practice. They approached performative quality and performability concepts through instrument, audience and concert venue, but for sure without using the word *performability*. In short, they showed an "*audience*" oriented attitude. Composers put forward their opinions concerning these concepts basically through the very foundations of performative skills and musical construct. The study shows that an instrument for them, is virtually no more than a tool to perform *correct* music with *character* and *emotional richness*. In short, they showed a "*result-oriented*", or maybe we should say "*concert-oriented*" attitude.

Main Codes & Code Families	Luthiers/10	Performers/10	Composers/10	Average
Timbre Quality	8.6	9.1	10.0	9.2
Action Height	8.6	8.2	4.3	7.0
Neck	10.0	6.4	2.9	6.4
Volume	2.9	3.6	8.6	5.0
Effortless	2.9	9.1	2.9	4.9
Physical Balance & Proportions	10.0	2.7	1.4	4.7
Comfort	7.1	5.5	1.4	4.7
Top	10.0	3.6	0.0	4.5
Tension	7.1	4.5	1.4	4.4
Projection	1.4	5.5	4.3	3.7
Concert Hall	0.0	3.6	7.1	3.6
Muscles	4.3	5.5	0.0	3.2
Fingerboard	5.7	3.6	0.0	3.1
Constraints of the Instrument	0.0	1.8	7.1	3.0
Psychological Reasons and Attachment	4.3	1.8	2.9	3.0
Sustain	2.9	0.9	4.3	2.7
String Quality and Material	2.9	4.5	0.0	2.5
Interior Structure Quality and Bracing System	5.7	0.9	0.0	2.2
Tacit Knowledge - Craftsmanship	5.7	0.9	0.0	2.2
Amplification Use	0.0	1.8	2.9	1.6
Back and Sides	4.3	0.9	0.0	1.7
Response	0.0	3.6	1.4	1.7
Aging and Longevity	4.3	0.0	0.0	1.4
Energy of Strings	4.3	0.0	0.0	1.4
Instrument Scale	4.3	0.0	0.0	1.4
Correct Intonation	1.4	2.7	0.0	1.4
Fight against the Instrument	1.4	2.7	0.0	1.4
Energy Economy and Muscle Relaxation	1.4	2.7	0.0	1.4
Weight	1.4	1.8	0.0	1.1
Sound Concept	0.0	2.7	0.0	0.9
Sound Hole(s) on the Sides	0.0	1.8	0.0	0.6

Figure 92 Code frequency (Groundedness) amongst participant groups as well as across-group mean value

4.2.1. Timbre Quality

In the interviews, the most frequently repeating phrase was the Timbral Quality family that can be seen in *Table 1* and *Figure 93* with its sub codes such as Colour Variety and Expressivity (v=8.0), Dynamics (v=4.4). Tonal Balance (v=2.6), Voice Beauty (v=2.2), Spectral Richness (v=1.7) and Luthier's Personal Sound (v=1.4). Luthiers expressed that they strive to find their personal sound. In parallel, all participant groups agree that well-known luthiers have their characteristic tones, and this tone cannot be copied. According to the luthier participants, they should find their tones (AM, CL, EP, TS), "*copying a luthier does not work... [t]his is not the way*" (AM). As the renowned luthier Ignacio Fleta is quoted for his famous quote "*one cannot copy my sound, but they can copy my guitars*" (Fleta as quoted by CL). A luthier is someone who deals with different wood qualities, densities and various differences. They work differently on different woods and they turn them into musical instruments. In other words, they sell instruments made of wood rather than selling wood (PB).

> *[I]t is the luthier who makes guitars from that wood and who needs to deal with different characteristics of wood. I sell guitars, not wood. Each wood species requires a different touch. That can be explained with the tacit knowledge we have. I mean, we treat each piece of wood differently, we turn them into guitars. (PB)*

Table 1 Dataset for code family "Timbre Quality"

Code Family & Sub-Codes	Luthiers	Performers	Composers	Average
Timbre Quality	***8.6***	***9.1***	***10.0***	**9.2**
Colour Variety, Expressivity	*7.1*	*8.2*	*8.6*	**8.0**
Dynamics	*5.7*	*4.5*	*2.9*	**4.4**
Tonal Balance	*4.3*	*3.6*	*0.0*	**2.6**
Voice Beauty	*0.0*	*3.6*	*2.9*	**2.2**
Spectral Richness	*0.0*	*0.9*	*4.3*	**1.7**
Luthier's Personal Sound	*4.3*	*0.0*	*0.0*	**1.4**

After finding their voice, they struggle to make guitars over many years which possess and project their personal voice (AM, CL). Likewise, performers are keen to create their sound (HM, IR, JM, KT, MD) and composers to hear the characteristic voice of performers (EBa, CS, OT, TE) playing their music. Nearly all of the experts interviewed (v=9.2) shared timbral quality as one of the essentially important aspects of performability. During the interviews, apart from putting forward Timbral Qualities as a theme, some participants made special mentions about this theme (AK[8], AE[9], EK[10], IR[11], KK[12]).

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[8] *Nowadays, the guitar performance phenomenon is understood in a way that's equal to perfection and hygiene, but old maestros had a great feeling for tone and timbre variety.*

[9] *Expressive qualities that high quality concert guitars can offer, for instance different colours, mean a lot for the sake of performance.*

[10] *I believe that performance has a lot more than agility. Dynamics, musically knowledgeable and historically informed approach, interpretation, colour. If any of them is neglected, then we can't talk about virtuosity, even if that performer executes with a high level of precision, in my opinion.*

Figure 93 Sub-code distribution for code family "Timbre Quality"

Although timbre quality is an intangible quality and there is no certain way or design intervention of supplying a Classical guitar with colour, particular makers' custom bracing design, the style they connect the neck to the sound box and the way they work with different wood densities are often mentioned as the required tacit knowledge for better results (AM, CL, EBa, PB, SE, TS). Participants pointed out that variables to define timbral characters do not guarantee a standard quality, and chance is an important variable (personal observation). In other words, even though a luthier follows the same way using the same woods, there is a fluctuation in the final product's quality. Re-evaluation of soundboard and strutting patterns, especially in the 1930s and then the 1970s (see Section 3.1 *Figure 52*, *Figure 53*, *Figure 57*, *Figure 59* and *Figure 62*) has remained a hotly debated issue. Variations in bracing patterns can result in serious differences in tonal qualities of particular instruments. Contemporary guitars are often criticised to lack timbral variety and a wide colour

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[11] *They forget some other qualities of making music, that are very important and they should be right there, such as colour, dynamics, and timbre alternatives. I think colour is something inherent of the sound, it is related with the concept of sound. I think in essence, this as a fact, affects the music.*

[12] *Personally, for me the important thing is nuance and timber palette and richness of tonal colours of a guitar.*

palette (EB, HH, HM, IR, TS). Timbral quality is vital because it is about the main purpose of music, which is communication (DL, EBa, EP, HM, IR, JM[13], SE) and expression (CS, EBa, HM, JM, KK, MD, OH, OT). Musicians perform "*to share their secrets*" (EBa[14]), and for doing so, they have "*so much will to express*" (HM), and timbral quality, as an expressive quality, is crucial for their performance (AE). In order to do that, one needs a clear separation of tones, shortly termed *balance* (CL, EB, EP, HH, HM, KT, KK), which should not be confused with physical balance and proportions (see Section 4.2.6). Another fundamental quality of tone is the capability of an instrument of how sensitively it responds to soft and strong attacks. Because music has "*high points and low points*" (HH), a great concert instrument should be able to respond to a performer "*playing from triple piano to triple forte*" (KK). In addition to this, a guitar that offers a wider palette of timbral colours can teach a learner (this explains the basics of performability concept). A high-end concert guitar can offer a learner a dimension that is *beyond* their cognition and they did not know "*... that this level even existed*" (HH) and teaches them "*what is possible*" (HM) and makes them "*a better guitarist ... because they* [these performable concert guitars] *have the voices which they* [players, especially advanced learners] *had never noticed before*" (HH).

4.2.2. Action Height

Another theme common to all three participant groups was action height. 18 participants (v=7) voiced it as one of the important assets of playable Classical guitars. Action height in guitar manufacture is determined by an array of features such as fretboard angle in relation to the soundboard, bridge height, saddle height, fret relief and fretboard thickness. Action height requires a fine balance between them. The action height was rated v=8.6 by the luthiers, whereas the rate is v=8.2 for

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[13] *Many times we forget that "the last chain" (orig. el ultimo eslabón) is just communication. That's the miracle of music. What I play changes something in you, and because that thing is changing in you, you give me back your energy. We are mediums. Whatever thing that makes that miracle be unstable, is not good for virtuosity or for final development of music, which is the miracle of expression, the intensity of expression.*

[14] *They become artists to share their secrets. High level of performance is an execution done by those who have succeeded to communicate their secrets.*

performers and v=7 for composers (*Figure 94*). Action height adjustment requires crafting skills. Luthiers fine tune the action height by sanding the saddle bone. High quality concert guitars on the retail products market have action height values varying between 3 to 4,8 mm. for the 1st and 6th strings. These figures were acquired from the promotional literature and descriptions of Casimiro Lozano for the former, and Roy Fankhänel for the latter. However, there are instruments with an action height outside of this margin which is intended for special needs.

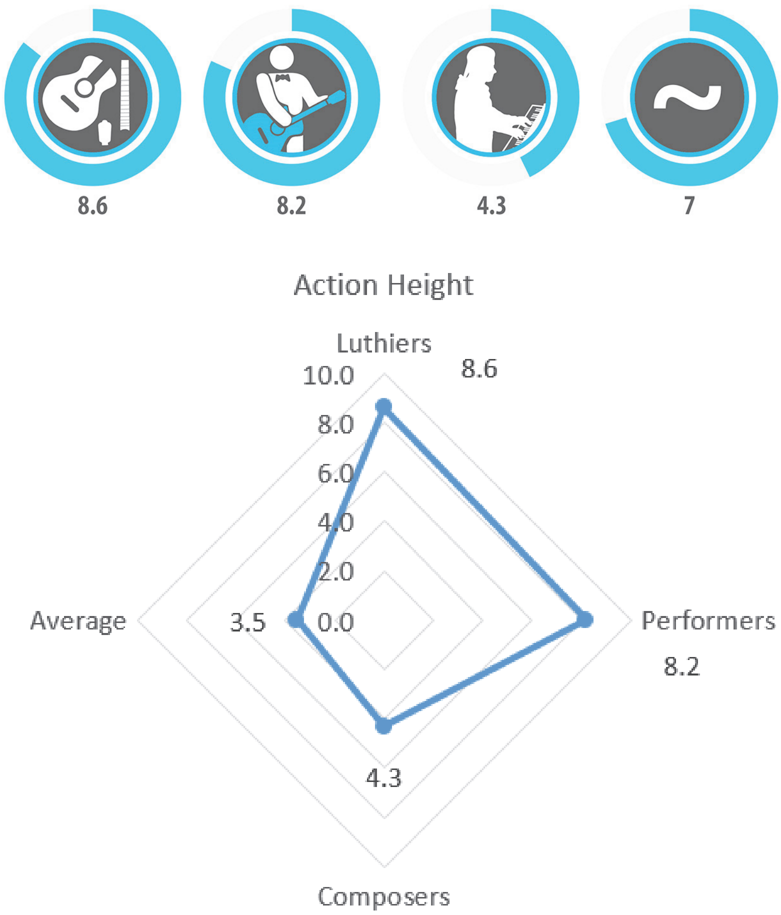


Figure 94 Distribution among participant groups for code "Action Height"

The action height is closely related with a performer's preferences, and luthiers explained to have produced different action heights for different clients (AE, AM, CL, EP, HH, TS). If and when luthiers manufacture instruments for dealers, rather than specific clients, they manufacture those instruments with a standard string height and this could be changed easily by an expert technician. Different heights are necessary to cope with variation in the plucking style and the control of performers over their attack. A lower action ensures comfort and a more playable instrument but it poses a risk to chatter, because when strings get closer to the frets, they easily hit the metal frets creating a buzzing noise ("fret buzz"). A virtuoso performer may decrease their torque and create a similar volume with a softer attack. Increasing the height is more risk-free, because it doesn't chatter easily; but this decreases the comfort as strings require greater distance and therefore greater force to press down onto the fretboard. An observation is that great guitars do not require high action (CL, EP), because they should offer a good deal of volume with an appropriate and correct attack style (AM, CL, CS, EP, EBa, HH, IR, MD) almost regardless of their action height. On the other hand, there are some virtuosi performers, such as Alirio Díaz, who prefer high action guitars. Alirio Díaz is known to have played on guitars whose action height goes up to 5 or 6 mm.

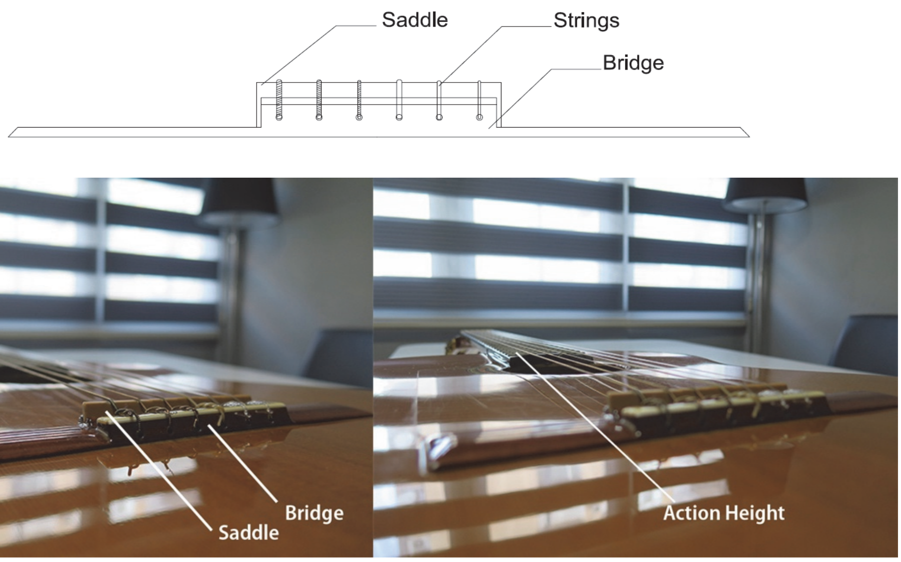


Figure *95* Action height and bridge mechanism

To sum up, the action height is an important determinant of the volume and tone. As seen in Figure *95*, the height is defined by the bridge saddle. The higher it gets, the louder a guitar will sound, because when the distance between strings and fretboard is larger, strings oscillate with a larger diameter and eventually create a louder and bigger vibration on the top tonewood, creating a bigger volume. However, it decreases the playability and comfort of a particular guitar as it would oblige a harder push on the left hand. On the other hand, low action height (around 3 mm) feels very comfortable, at the cost of less sound power, because since the distance of the strings is small, strings can't oscillate as free as guitars that have a higher action, and they apply less energy to the sound board, resulting in a lower volume. Low action guitars produce a nice singing sound, but they may be weak at times in large concert halls (HH).

Figure 96 Greg Smallman action height adjustment bolt
(Image source: [left]: WEB 55, [right]: WEB 56)

It was stressed by an important number of participants that the action height should have a fine balance between two variables, loudness and comfort. As it goes high, the playability drops, or in the opposite case, the guitar speaks with a low voice. CL expresses his opinion in line and claims that action height is the most important quality in favour of playability amongst others, because "*it makes the difference between a good guitar and a standard one*". For him, a guitar that requires a bigger distance is just an ordinary and tiring instrument (CL[15]). In addition, very high action might jeopardise ornaments and legatos (AE, AM). An aspiring learner practising each day for 6 to 8 hours may face injuries in their tendons and muscles and be

[15] *When a guitar needs more height, I think that this particular guitar is no special, it is just a straight guitar. Indeed, a tiring one.*

obliged to quit their career due to a tiring and *wild* guitar (EP[16]). However, a "tiring" high action guitar could be used as a tool to practise for a concert performer, because after getting used to a tiring guitar, easier guitars feel much easier to play (KT[17]). There are several attempts to design a guitar whose action height can be modified easily. The most well-know is the action height adjustment of Greg Smallman. As can be seen in *Figure 96* his guitars feature a system which enables the action to be modified easily with a bold eliminating the need for a luthier. Touring musicians may utilise it when they travel to different climates: if the guitar shrinks due to low humidity or vice versa they can easily change the height thanks to this design feature of Smallman guitars.

4.2.3. Neck

The neck was rated high as a quality of design for performability (v=6.4). It has a substantial role to determine the tension of guitar. In guitar manufacture, different design standards regarding the neck and body are applied. These are French method, Vienna method and Spanish method (EP, HH). In the Spanish method, the neck is produced first and then the sound box is attached to it, whereas in the French method the sound box is produced first. The French method allows for more flexibility, which enables the fingerboard elevation (EP) that was mentioned as an aspect of playability in expert interviews.

Table 2 Dataset for code family "Neck"

Code Family & Sub-codes	Luthiers	Performers	Composers	Average
Neck	***10.0***	***6.4***	***2.9***	**6.4**
Thickness	*5.7*	*3.6*	*1.4*	**3.6**
Width	*5.7*	*3.6*	*0.0*	**3.1**
Contour	*2.9*	*4.5*	*1.4*	**2.9**
Angle/Elevation	*4.3*	*0.9*	*1.4*	**2.2**

[16] *3,8 mm. is the maximum action height which doesn't tire a musician aspiring to be a virtuoso, because it takes 6 or 8 hours of study per day to master an instrument. This is serious*

[17] *A difficult guitar is like trying to run in a pair 45 size sports shoes.*

The neck has some input to ensure performability concerning design considerations clustered in four main subjects (see Table 2). First of all, Angle/Elevation (v=2.2) is a determinant which directly defines the angle between the sound box and fingerboard. However, this elevation can cause "*very different angles from the string where it comes out from the box and passing all the neck*" (AM), and apart from ensuring an easier reach to high registers (AE, AM, CD, MD, TS), it changes the string tension in turn. If the angle allows an elevation, the tension tends to get softer. In order to give a stronger action, it should be compensated with a stronger sound box, thicker top plate and tougher bracing (AM, TS). Secondly, Neck Contour (1.47) gives an important sensitivity and varies from person to person. So it is a matter of preference and biometric structure (AE, CS, PB, HM, KK, MD, KT, SE). *Figure 97* illustrates some of the most widely used neck contour forms; they vary from 21 mm. to 23 mm. and the section can be in various asymmetrical and symmetrical shapes from sort of flat to rounded contours. Thirdly, some ergonomic aspects such as Thickness (v=3.6) and Width (v=3.1) was mentioned as foundationally important aspects on performability by all participant groups (AM, CL, CS, DP, EP, HH, HM, JM, KK, KT, MD). Although "*millimetres can count*" (HM), it was also voiced by participants that "*a good player can really make music on any guitar*" (AM[18]) regardless of its quality.

[18] *I think a good player can really make music on any guitar, because I saw it; and I saw musicians, I gave them guitars with really thick fingerboards and they played fabulously.*

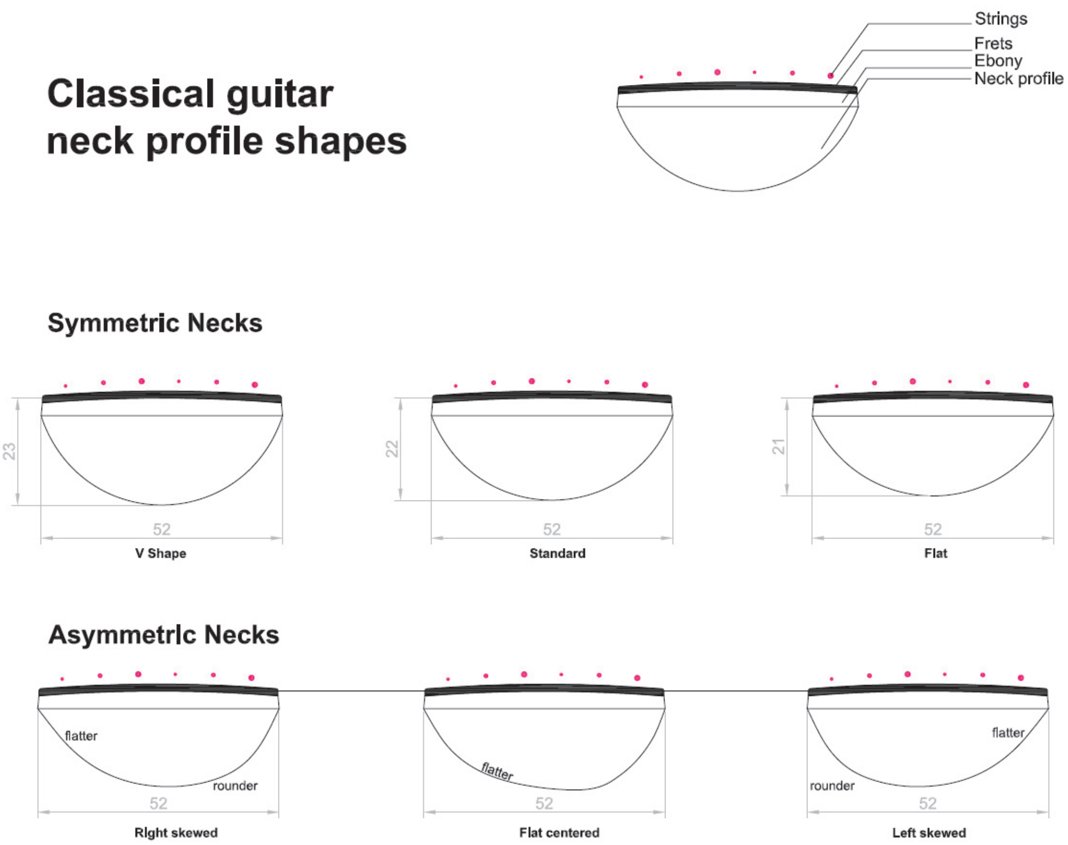
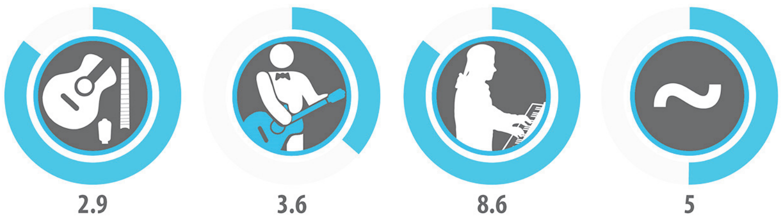


Figure 97 Neck profile shapes
This drawing is based on neck and fingerboard manufacturing details explained by Sloane (1976, p. 43-49; 71-75) and Courtnall (1993, p. 167-184; 275-288)

The neck thickness should give a comfortable feel to the left hand, and normally varies between 21 and 23 mm. for Classical guitars depending on particular performers or whether it is a Flamenco or Classical guitar. Flamenco guitars usually feature slimmer necks (AE, AM) for easier access. Another reason to manufacture thinner and narrower necks for Flamenco guitars is that their body is lighter, therefore a lighter neck is necessary to compensate this light body in order to keep the string tension in a nice and comfortable level (AE, AM, EP, TS). Its thickness is chosen depending on the anthropometrics of the performer, and "*defines the width of the fretboard*" (EP); therefore, thickness ought to be bespoke for particular players. Thin necks may facilitate hand span and ease of reach; however, they tend to be short-lived, because, the neck can bend because of the tension caused by the strings over many years. However, thick necks might make it too difficult to reach the lower strings. Thicker necks could be accepted at the beginning but later, performers think they are not comfortable (CL). In order to be able to make a neck thinner, interviewees mentioned their neck design with reinforcement ebony piece inside the neck; it increases the flexural strength and enables a neck to be tougher against the string force which tends to bend the neck. Therefore, neck can get thinner with these reinforcements and playability may increase. The width of a neck is another important aspect that is defined with respect to a particular performer. Usual the width at the 1st fret is 52 mm, but this may be varied between 50 and 54 mm. for those who have smaller or larger hands and fingers (EP, AM, CL). At the 12th fret, the width is usually 10 mm. wider than the 1st fret. Namely it is normally 62 mm. and could vary between 60 and 64 mm.

4.2.4. Volume

Volume has been the focal point of attention for the last 40 years of guitar design and manufacture (Stenzel, 2004). Almost all of the development has been done to increase the volume and projection of the Classical guitar, so that it can compete with, say, the violin or cello if not the piano (EB, EBa, DL, EP, EK, JM, KK, KT, MD, OT; Stenzel, 2004) . The Classical guitar is considered a *disadvantageous* instrument by luthiers, performers and composers alike (DL, EBa, EK, EP, JM, KK, MD, OT, TE, TS). Opinions concerning volume related issues were voiced by 2,51/5 of participants (see *Figure 98*). One striking result of expert interviews is that some luthiers, especially those who follow Classical guitar traditions, are reluctant to boost their instruments' volume, as opposed to performers and composers who are in need of power and volume. As can be seen in *Figure 98*, luthiers' rate to mention the volume as an input for performable instruments is v=2.9, whereas the rate of performers and composers are v=3.6 and v=8.6 respectively.



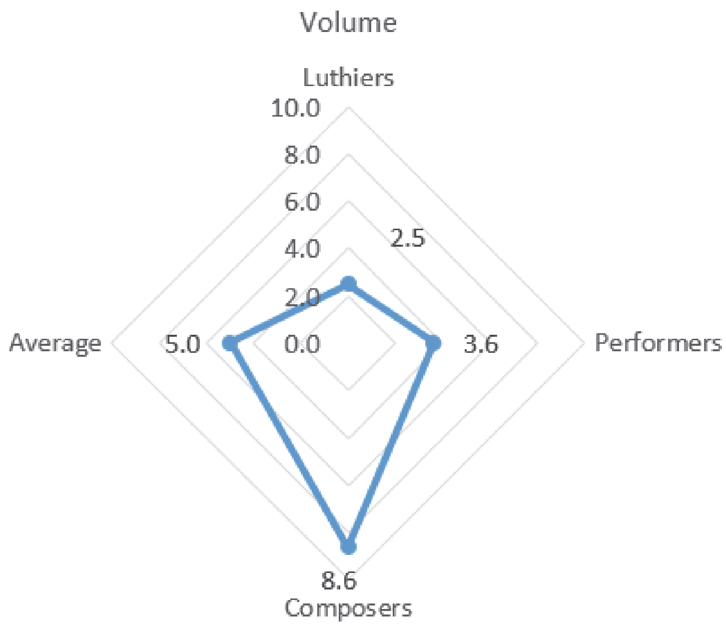


Figure 98 Distribution among participant groups for code "Volume"

Controversial opinions in literature and among luthiers or performers about contemporary guitars, whose primary aim is to increase the volume (see Chapter 3), perfectly match the different opinions voiced by the experts interviewed. Although it is a reality that the Classical guitar is a weak instrument compared to symphonic instruments (AE, EBa, EK, FK, HM, JM, KK, KT, MD, OT, TE), participants exhibited three main standpoints considering volume. (i) A number of participants argue that volume is essential and thus an important input for performable instruments. Although trying to elevate it using contemporary design ideas and materials may or may not cause a deviation in instrument's character coming from its Spanish roots, luthiers should follow their research and try to stay as close as possible to the traditional Classical guitar timbre (AE, CL, CS, DL, EBa, EK, FK, JM, KT, MD, OT, TE), because they are "*still fighting against the volume*" (JM). (ii) Some participants argue in favour of a Classical guitar that is traditionally a chamber music instrument, thus should not be modified using non-natural materials (i.e. carbon fibre) because it jeopardises its tonal character (AK, AM, CD, EB, EP, HH, HM, IR, PB). According to some of them, contemporary Classical guitar in the present day does not appeal to Classical music listeners (CD, TS, HM, HH) because they sound harsh, and some luthiers have given up their experiments with advanced materials (TS). The comment below coming from a luthier who experimented with advanced materials for decades and then quit around ten years back in the writing time of this thesis is striking in its self-criticism:

> *Often, you can hear the, well, it depends on how much carbon you use in a guitar, if it's fairly less, then you can't hear it. But most of the time you can hear people using carbon in a guitar, because there's some kind of tone, which is always the same which you can't change which is there and it is the tone of carbon. It has a tone but it is always the same. It has a sound, but at the same time it is dead. It is a very strange phenomena. (TS)*

These participants who argue that the Classical guitar should remain as a chamber music instrument support the idea that a small concert venue with good acoustic properties where there are no more than a few hundred listeners is good, like how it was in the past (CD, HH, HM, TS) "*where the guitar sounded beautiful. [those listeners] would become guitar lovers*" (TS). In contrast to composite top or lattice guitars which is used for venues with a few thousand listeners, "*[t]oday a guitar performer can't play in full venues of 1,000 listeners, except some star virtuosi such as Paco de Lucia., not even 700-800 listeners attend guitar concerts today; [s]o, making more powerful guitar is somewhat meaningless*" (CD). (iii) Some participants think that both traditional and contemporary guitars suffer in a large venue. There is no guitar that can really fill a large concert venue (AK, KK, SE), hence amplification is mandatory and can solve the volume problem in the most optimum way (KK, SE).

Whether they approve or reject the use of advanced materials, one point expressed by many is that the volume is insufficient as of today. Even the highest grade contemporary guitars' volume and power is not completely verifiable (EBa, EK, TS). According to the renowned luthier Matthias Dammann, it is partly because the volume is a psychological phenomenon; our brain perceives loudness depending on many aspects from the room size to its fundamental resonance (Kontrapunkte, 2011). Guitars with a strong midrange sound, so to speak a nasal tone, human ear perceives it as if it is louder; so objectively it is not louder, but it is so subjectively (TS).

In general, contemporary instruments are welcomed by different participant groups. Some experts expressed their affection for those radically designed guitars. On the other hand, they seem to have some aspects which make them question their instruments. To sum up, the majority of participants pay homage to contemporary instruments, although they believe that these instruments are not the ultimate end result -including the participants using these instruments (CL[19], JM[20], SE[21]). While some participants argue that contemporary instruments, i.e. Smallman, Dammann, Humphrey or Connor style guitars, do not have an intimate and singing quality of traditional guitars, some of them do not agree. Their standpoint is that expressivity and tonal beauty is given by the player, and not the instrument itself (CS, JM, MD). "*I do not agree that these guitars have lost their charm, one must know how to play them*" (MD), often those contemporary guitars require a learning curve, "*on a double-top guitar, say Dammann, you have to reduce your attack, and then the response is so explosive*" (IR). Even so they are in search of a "missing" component. Manufacturing guitars, luthiers are usually battling compromise to get a quality over another, in other words a favour over another. They may get comfort, while it will decrease the volume (McAllister & Watt, 2014a).

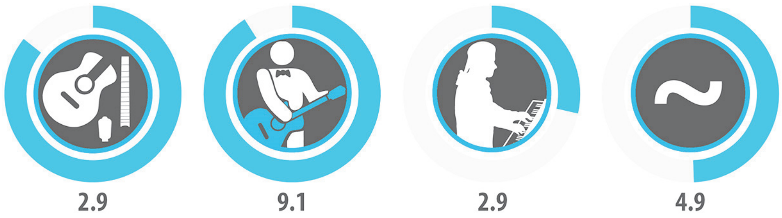
19 This is one of the contemporary techniques developed by Matthias Dammann, and it gives the performer a focused and powerful sound, compromising the traditional singing qualities of the Torres guitar, though.

20 I think he (Greg Smallman) did a fantastic contribution to the guitar. But he is a scientist. He comes from military and he is a physical acoustician. He is a scientist. Probably it is another step in the guitar evolution but not the final result. Since him, people began to think about projection and other materials.

21 For recording, I'd do on my [double top] *guitar. But Hauser means something else, it means love and psychological attachments.*

4.2.5. Effortless

Effort is often associated with comfort and muscular torque necessary to activate strings in order to produce sound, and was mentioned by all participant groups at v=4.9 average rate (see *Figure 99*). To be more precise, *Effortless* code was often mentioned as a feature of comfort of performable instruments. Therefore, a comfortable guitar should be effortless, but for sure a comfortable instrument is expected to offer more than just effortless sound production (see Section 4.2.7.). A serious learner spends many hours each day and it may create serious outcomes (AE, EB, EP, DL, JM, MD, OH). Although a guitar still requires serious physiological effort to play, therefore "*effortless*" is a metaphorical quality, this code was identified as a balance of tension, action height, fretboard precision and neck angle. A guitar can require less effort if these features are satisfied and it makes the performance easier (AE, JM) "*meaning that there is no physical overstrain*" (MD) and "*technical and musical aspects happen in a way that saves effort*" (IR) and a performer can focus on making music (AE, AK, CS, DL, FK, HM, JM, KK, MD, OH, SE), therefore s/he is not obliged to "*adjust [their] technique*" (HM). As a result, an effortless instrument enables a performer to "*concentrate on music*" (AK), "*perform and realise [their] aims more easily*" (KK) like "*playing a game*" (FK). On the contrary, controversial opinions were expressed by some experts. They support the view that effortless instrument sometimes tend to lack expressive possibilities and colour (HH, IR, TS). Although it might just be a mere coincidence, it may as well be rooting from their top material and bracing system (AK, EB, IR, HH, HM, KK, PB, SE, TS) and it is "*one of the serious problems*" that contemporary players pay too much attention to having effortless guitars (EBa). Some experts emphasised that it is the player who should produce the sound, and definitely not the instrument by itself. The piano has a mechanism to stop the strings or the *chitarrone* (from the Middle Ages) have bird feather to damp the unwanted overtones (HH); but since the Classical guitar does not have a system like this, free oscillation of strings that can be seen on very effortless guitars will for sure damage one’s musical quality (HH). In other words, guitars which require very little effort to sound, tend to be troublesome at times because of over-sustain of unrelated notes.



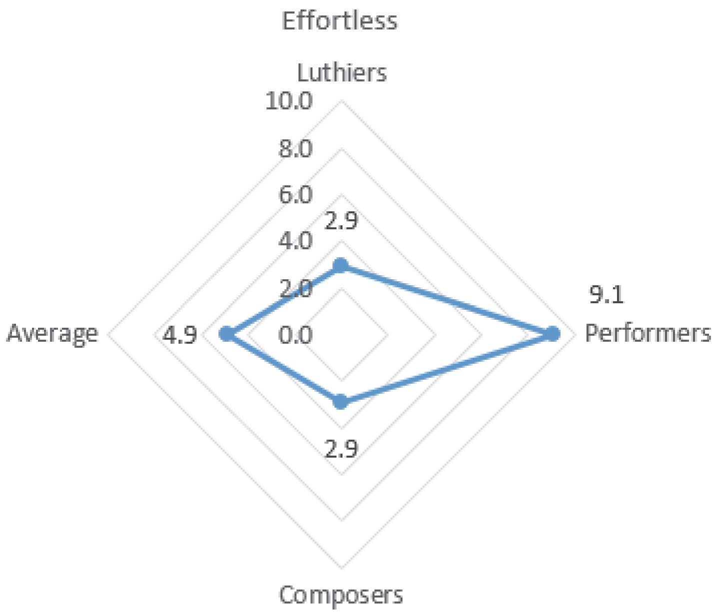


Figure 99 Distribution among participant groups for code "Effortless"

4.2.6. Physical Balance and Proportions

Every good guitar has good proportions. This was expressed by v=4.7 of all participant groups. Luthiers believe that everything is about good proportions that makes an instrument performable. Luthiers rated the Proportions code highest (v=10), whereas it was v=2.7 by performers and v=1.4 by composers (see *Figure 100*). It gives an instrument its beauty. Upper and lower bouts, neck size and contour, headstock, depth of the box, fingerboard and the top. Each component mentioned above is explained in detail in related sections. Each piece has an effect on the whole instrument (AM, HH, CD, DL, EP, PB, AE, CL, MD, HM, TS. Therefore, each part has a fine balance, "*[one] can't just change anything (one parameter) without* *altering the others*" (PB). Especially measurements of internal bracing and components are very important. "*Sometimes you don't even know which detail it is. If it is something to do with some millimetres here and there in the fretboard, or in the bridge, you cannot really tell precisely*" (HM). The physical balance was mentioned in contact with four specific design details as seen in Table 3. One of them is the Neck Angle with Respect to Top, which has an important effect on the tension in addition to enabling elevated fretboard and thus improving the comfort. Another sub-category is the Ratio and Proportions: they are important, as they the define tonal character of an instrument. The third sub-category is the Saddle & Bridge Height that was only mentioned by luthiers and is used by makers to fine tune the action height of guitars. Nevertheless, being sub-code of a code family shared by all three participant groups, it is mentioned in this common ground section. The fourth sub-category is the Weight Balance which has important reflections especially in live performances important because posture and related tools and ergonomic rests have gained enormous importance for the last few decades. "*During the course of a performance, it is important that the guitar is balanced because it saves you lots of work*" (DL), which bring out the dilemmas of footstool or guitar rest explained in Section 2.2.3.

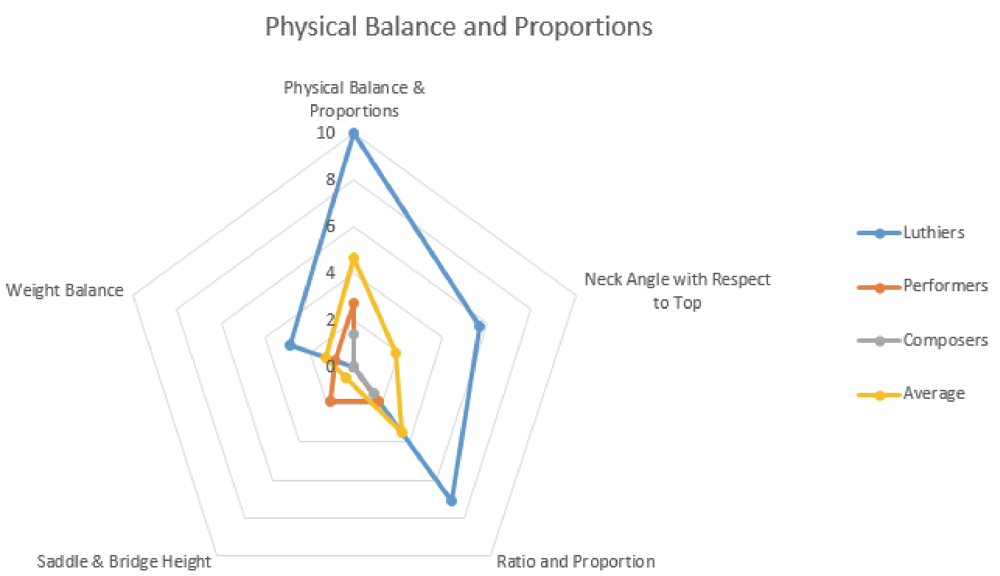


Figure 100 Sub-code distribution for code family "Physical Balance and Proportions"

Luthiers cannot always get the same results, but their instruments have several characteristics which can be traced throughout many years (EP, AM). For CD, what they need is some luck and good proportions. For instance, Ignacio Fleta is known for his guitars' upper bout that is relatively bigger than other guitars. This, in turn, makes up for his personal sound. (Morrish, 2002). There are some remarkably successful box shapes and proportions in Classical guitar history. Hermann Hauser in the 1930s and a decade later Ignacio Fleta are the two most copied plantillas among those. Both keep the width of the soundboard relatively small, but achieve a rather larger surface, thus a big volume. Hauser succeeds by designing a top plate almost approaching to a rectangular shape, whereas Fleta creates an unusually big ratio of upper to lower bout (Stenzel, 2010).

Table 3 Dataset for code family "Physical Balance & Proportions"

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Physical Balance & Proportions	***10.0***	***2.7***	***1.4***	**2.7**
Ratio and Proportion	*7.1*	*1.8*	*1.4*	**3.5**
Neck Angle with Respect to Top	*5.7*	*0.0*	*0.0*	**1.9**
Weight Balance	*2.9*	*0.9*	*0.0*	**1.3**
Saddle & Bridge Height	*0.0*	*1.8*	*0.0*	**0.6**

4.2.7. Comfort

The average rate of comfort from all participants was v= 4.7. Luthiers expressed high profundity to comfort in terms of playability and performability, more than any other groups, with v=7.1 average rate (see *Figure 101*). "*When talking about a "good" guitar… [f]irstly, it needs comfort*" (EB). Comfort is an umbrella term including but not limited to "Effortless". It means good proportions, decent tension, expressive timbral richness, easy action height, well-shaped fretboard, proper neck thickness, width and contour (AM, CL, CS, DL, EB, EP, HH, HM, JM, KT, OH, PB). However, for sure, all these aspects should be proportional. On the other hand, although there may be exceptions, very easy guitars tend to be muffled or weak, whereas very sonorous instrument show symptoms of less comfortable instruments. Hence, a fine balance is crucial. Some experts expressed that comfort is important mainly because a performer on a comfortable instrument can focus on the expressive side of music rather than the mechanical side of performing (AE, CL, DL, HH, HM, JM, KT, MD, PB). On the contrary, a number of participants argue that seeking for comfortable instruments jeopardise the timbral beauty and tonal capacity. Thus, they claim, performers should get used to performing on less comfortable instruments (EB, EBa, KK, SE). Having said that, playing on comfortable guitars is a preference (AK, KK, SE), and one may choose if they would afford to compromise some aspects like volume capacity or timbral colours. Another aspect mentioned to have an effect on the comfort is the strings (DL, EB, HH, HM, IR, MD, TS). Although it depends on personal taste, carbon strings, which is preferred by many performers, tend to be less comfortable, but they are powerful, though.

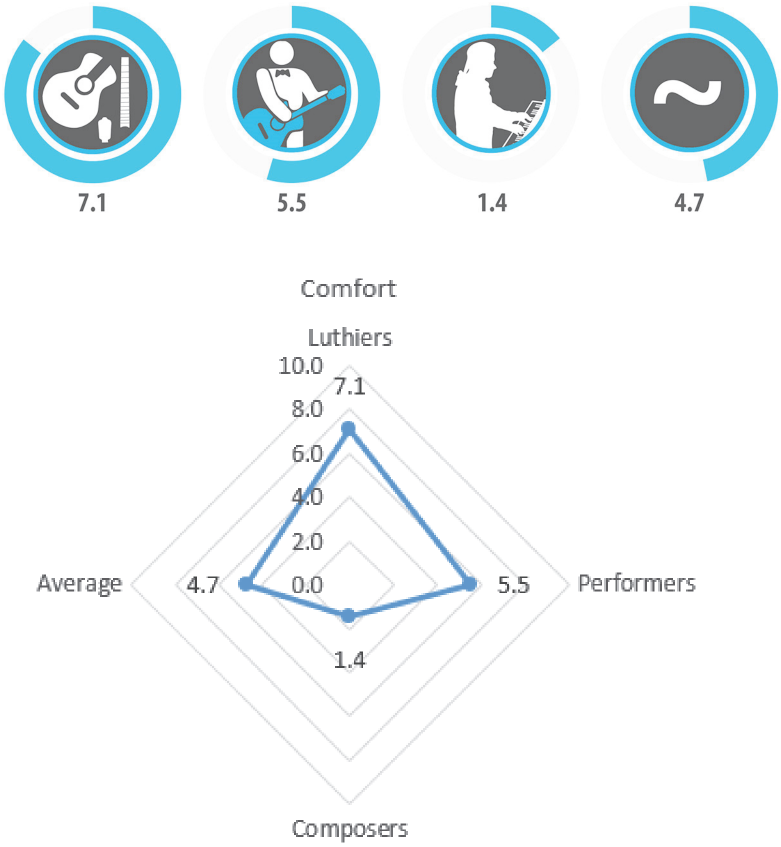


Figure 101 Distribution among participant groups for code "Comfort"

Some experts argue that comfort is also something learned (PB, EB, HM, JM, MD, DL, OH) which brings forward the performability phenomenon. As explained in Section 2.2.5, a number of researches, most notably Furuya & Altenmüller (2013) have shown that amateurs and advanced performers demonstrate substantial differences in terms of muscular torque they apply for sound production. In addition, there are products designed to decrease the stress applied by the player (see Section 2.2.3 and 2.2.4). At this point, experts and the literature findings are in line that pedagogical techniques have improved the self-consciousness of players about comfort. As a result, Classical guitar design in the present day has turned the "comfortable guitar" concept into reality due to 2 main reasons: (1) new materials have enabled more powerful instruments, thus players do not need very high actions anymore; and (2) the developments in instrumental education and pedagogy, for instance recording aids, practise tools and improved right hand techniques, have enabled players to acquire a similar volume and tone from more comfortable instruments which feature lower action height and softer tension.

4.2.8. Tension

Like many qualities concerning acoustic instruments, the tension is closely related with, or is result of some other aspects. v=4.4 of the participants mentioned the tension as an important quality. It is as low as v=1.4 for composers, whereas v=7.1 luthiers think that it is crucial. Tension was mentioned in close relation to six phenomena as seen in Table 4. These are: Bracing System and Material (CL, EB), Neck Material and Thickness (TS), Soundboard and String Relation (AM, TS), The Feel of Strings (AE, AM, CS, IR, JM, KK, SE, TS), Top Tension (AE, EB, EP, TS) and Top Thickness (CL, TS). Whereas some of it is coming from the natural structure and characteristic of wood, some of them are modified in a purposeful way (AE, AM, CL, CS, EB, EP, IR, JM, KK, SE, TS). For instance, the wood has its own hardness and grain structure, but neck elevation or thickness is modified by the luthier. In other words, the luthier's tacit knowledge is shaped in a way to intervene the inherited characteristics of the wood (CL, PB). Tension is basically defined by a fine proportional development among those in its widest meaning, and plays an important part to define the comfort and the required effort. An exception can be the effect of headstock whether it has an influence on the tension or not. Some luthiers think that it makes a difference and therefore Flamenco and Classical guitars have slightly different angles (AM, EP), but some makers think that it is customary to shape them at slightly different angles but in fact do not make a notable difference (CL, TS). In the end, the player feels the hardness of strings, but there is a finely adjusted and sophisticated proportional balance behind to satisfy a nice tension on the strings. All of participant groups described the tension as an important quality that makes an instrument comfortable.

Table 4 Dataset for code family "Tension"

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Tension	***7.1***	***4.5***	***1.4***	**4.4**
The Feel - Hard or Soft	*4.3*	*3.6*	*1.4*	**3.1**
Top Tension	*4.3*	*0.9*	*0.0*	**1.7**
Soundboard and String Relation	*2.9*	*0.0*	*0.0*	**1.0**
Top Thickness	*2.9*	*0.0*	*0.0*	**1.0**
Bracing System and Material	*1.4*	*0.9*	*0.0*	**0.8**
Neck Material and Thickness	*1.4*	*0.0*	*0.0*	**0.5**

4.2.9. Projection

Projection is probably the most confusing quality of musical instruments; be it a cello or a guitar, projection capability of an instrument confuses many. Confused comments and criticisms of amateurs and beginners, or sometimes advertisements of concert instrument dealers have exhibited misguided information regarding projection. This quality of musical instruments is often misguidedly used in the place of volume. Projection implies the ability of an instrument to push the produced sound in a direction forward, usually through the front side of the instrument. Most musical instruments have sound holes in the top plate of them, where there are supposed to be listeners for the place they were intended to: the concert stage. There are very few instruments which are not fitted with a sound hole in the top plate. *Figure 102* shows the Turkish *Bağlama* and Indian *Sitar*, two examples of these instruments which do not have sound holes in the top plate. It could be claimed that these instrument were not designed for the concert stage. However the Classical guitar, as many Western musical instruments, were intended to be played in concert venues, thus have directional sound holes. Additionally, projection capacity has become one of the most serious considerations for a concertizing performer. It is fairly obvious by performers' comments.

When I try a guitar, I try myself first, then I take it to a concert hall and I give it to a friend of mine and I go to one of the seats and I listen in a concert hall. Because the projection is very essential. If you are a concert artist, your criteria changes from playability to audibility. (KT)

Figure 102 Two instruments without front sound holes on their top plate: the Bağlama (left) and Sitar (right) / Image Sources: [left] WEB 57, [right] WEB 58

A good Concert guitar is thought to have a special ability to push the sound forward far into the concert venue by v=3.7 of participants from all groups (DL, EB, EBa, HH, HM, JM, KT, MD, OT, TE). Although there are counter-arguments in the literature, general opinion is that contemporary guitars offer a more powerful projection. This is paralleled by many participants (CL, EB, EP, IR, JM, MD, TS). However, some of the participants argue that this prevailing opinion of contemporary guitars' having better projection capability is exaggerated, that is, either there are traditional guitars as powerful as contemporary ones or traditional instruments offer even better projection (HH, HM, EBa, EK). The following comment coming from a concert artist gives an interesting counter-argument to the prevailing laud-contemporary phenomenon:

Once I compared a guitar from the 19th century with my Gioachino Giussani spruce guitar (1990) and people from the audience said "don't get surprised but their projection power is very similar" which I wouldn't expect from a 19th century instrument. I didn't notice, of course, but the audience sitting in that concert hall, roughly some 30 or 40 metres away *from me, did notice. Those old guitars may not be laud up-close, but they are able to carry the sound successfully, which explains the projection phenomenon. (HM)*

Hermann Hauser, too, mentions that traditional guitars are at least as loud as contemporary instruments in distance, if not louder:

... Miguel Llobet[22] for instance, if you listen to him, this is music. And if you see the guitar they play, for instance I saw the guitar which was played by Miguel Llobet, the old Torres from the 1850s, I saw that guitar, if you see the quality of that guitar. This guitar does not push loud music, this guitar is strong at distance, you can hear it very clearly at distance. And that guitar was made in 1859. If you hear the sound of this instrument, it is still playable in concerts… The people at that time knew what to do without the technology only with their ears, and the ears, you cannot lie… The traditional guitar's sound quality is better, more brilliant, louder at distance and charming and the secret is that it is not loud, but in distance it's able to carry the sounds forward; its projection capability is great... Considering Andres Segovia playing in Munich Hercules Hall to 1200/1400 listeners, even though it is not a hall for classical guitar concerts but Andres Segovia played there. In the last row, you could hear him clearly, each note sounds separate even in the last row. (HH)

4.2.10. Sustain

Sustain is a quality of performable guitars voiced by all groups at v=2.7 rate. It seems to be more important for composers, since their average rate is v=4.3 and higher than the luthiers and performers at v=2.9 and v=0.9 respectively (see Figure 103). In fact, sustain is a psychological quality. When the energy of the string is used up faster, that is when a guitar has stronger coupling, the human ear perceives the

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[22] *Miguel Llobet (1878-1938) Spanish guitarist and composer*

sustain as being shorter (Richardson, 2010). If one measures it using a device, they find out that it is not really shorter, but we perceive it shorter (Kontrapunkte, 2011; Stenzel, 2004).

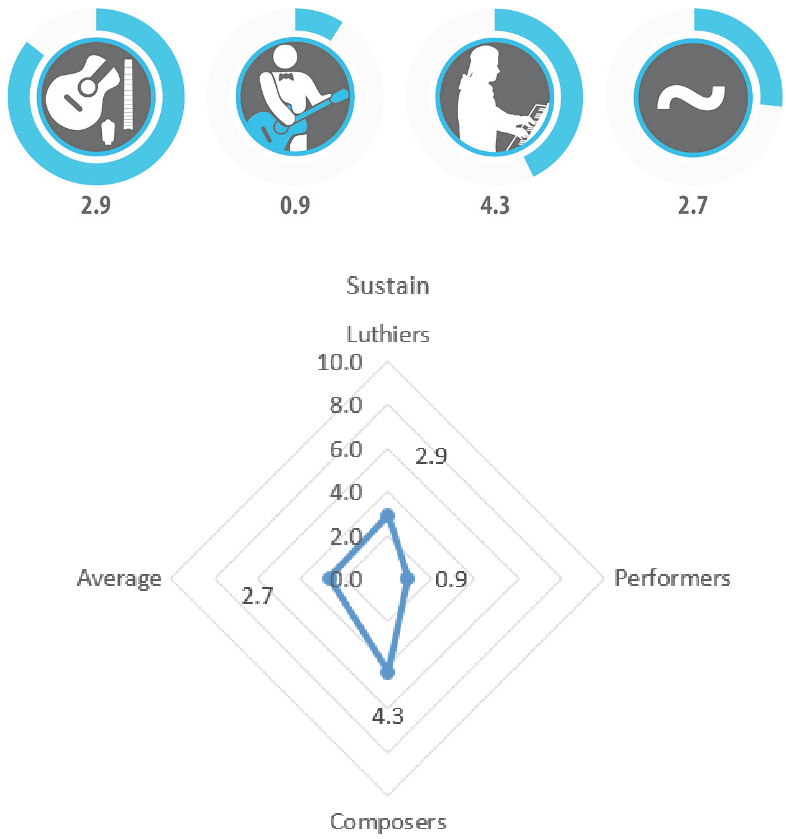

Figure 103 Distribution among participant groups for code "Sustain"

Sustain is important in order to hear different partitions of a piece (CS, EB, EP, FK, HH, TE). High, mid and low frequencies should sustain more or less the same, otherwise one overpowers the other partition (EB). Long sustaining guitar sounds as if tones are sort of embracing the coming tones (TE), and short sustain is a challenge (CS). On the other hand, long sustain comes with its own difficulties: off the tone sustaining voices and overtones should be silenced by the performer (McAllister & Watt, 2014c). Sustain was mentioned as a quality which sometimes needs to be overcome when composing for guitar (CS). The Classical guitar has relatively short sustain ability, and this is one of its constraints; but there are some techniques used by composers (i.e. tremolo) to prolong its sustain ability. It was observed during the interviews that string quality have a strong effect: carbon or other high tension strings which has high stiffness seems to sustain shorter than less-stiff nylon strings.

4.3. Results Unique to Luthiers

The luthiers was chronologically the first group of the interview series conducted with a sub-group consisting of seven luthiers in order to elaborate on their perspectives concerning performability. Master builders shared first-hand information regarding their design-and-make activities, which were often user-centred and shaped by their clients' needs. What interests me most in this subgroup of interviews is the role of design, they realise in an attempt to facilitate the playability beyond a mere consideration of body size and anthropometrics of prospective consumers. Master builders take into serious consideration the needs, preferences and requests of players and make changes accordingly when they make for specific players. In fact, their manufacturing activities are two-fold: (i) making for specific clients and (ii) making instruments to be sent to national or international agents where they are displayed physically or virtually through online channels, thus the end user is indefinite. When they make for specific players, as in the first case, each instrument is bespoke and unique. They take into consideration the preferences of their clients besides dimensions and anthropometrics,. However, when they build for an indefinite user, as in the second case, they aim to meet a *standard* performer's needs and body size.

One of the distinct characteristics of luthiers is the mathematical logic of instrument making they possess. They bear a relationship with the chemistry of their artisanship and they have a clear insight concerning the playability concept. There is a tendency to explain this term by breaking it down into (a) top tonewood, (b) fingerboard, (c) bracing system, (d) back plate and sides and (e) instrument scale. The majority of the luthier participants demonstrated willingness to use their *formulas* to increase the playability of their production. 3.57 of them mentioned the playability as an important goal, whereas the others expressed signs which imply that the traditional

Classical guitar manufacture in the present day does not demand considerable amendments. Their tacit knowledge is the key to the playability according to v=5.7 of luthier participants.

The luthier interviews provide support to suggest that the playability of an instrument depends on two variables: instrument and performer (NB interviews with performers and composers point to additional variables, see Sections 4.3 and 4.4). It is safe to suggest that the luthiers are mainly instrument and performer oriented, that is, they know the mathematics of making playable guitars and they care for performers' needs and preferences. Luthiers, besides accepting the significance of a playable instrument, quite often pointed to a performer's skill (v=8.6) for performability. This view supports that the performability is something brought out from an instrument by the technical approach of a performer, even though a playable guitar is also important. That is, most well-known guitars can be fully exploited only in the hands of a master performer. In other words, they become a tool to make music with expressive beauty when played by those who have the required skill, therefore, performers need to have the correct technique. Therefore, for some luthiers (PB) difficulties of conventionally constructed instruments should not pose any issues; these should be seen as performers' issues, in line with the literature (Heijink & Meulenbroek, 2002; Parlitz et al., 1998; Rosenbaum et al., 1996) which supported that left hand overuse of muscular torque and wrong posture are problems of the amateurs, whereas virtuoso performers overcome those issues during their training. On the contrary, v=8.6 of the luthiers state opinions that the instrument is as important as its performer (AE, AM, CL, HH, EP, TS) in order to not fight against it.

> *A performer would encounter problems in terms of expressivity, even though they, for sure, can make music on low quality instruments. Performer and luthier are on the lookout for feeling, expressive capabilities, colours and dynamic qualities a fine guitar can offer. In a concert, a well-known guitarist may perform dead-pan or without feeling. Therefore, the capability of transmitting musical ideas and*

dynamics is the important thing. Consequently, if a guitar is more playable, the performer can "forget" the technical part and concentrate on making music. (CL)

An important observation is their ability to foresee the consequences of various structural qualities like top tonewood thickness and geometry, fingerboard angle, interior strutting, action height, materials used in back and sides and proportions and sizes of instruments. All luthiers stated these concepts as significantly important to determine the end product and they are certain that a master builder could modify these qualities to fine-tune their instruments. The interview series indicate five concentrations concerning the performability: Top (v=10), Fingerboard (v=5.7), Interior Structure Quality and Bracing System (v=5.7), Back and Sides (v=4.3) and Instrument Scale (v=4.3)

4.3.1. Top Plate

Based on the data gathered from the interview series, the top tonewood of a Classical guitar is rated as the most important part of guitar design by all (v=10) of the luthier participants. It is of primary importance to define tone, response and volume (AE, AM, CL, EP, HH, PB, TS). However, based on the field work and desktop research, one may argue that luthiers, besides performers, have controversial opinions concerning the technology-bound innovations in top tonewood development emerged after the 1980s. Much of the conflict roots from the new applications of wood and new materials, in addition to the subtle ways to work the wood material which in turn creates one's trademark sound. Andrés Marvi has strived for his unique tone throughout his long career (AM[23]). Marvi is not the only one with a never-ending curiosity; Ana Espinosa describes her hybrid model as being playable like a Flamenco with a classical guitar timbre and personality. "*I chose the wood for*

[23] *Well, the sound is special, it is my sound. You cannot make copies. My guitar production has come a long way. I have my own evolution. Guitar makers should fine their own sounds. Copying a luthier doesn't work in the long run. This is not the way. My guitars from some 30 years ago are different from what I make these days.*

Flamenco, and I made a classical guitar system in the top. Fingerboard is somewhere between the classical and Flamenco guitar. A fine balance."

Expressiveness of a guitar mean a lot for a performer (AE) and it is an important determinant of comfort (EP). Nevertheless, it is a challenging duty trying to get a similar quality and character from different guitars although they are made using the same exact materials and methods due to numerous variables in wood quality and the way to work the wood (AM, EP, PB, AE, TS). Eventually, the interviewed luthiers explained to have developed some approaches to tame these inconsistencies between different materials that form five sub-categories (see Table 5): Material and Tonewood (v=10), Geometry (v=7.1), Thickness (v=5.7), Top Tone (v=1.4), Workmanship (v=2.9).

Table 5 Dataset for code family "Top Plate"

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Top Plate	***10.0***	*3.6*	*0.0*	4.5
Material and Tonewood Selection	***10.0***	*3.6*	*0.0*	4.5
Geometry	***7.1***	*1.8*	*0.0*	3.0
Thickness	***5.7***	*0.0*	*0.0*	1.9
Workmanship	***2.9***	*0.0*	*0.0*	0.9
Top Tone	***1.4***	*0.9*	*0.0*	0.8

Material and Tonewood Selection is rated as the highest (v=10) sub-category concerning the top tonewood. The quality and aging is substantially important (AE, AM, CL, EP, HH, PB, TS). On the contrary, it was already mentioned earlier in this chapter that, as it was nicely expressed by a luthier participant, "*it is the luthier who makes guitars from that wood*" (PB) and what is of greatest importance here is the lutherie of a maker. This is in line with the perspective extensively shared by makers and performers that "*[e]xpensive guitars are made from expensive materials to meet commercial expectations, not to meet structural or acoustic requirements*" (Huber, 1994, p. 82). It justifies the significance of a craftsperson's artisanship. Each top has its own tone (Top Tone, 0.71) and it needs to be modified accordingly (CL). Selecting the wood is important, as different qualities result in different characters. Even the same wood can provoke different qualities (AE, CL, EP, PB). Wood grain patterns provide useful information about its seasoning. Regularity and uniformity of grains (age circles), be it finer or rather wider, means that the climate and humidity was regular through the years, whereas a mix of fine and wide age circles point to a change of climatic conditions (CL, EP, PB; Bucur, 2006). "*Some luthiers prefer a denser… or wider age circles in a finer pattern*", so it is not simple to decide which one is superior (PB). The top tone is the tone of a tonewood which is something inherent. Luthiers understand this quality by their tacit knowledge and how they should modify it, therefore selecting the top tonewood and deciding how to work on it is an important determinant of the overall quality (CL, EP, HH, PB).

> *For instance this red cedar (showing two tonewood sheets as seen in Figure 104) has straight age circles but they are not very fine, they are rather wide. It produces a specific timbre. This is an excellent top, age circles are finer and more uniform. We can't say one is better than the other, but they are different. This one (the finer one) produces a sweeter tone, whereas the other is different.* (CL)

Figure 104 Casimiro Lozano explaining different tonewoods during the interview

Top Geometry (v=7.1) is a tool to cope with different material qualities and densities (AE, AM, EP, HH, TS). Depending on different densities of wood, makers modify the top geometry, if the wood is very soft, they "*need to increase the tension, namely the top's bump*" (EP). Figure 105 shows the final geometrical form of the top tonewood from (1) flat to (3) curved top geometries made by luthiers. This curve takes its final shape after the guitar is fitted with strings; the string tension increases the curve. Some luthiers make it flat, and some of them create a curved top which, they believe, enable them to work the top thinner, thus improve the vibrational capability of the top plate. The tensile force of strings needs to be estimated by makers so that the top will get its "ideally" perfect form. "*[It] means that the string pulls the top out… and I can go thinner in this part… so it is not important to have a strong top plate there. I make it very thin. It's better for vibrations*" (AM).

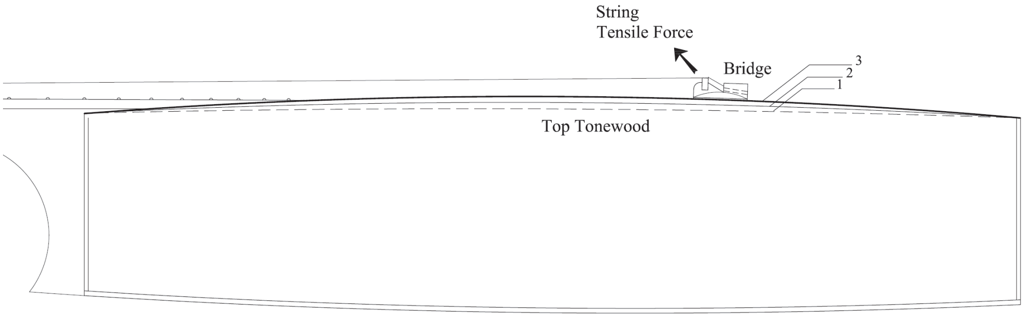

Figure 105 Top tonewood geometry and string tensile force effect

Figure 106 Vibration of top - Holographic Interferometry, 533 Hz. (Richardson, 1994, p. 6)

Some luthier participants explained geometrically modified top plates realised by replacing the soundhole in order to gain space for the vibrating mass. One reason, as *Figure 106* shows, is that guitar top soundboards have important modes (vibrating regions which have varying shapes with respect to frequency) around the lower bout. Replacing the soundhole to the upper bout of the body around the neck connection saves up some space and ensures that the top will have more vibrations thanks to a greater surface area. Theo Scharpach designed a free-floating top which is aimed to minimise the damping of the neck on the soundboard (because the contact area is minimised) and to enhance the capacity of the top tonewood (Scharpach, n.d.).

Figure 107 Theo Scharpach Free-floating Top (WEB 59)

The idea of modifying the traditional geometry of the soundhole is often attributed to Francisco Simplicio and his experiments back in the 1920s (Huber, 1994; McAllister & Watt, 2014b). Theo Scharpach applied this idea, firstly, to gain space, and secondly, to create a stereophonic effect. Scharpach double soundhole's unique shape and size is based on experiment. As seen in *Figure 108* (centre) and *Figure 109*, the two soundholes, named as bass (47.4 cm^2) and treble (17 cm^2) soundholes, have different shapes and sizes:

> *[These soundholes] are not this way just by some accident, there is a reason why they are different and asymmetrical. One friend of mine helped me measure the necessary sizes of those holes by miking the room at different positions to see how these two holes have a negative and positive influence in each other. So, the shape of that sound hole is very important. And interesting enough, double-soundhole guitar is very difficult to record. Human ear can hear the sound in ambience along with the echoes and ambience sounds, but when you put the microphones close, then you have to deal with a gap between the sound holes. So, it is really difficult to get the whole image of the guitar's voice in a good*

recording. But these sound holes have a positive influence to push the sound forward. (TS)

Figure 108 Unusual sound hole placement and designs / [left] Francisco Simplicio (WEB 60), [middle] Theo Scharpach (WEB 61), [right] Christopher Dean (WEB 62)

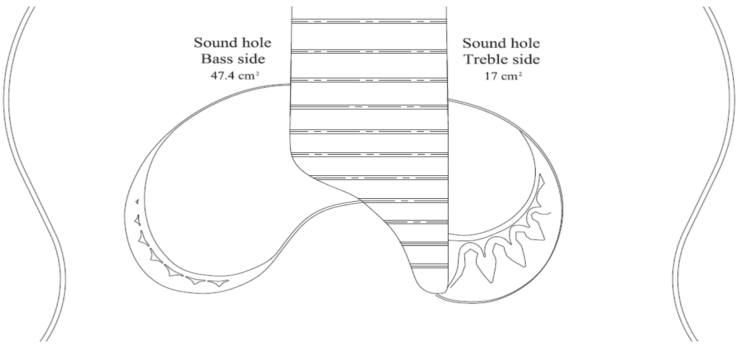

Figure 109 Scharpach double soundhole form

Top thickness has a fine balance and has a direct connection to contemporary guitar design methods. The luthiers, who praise traditional construction methods, deem very thin tops responsible for the lack of timbral variety in non-conventional guitars. Traditional guitars do not have very thin tops (AE, EP, TS, PB), they are rather thick around 2.3 to 2.7 mm. as opposed to exceptionally thin contemporary tonewoods whose thickness is often less than 1 mm (Summerfield, 2002). As Franz Jahnel (1973) explains in his work with the title of "*Developing Guitars Under Repeatable Situations*", if the thickness of a soundboard gets thinner, especially if two thin tops are glued to each other, it gets easier to get the same quality repeatedly in an industrial setting, because this method simply vanishes the unique characteristic tones of a soundboard. Therefore, this is said to have decreased the tonal range and timbral variety of a concert guitar. Jahnel's paper aims to explain the mass-produced industrial factory guitars and he does not point custom made master guitars. However, a soundboard made up of two thin tops glued together, explains the double-top concept and this marks the beginning of a fiery argument in guitar manufacture today. As the double-top soundboard becoming an industry standard, many performers have argued in favour of double-top and composite-top construction methods including star virtuosi, such as David Russell or Jason Vieaux, whereas the supporters of traditional classical fan-braced guitars advocated that this new soundboard design would bring a lack in timbral variety.

4.3.2. Fingerboard

Fingerboard is mentioned by v=5.7 of luthier participants in relation to (see Table 6) Fretwork and Precision (v=5.7), Fret Shape and Relief (v=2.9) and Bass Side Asymmetry (v=1.4). Precision is often associated with the action height (AM, AE, EP) and correct tones (CL, EP, HH, PB). If the fretboard and all frets are precise, a luthier can set up a lower action height (AM). Although preferences for fret shape and relief vary, the luthier interviewees define higher frets to be more playable (EP, TS). The flat ones are not in demand, and slightly curved ones make barres easier. High relief frets offer elasticity. Higher frets give more possibilities with the right hand (TS). *Figure 110* shows the most frequently used fret type and dimensions.

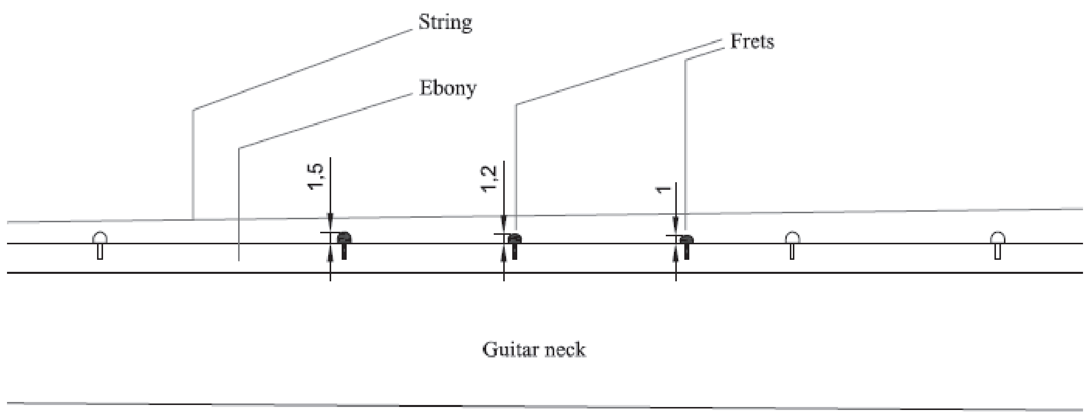

Figure 110 Most common fret measurements

Elevated fingerboard concept is one of the most controversial design implementation in Classical guitar manufacture (Morrish, 2002). Contrary to what is often believed, elevated fingerboard was not introduced by Thomas Humphrey; the archtop guitar, often credited to Orville Gibson, had long featured elevated fingerboards prior to Thomas Humphrey. Instead, Humphrey was the first maker who adopted it to the Classical guitar. This elevation facilitates the reach of player to the higher registers, because depending on the angle and the way the neck and sound box in connected, the fingerboard is raised so that the higher frets are clear of the guitar body. Eventually, the elevation allows the performer to reach higher registers with less effort (AM, AE, TS) as seen in Figure 111. An important observation from luthier interviews indicates that the elevated fingerboard not only caters for facility to reach high registers, but as a serious outcome in luthier terms, it gives a new angle to the fretboard in relation to the soundboard that was mentioned by v=4.3 luthiers.

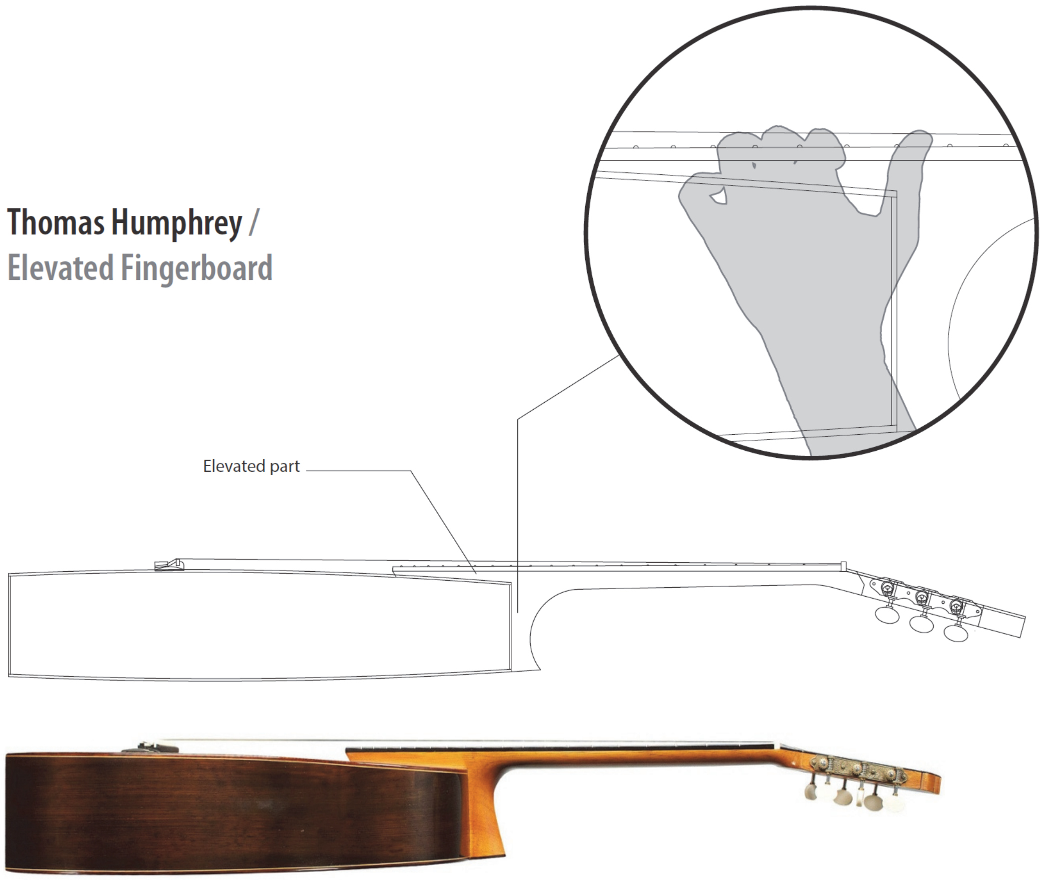

Figure 111 Thomas Humphrey, Elevated Fretboard (Image source: WEB 63)

Table 6 Dataset for code family "Fingerboard"

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Fingerboard	***5.7***	*3.6*	*0.0*	3.1
Fretwork and Precision	***5.7***	*1.8*	*0.0*	2.5
Fret Shape and Relief	***2.9***	*1.8*	*0.0*	1.6
Bass Side Assymetry	***1.4***	*0.9*	*0.0*	0.8

Guitars manufactured by Thomas Humphrey, the so-called Millennium model which features his famed raised fretboard (Figure 111) features a sound box that gets thinner where the sound box is attached to the fretboard. The space loss in this part results in a diminish in the sound power and timbral range meaning lower volume and narrower sound spectrum (CD). Therefore, cautions concerning this design implementation was observed during luthier interviews. Different luthiers apply different fretboard elevations and neck angles. Andrés Marvi stated that he elevates only 4 mm. because it gives a better sound and balance to his guitars, whereas Humphry raised around 15 to 25 mm. in different guitars (Morrish, 2002).

An alternative to Humphrey elevated fretboard is the infamous cutaway guitar body that is often seen in mid-low quality classical guitars or steel strung guitars for which the volume and power are not the primary concerns. Central to cutaway body design is that the part, which is cut and removed, does not encompass seriously important vibration. Richardson's Holographic Interferometry (*Figure 106* and *Figure 114*) shows that cut-away region does not have important vibrations up to 553 Hz, which is normally close to the higher end of Classical guitar tonal range. However, the cutaway guitar design would reduce sound production ability and some higher harmonics of a guitar, though. Therefore, concert performers do not prefer to play on a cutaway guitar (personal observation). Theo Scharpach, instead, designed a unique semi-cutaway guitar body (*Figure 112*). His design implementation allows for easy access and reduces a relatively small part of the soundboard. In short, his design alternative does not cause a regression in volume.

Figure 112 Theo Scharpach guitar semi-cutaway with elevated fingerboard (WEB 64)

Bass side asymmetry is the asymmetrical surface structure of a fretboard. Its purpose is to minimise the string amplitude differences. Action height of a Classical guitar is usually somewhere between 2.5 and 5 mm. Bass and treble strings have different diameters. In addition, 5th and 6th strings cause larger oscillations than the 1st and 2nd strings. Therefore, they cannot have the same action height. A solution is the bridge saddle: it allows for different action heights for different strings. This can partly satisfy a performer's needs, but cannot completely solve the string amplitude difference problem. Luthiers create asymmetrical fretboards, as seen in *Figure 113*, that drop off a little in bass side to allow for a bigger action height for bass strings which create larger oscillations, whereas treble strings can still remain relatively closer to frets for a comfortable low action.

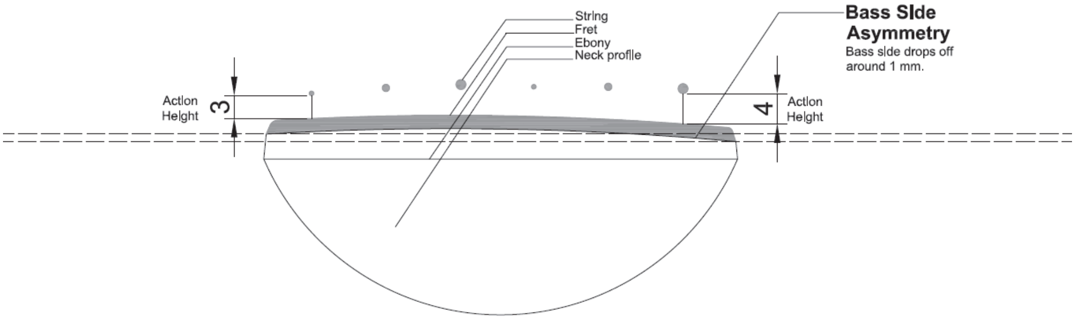

Figure 113 Asymmetrical Fingerboard - Bass Side Drop

4.3.3. Interior Structure Quality and Bracing System

Bracing patterns have a great influence to define the tonal character of a particular Classical guitar (AM, EP, HH, PB). *Figure 51*, *Figure 52* and *Figure 53* in Section 3.1 explain the strutting systems of three famous makers of history. Detailed design modifications and subtle differences in the bracing patterns of these famed luthiers can be seen in these figures. These modifications may alter the resonance frequencies, distribution and shape of modes which give each instrument its unique tonal character (Richardson, 1994). The precise shapes of the modes can be detected using advanced equipment and Holographic techniques. *Figure 114* shows the vibrations on guitar soundboard under (a) 268 to (j) 1174 hz. frequency.

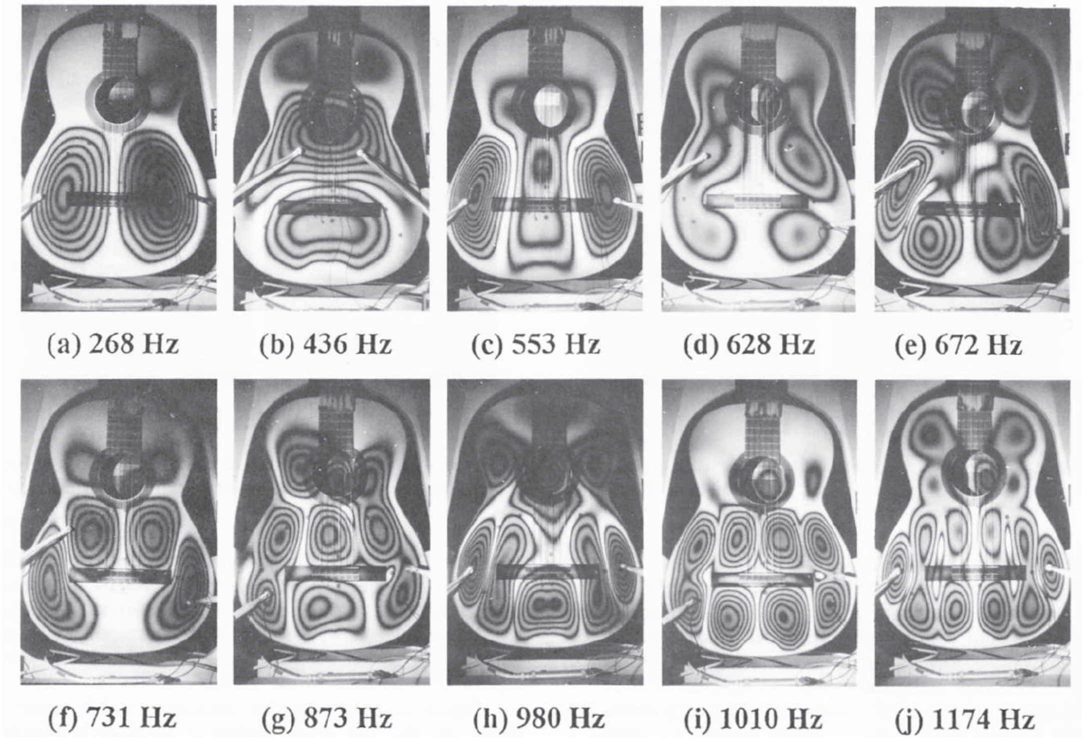

Figure 114 Holographic Interferometry - Modes of vibration between 268-1174 Hz (Richardson, 1994, p. 6)

Defining the modes' shapes is the fundamental duty of bracing and coupling between strings and body, which in turn defines the tonal qualities of each instrument (Dominelli, n.d.). As can be drawn from *Figure 51*, *Figure 52* and *Figure 53* Section 3.1 an unlimited number of variations –can be– and have been implemented in bracing systems by numerous luthiers. In addition to fan-struts, a set of harmonic bars of different length, thickness and alignment were devised by different makers. Those include angled harmonic bars used by some luthiers including Ignacio Fleta, Jose Ramirez, Santos Hernandez, or as David Rubio prefers to name it the *nodal bar* which he used in his later guitars that refers to an extra bar from the centre of the bridge plate to the edge of the soundboard. In addition to harmonic bars, very unique strutting patterns of curved braces (i.e. those of Casimiro Lozano or manuel Contreras as seen in *Figure 56*a) paved the way to create specific timbral characteristics of different makers.

Fan-struts lie alongside the grains of a tonewood (e.g. *Figure 51*) and their aim is to balance longitudinal and transverse stiffness of the top plate. As a slightly different phenomenon, harmonic bars (especially an example to this phenomenon as seen in the José Ramírez guitar in *Figure 52*) add asymmetry, thus creates asymmetry in vibrations altering timbral colours. This asymmetry could be seen in *Figure 115*b; left and right sides of the soundboard move differently, as opposed to Figure 115a and c, and can elevate the sound radiation of an instrument. Modes involving equal amounts of movement in left and right sides -bass and treble sides as seen in *Figure 115*a, c and d- "*are naturally poor radiators of sound because they induce no volume change in the air as they vibrate*" (Richardson, 1994, p. 5).

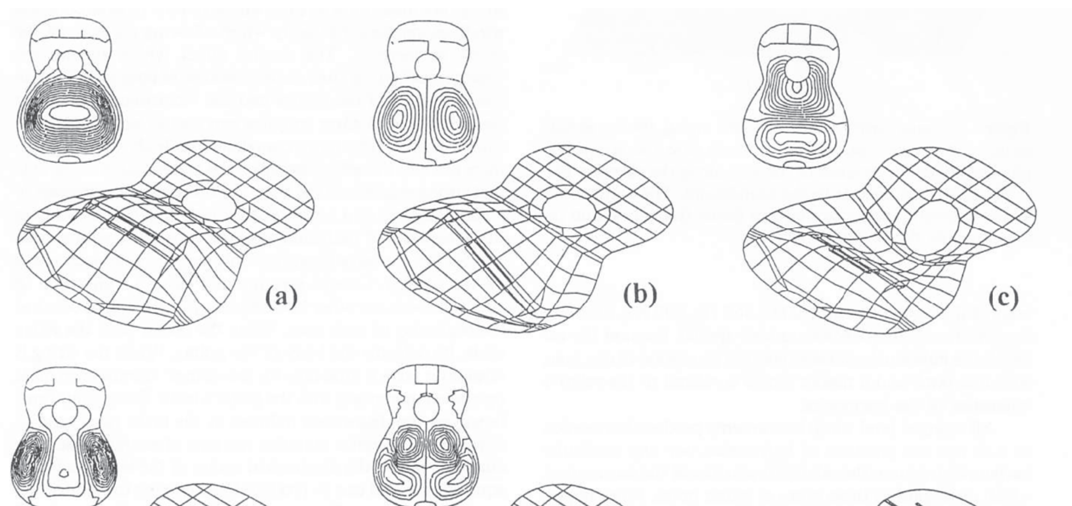

Figure 115 Classical guitar soundboard contour and relief plots of vibration modes (Richardson, 1994, p. 4) in (a) 150 to (e) 800 Hz range (and (f) the particular guitar's internal strutting)

4.3.4. Back and Sides

Back and Sides code was mentioned in relation of Back and Sides (v=4.3), Material (v=2.9), Tension (v=1.4), Thickness (v=1.4) as seen in *Table 7*. Double-sides in guitar manufacture was researched thoroughly and popularised -if not developed- by the French luthier Daniel Friederich and applied by some makers such as Andrés

Marvi from interviewed luthiers in addition to Manuel Contreras and Dominique Field. The back plate or sides do not produce a tone in guitar, but their most important function is to project. However, that does not mean that these parts do not contribute to the overall interaction and tone colour; the simplest explanation for their function is that they add harmonics and depth to the guitar voice. The problem is that, the back and sides, like any piece of mass, tend to absorb energy. Guitars with double sides and/or thick back plates aim to minimise the energy absorbed by the back and sides. If the sound box, thus the back and sides, is strong and tough, it does not absorb "*that much*" energy (AM). Especially double back and sides is used in Brazilian rosewood guitars because this rosewood type often comes in thin sheets. A double back and/or sides do not vibrate (which causes some energy loss) as much as a thin back does, therefore, in lutherie jargon, it caters for a *walking* and resonant top.

Table 7 Dataset for code family "Back and Sides"

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Back and Sides	***4.3***	*0.9*	*0.0*	1.7
Material	***2.9***	*0.9*	*0.0*	1.3
Tension	***1.4***	*0.0*	*0.0*	0.5
Thickness	***1.4***	*0.0*	*0.0*	0.5

In addition to double backs, Manuel Contreras has made double tops; in contrast to what is often believed, Contreras double top is in fact different from the Nomex double tops: the top is stabilised to the back plate. Thus, his sought-after design innovation, is worth a mention. Contreras double-top design motive finds its roots in the increased mass-to-strength ratio. Theo Scharpach design process includes arched backs. The arched back is a near-iconic Australian school guitar feature applied by many Australian makers like Greg Smallman and Simon Marty. Scharpach explains central to his arched back and/or sides is to make them tougher and reduce their vibration capability (TS). If the back and sides vibrate less, then they can project the image of the guitar sound better and cater for greater vibrations in the top tonewood (AM, TS). *Figure 116* shown an arched back Theo Scharpach guitar whose back has a curve that increases its strength reducing the vibration capability. Andres Marvi uses double sides and a thick back plate; in addition, he explained his four-bar back bracing (*Figure 117*) in order to make it harder and stronger (AM).

Figure 116 Theo Scharpach arched back (WEB 65)

Figure 117 Andrés Marvi showing his four-bar supported back plate (Source: Chris Kamen, Interview with Andrés Marvi, WEB 66)

In the present day, the prevailing paradigm of selecting wood for back and sides of top quality concert guitars is exclusively Brazilian rosewood (Dalbergia Nigra) centred (Sloane, 1976). There has been a rise in the demand for Brazilian rosewood since the 1990s. This is claimed to be a marketing strategy, because Brazilian rosewood has been one of the most traditional woods in classical guitar manufacture for more than a century, but not exclusively. Ignacio Fleta (Spain), Danielle Friedrich (France), Hermann Hauser (Germany), José Ramirez (Spain), José Romanillos (Spain) and others manufactured classical guitars of outstanding quality using another wood: Indian rosewood (Dalbergia Sissoo) or East Indian rosewood (Dalbergia Latifolia), which has quite similar qualities to Brazilian rosewood. Surprisingly, since Brazilian rosewood was listed in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) in 1992 as an endangered species, prices of this wood increased dramatically. Hence, it would be considered a luxurious and top quality wood since then that is used solely for finest instruments. Especially dark coloured Brazilian rosewood with fine grain patterns is extremely rare and expensive (personal observation). On the contrary, guitars from the first half of the 20th century quite often feature Brazilian or Indian rosewood independent of their price and exclusivity (Bucur, 2006). Brazilian rosewood is considered to have a slightly punchier and deeper sound, whereas Indian rosewood offers more purity and stability. In addition, Indian rosewood is much more resistant to cracks and humidity changes (AM; Bucur, 2006; EP, PB) which ensures stability in timbre quality for a musician touring across different continents and climates.

High commodity price is an important determinant for selecting concert instruments. High quality materials, for instance some fifty-year-old high grade Brazilian rosewood is expensive, so is a guitar made from that material; but not equally proportional with a comparatively less expensive material-inexpensive guitar combination. That is, expensive guitar-cheaper guitar comparison has a much steeper slope than an expensive material-cheaper material comparison. In other words, if expensive materials cost twice as cheaper materials, then guitars (made with expensive materials) cost much more than twice as guitars (made with cheap materials). It is because "*[t]he quality of the materials are definitely related to the ultimate quality of the guitar, but not necessarily in proportion… [g]uitars with* *expensive woods and high selling prices usually receive better workmanship than do cheaper instruments by the same maker*" (Huber, 1994, p. 82) which explains the exaggeratedly high price tag of Brazilian rosewood guitars –although Brazilian rosewood material itself is not that expensive. Nevertheless, this fact does not help stop the increasing demand for this "nearly extinct" rosewood in top quality concert guitar manufacture.

4.3.5. Instrument Scale

Scale length is a term used for a Classical guitar's string size measured from bridge saddle to nut (see *Figure 118*). The standard string length is 650 mm. but, there is some room for variation. Depending on the performer, the scale length can be expanded or stretched between (usually) 665 and 640 mm. The need for variation in scale length arises from the ergonomic differences of users. Prevailing Classical guitar scale length values are 640, 650, 655, 660 and 665 mm (AM, CL, EP, HH). v=4.3 of luthier participants proposed instrument scale as an important determinant of performability (AE, AM, CL, EP, HH, PB, TS), as it is directly related with performer needs. *Figure 118* shows different scaled guitars in relation to a fixed performer body. Different scale lengths affect the fret sizes and placements, neck thickness and width, as well. Some makers interviewed argue that the standard 650 mm. scale length may not give the best results; 660 mm guitars can give better results than the standard 650 mm (CL, EP), because their string tension is higher which caters for longer sustain of voices. However, not many performers prefer 660 mm. size as they are not accustomed to it (CL).

Instrument scaling requires a precise wood work to correctly scale instruments due to a very complex phenomena: string amplitude. Classical guitar strings are made using different materials. Trebles are usually made of nylon variants or carbon composites, and bases are made of metal alloys with nylon or silk core. Therefore their amplitudes are fairly different. It requires very high craftsmanship and a great hearing ability to create equilibrium between different string diameters and differently stretching strings. The compensation is necessary because strings expand differently when they are fretted. When pressed, the 650 mm string length grows an extra 2 mm (HH, TS). Therefore, string length is never 650 or 640 mm, when compensation is taken into account (HH[24]).

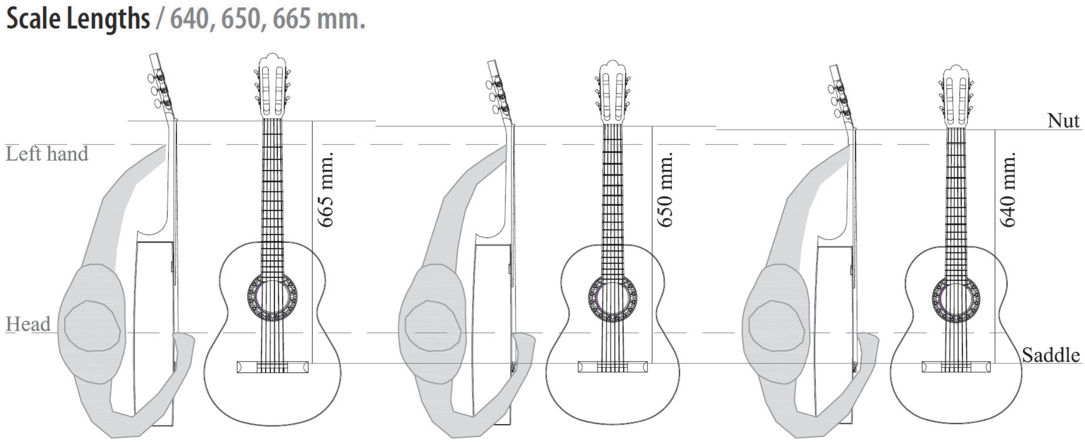

Figure 118 Different scale lengths and scale object

4.4. Results Unique to Performers

The second part of the interview series was conducted with a subgroup of eleven performers. Performers selected depending on their instrumental preferences and musical approach, so that the participant list includes concert performers playing on conventional and non-conventional instruments, as well as academics and guitarist-composers. In other words, the performer subgroup has participants of different genres and styles which facilitate to unveil different perspectives. Videos and recordings were transcribed into text afterwards, and the text was utilised through the qualitative analysis phase. Research proposes different concerns of performers regarding performability. In fact, the way performers explain their need for playability does not necessarily parallel the goals that luthiers try to achieve. Performers seem to have concerns that could not be addressed by the playability which made it necessary to coin a new term, performability, throughout the study.

[24] *This is something to do with the playability of an instrument because if it's not clean, you have a big problem. Including the compensation it is not 65 centimetres, it is 65.2 maybe. The first string is 64,8 the second string is 64,9 and for the G string we have exactly 65 including the compensation.*

Analysis reveals three clusters of prevailing performer opinions regarding performability of classical guitars. The first one is related with the playability rooting from the Sonic Appeal of an instrument and observations are concentrated around three codes: Correct Intonation (v=2.7), Response (v=3.6) and Sound Concept (v=2.7). The second cluster, Directional Projection, is about audibility on stage as an ensemble member to other members or to the conductor (if that is an orchestral concert), which were mentioned in relation to Sound Hole(s) on the Sides (v=1.8) and Projection (v=5.5). The third cluster, Performer Wellbeing and Instrumental Adaptation, is about the performability that arises from one's own technique which was inserted into codes such as Making Music vs. Performing (v=8.2), Muscles (v=5.5), Energy Economy and Muscle Relaxation (v=2.7) and Fight against the Instrument (v=2.7). Unlike luthiers, performers use subjective and complicated terminology to communicate their needs and preferences. Their comments are more abstract in their nature and have intangible borders. Therefore, these three clusters, explained under the following subtitles, will be explained within combinations of different codes (whereas the luthier outcomes were explained code by code).

4.4.1. Sonic Appeal

The first cluster revealed is the playability arising from the sonic appeal of an instrument and it was mentioned by v=4.5 performers (see *Table 8*). It is about the high potential ceiling of the instrument for musical expression. Correct tones are a primarily important '*must*' rather than a quality (KT) and was mentioned by v=2.7 of performers (KK, KT, SE). However, the difference from luthiers is that, some performers, on the contrary, feel cautious about playable guitars, and some of them showed critical attitudes towards (AK, IR, KT, KK, SE). A playable guitar offers comfort and effortless execution at the cost of tonal colours, though (IR, SE).

> *I think that an easy to play guitar is the one that allows all the technical and musical aspects happen in a way that saves effort… Then, in this case, I think that two circumstances often coincide: in my opinion, an*

easy guitar is the one with less timbral colours. This is what I've seen in my experience, and it is very difficult to find a balance between playable and colourful guitars. (IR)

Table 8 Dataset for "Sonic Appeal" and related codes

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Sonic Appeal				
Response	*0.0*	***3.6***	*1.4*	1.7
Sound Concept	*0.0*	***2.7***	*0.0*	0.9
Correct Intonation	*0.7*	***2.7***	*0.0*	1.4

Codes cumulated in this cluster point to the playability arising from the domain of sound. The satisfaction of sound takes precedence of playability and comfort, even though a guitar is not ergonomic and easy, the tonal beauty of that instrument can be a preference over the ease of playability (OH, SE). Although performers complain about difficult guitars at times, it is an obligation for a concert performer (KK[25], SE[26]), and they have to press even though these guitars have a high action, "*just like a cello player has to press, as well*" (SE[27]). On the other hand, it does not mean that the concept of playability is compatible with a guitar which is sonically appealing but physically painful. The performers' praise for traditional guitars' sonic appeal over non-conventional guitars is a manifestation of their preference on the near-iconic status of the so-called "old world sound" over the innovation-induced non-conventional instrument. Nevertheless, some performers argue that contemporary guitars, which are often deemed playable but sort of deficient colour-wise, did not lose traditional guitars' charm, because it is given by the performer (CS, EB, HM, JM, MD, SE), and they have their own charm (JM, MD), but they require a slightly

[25] *I'd wish to have a playable and comfortable guitar, too, like others; but I have to bear in mind that there are other important factors such as volume, dynamics and colour. A milder guitarist, who plays mellower than me, may feel more comfortable with a "player friendly" guitar, thus could prefer a more playable guitar.*

[26] *If you love, you wouldn't care whether it is easy, high, low etc. I do wish I'd be able to have an easy and "lovely" guitar (laughs).*

[27] *For many years we complained about difficult guitars, such as high action, but eventually, at the age of 28 or 30 we all acquired a sort of guitar which we had criticised and complained before. Because that is an obligation.*

different technique (JM, MD).. Once a performer learns how to attack them, the contemporary guitar reveals its own charm and beauty (JM, MD).
The Sound Concept code is rated v=2.7 by the interviewed performers who associate it with the sonic beauty (HM, IR, MD), which is disappearing (IR). Reportedly, an important consequence of the playable guitars is that there appeared a uniformity in the sound of many performers lately (EB, IR, KT, SE), rooting from the *over balanced* contemporary and, so-called playable instruments.

> *I think that the concept of sound is getting lost while many players including students and professionals playing without any characteristics in their sound unique to them. I think so; or if not getting lost, they are converging into a uniform and standard sound. (IR)*

Figure 119 is an illustration which visualises performers' understanding of playable guitars in an abstract way. It is a combination of comfort, power and expressive qualities. In addition, "*[g]uitarists, however... must also master the art of sound production*" (MD). Each performer should look for their sound concept; and a performable instrument can instruct them to find their tone by offering them a rich and wide spectrum of colours (HM, JM, DM), it is a matter of unveiling those sounds sometimes "*by chance*" (HM).

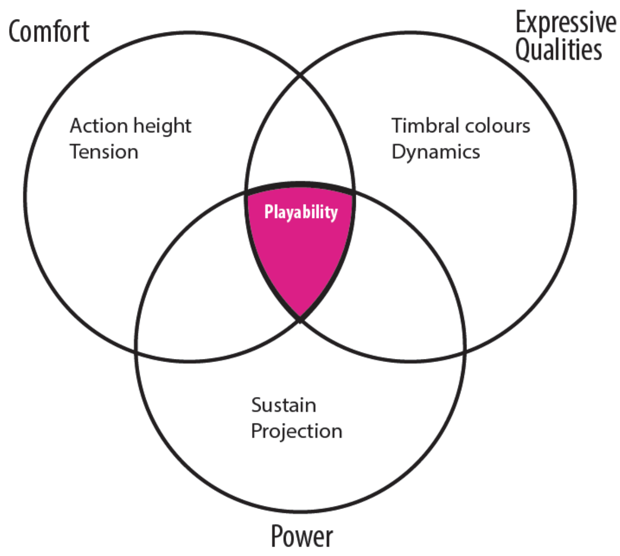

Figure 119 Comfort, Expressive Qualities and Power

Despite the cookie cutter syndrome of performers, for which contemporary guitars have been partly accused of, performers agree that an easy guitar is essential for a guitarist who often gives concerts. The comfort given by a playable guitar enables a player to focus on music and interpretation rather than just performing (AK, CS, IR, JM, MD). Marcos Díaz, in parallel, is a believer in the value of effortless sound production, and physical and cognitive considerations of instrument designers:

> *What I expect as an interpreter is that these guitars (talking about his non-traditional guitars, Matthias Dammann and Stephan Connor) should allow me to make music the easiest way possible, develop speed, handle different timbres, perform dynamics and create my personal sound. Especially developing my own sound and my personal way of interpreting music... (MD)*

Response is another quality associated with the sonic appeal and mentioned by v=3.6 of performers. The response of a Classical guitar is the voice or tone that is produced and projected upon an attack and is dependent on a set of variables. It is explained by performer participants that strutting patterns has the greatest effect among many (AE, CL, EP, HM, TS). As it is explained in Section 4.1.1 and 4.1.5 (a) good coupling between strings and top tonewood and (b) efficient sound radiation ensures an adequate transfer of energy from strings to the vibrating surfaces of the guitar. And our ear perceives this energy as sound. To sum up, good coupling means an adequate connection (neither too stiff nor too loose) of strings and top, and efficient sound radiation is enabled by a carefully regulated stiffness-to-mass ratio determined by virtually limitless strutting styles and patters, and properly controlled shapes of the modes (Richardson, 1994, 2010; Stenzel, 2004, 2010). Efficiency of the above-mentioned energy transfer has a serious effect on response, so to speak, the first thing a listener hears from an instrument. Initially, we first hear the tone of a guitar played by a performer (KK).

When the coupling increases, in other words gets stronger, "*the radiated harmonics of the string increase in initial intensity but decay more rapidly*" (Richardson, 1994), because the energy applied by the nail is consumed faster. *Figure 120* shows the effect of over-coupling and the decay of the voice; besides the criticism found in the literature, some contemporary non-conventional Classical guitars are criticised for their responsive but quickly decaying tone, especially on higher notes (McLellan, 2013), which seems to be a disadvantage for some expert participants (HM, HH, EBa, TE, TS). The powerful voice of some contemporary guitars lacks purity and sustain of more controlled instruments (Richardson, 1994), warm and rich character of traditional instruments (AK, HM, IR, EB). This clearly is a dilemma among guitarists, because this intense but immediately vanishing tone is perceived as being louder than it actually is. In addition, it is also perceived shorter-sustaining than it is. In fact, if it is measured using precise machinery, one can understand that the tone is not actually shorter, but it is perceived shorter. Likewise, it is also not louder, but is perceived louder and that it has more presence (Kontrapunkte, 2011). So, this brings about many opposing views from experts. If an instrument has a relatively faster response, that particular instrument is perceived percussive and quickly decaying. That is the reason why those contemporary instruments are known for their piano-like response (HM, TS). Contemporary manufacturing methods exaggerate this false-perception (TS; Stenzel, 2004). If, otherwise, the coupling (namely string-tonewood energy transfer) diminishes, the decay problem can be solved; but then the guitar loses its attack and starts to feel sort of slow to respond making fast passages and tremolos somewhat difficult to play. That being said, this slow response might not be measured. Probably, it is not really slow, but the human ear perceives it as being slow. For performers, selecting their instrument, so to speak their "*voice*", always requires accepting compromises (McAllister & Watt, 2014b), and performers need a balance between sustain and fast response.

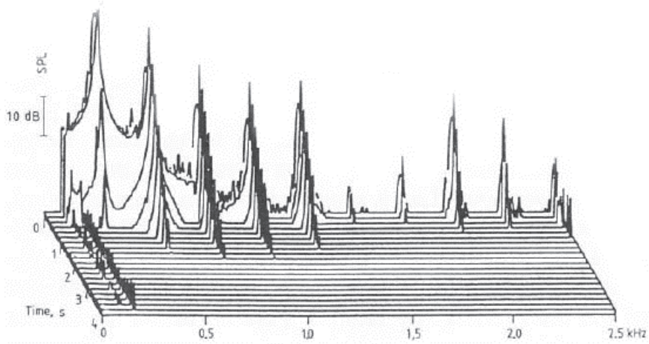

Figure 120 The fast decay of voice illustrated (Richardson, 1994, p. 3)

4.4.2. Directional Projection

The second cluster emerged from the performer responses is about the performability of a guitar regarding its projection capability in a concert venue (see *Table 9*). The concert venue and presentation of Classical guitar have come a long way in the 19th century. The venue has shifted from relatively small gatherings to large orchestral concerts or chamber music ensembles, which brought along two problems: audibility to (i) listeners and (ii) to orchestra conductor and/or ensemble members. Findings pointed to some qualities of performable guitars which performers take into account when deciding their instruments for particular concerts or recitals, among their other instruments. One of these important qualities is the volume of sound, and more importantly, how to project that sound. Volume and audibility to listener issue remains unsolved in the present day (AK, CS, DL, HM, JM[28], KK, KT, MD, SE) and a number of performers think that the traditional guitar has been partly replaced by some technology-bound guitars built with non-conventional processes, not because these contemporary guitars are better, but because they are powerful. (EB, HM, JM, IR, MD).

Table 9 Dataset for code "Directional Projection" and related codes

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Directional Projection				
Projection	*1.4*	***5.5***	*4.3*	3.7
Sound Concept	*0.0*	***2.7***	*0.0*	0.9
Correct Intonation	*1.4*	***2.7***	*0.0*	1.4

It seems the contemporary guitars are quite good at what they were designed for: power and volume (EB, JM, MD). An important observation from performer interviews is that concert players need different directional projections in different concert or recital settings. For instance, playing a solo recital, the guitar should push the sound forward towards the audience, whereas when they play duo or trio, the other ensemble members need to be able to hear; or, if it is an orchestral concert, the conductor should definitely hear the soloist. An important design improvement is the soundport (JM, MD), a design novelty (see Figure 122) first proposed by the avant-garde luthiers of the first half of the 20th century such as Erwin von Grüner (1925-2001) and widely used by well-known luthiers such as Robert Ruck (Figure 121).

[28] *We are still fighting against the volume, so we are trying to be heard instead of striving for a better sound. We only produce a beautiful sound when we play solo.*

Figure 121 Soundport examples, [left]: Erwin von Grüner (WEB 67), [right]: Robert Ruck (WEB 68)

It is the name of Stephan Connor who made a great contribution to this rather unconventional soundhole's popularity, and it is known as the *Connor soundport* by many. Stephan Connor is the first luthier who fitted this soundport with a magnetic cover, and he has used it as a standard on his entire production for the last decade. When the soundport is open, it pushes the sound toward the conductor or other musicians:

> *[W]hen we are accompanied by other musicians, we have to fight against the sense "they aren't able to hear us… I play with orchestras very often, and the maestro is very happy about that little monitor (Connor soundport, Figure 123). He can hear everything, control better. When I play chamber music my partner, as well, is able to hear the guitar immediately. I also have the sense of the primitive sound of the guitar. So I can look for different dynamics or timbers. (JM)*

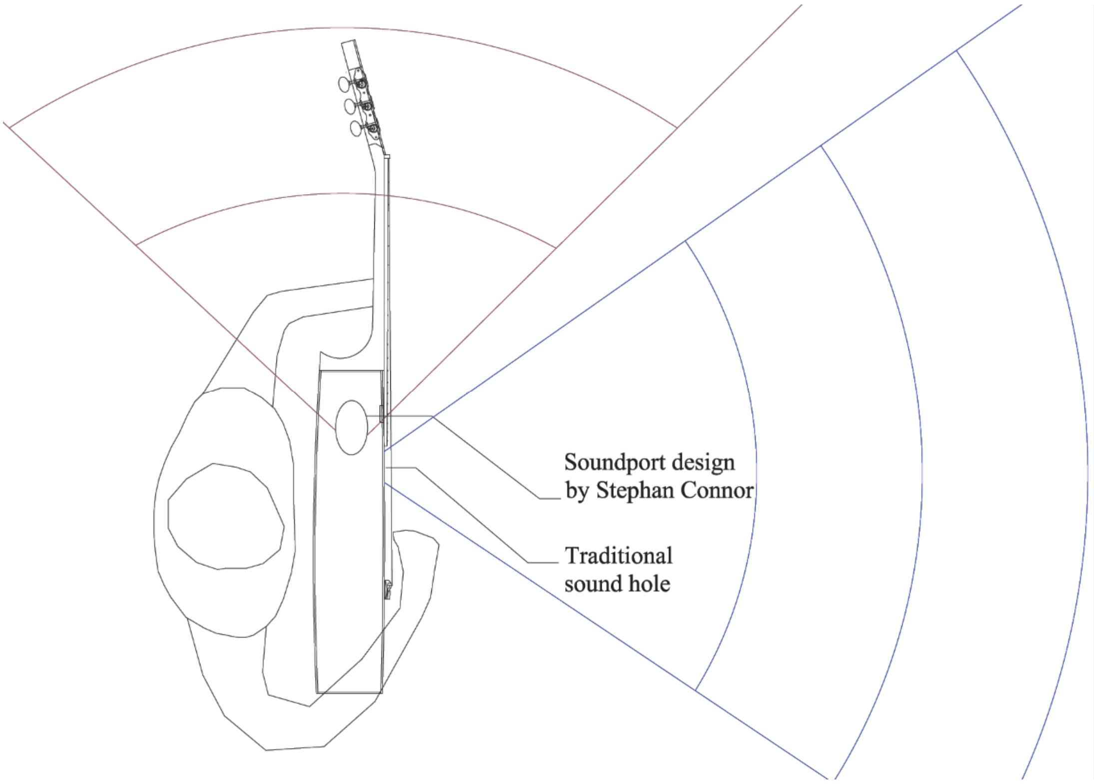

Figure 122 Stephan Connor's soundport design

As seen in Figure 122 and Figure 124, the soundport is located on the side of guitar and the aim is to project the sound in another direction. Traditional guitars project the sound forward, where the listeners are located. However, the conductor and accompanying musicians may have difficulty to hear because they are not in the sound target of the guitar. Stephan Connor's soundport design makes a wider sound projection possible and carries the sound towards the conductor (and/or other ensemble musicians) as well as the audience (see Figure 123). Unfortunately, this design feature conceivably diminishes the projection capability of the standard soundhole located on the top tonewood which faces towards the audience. Therefore, it is especially important when playing chamber music and orchestral music, or otherwise, it can be closed if necessary using its magnetic cap. Since Connor soundport is located on the side of the guitar, and this part is not a tonewood, so does not "produce" sound, removing this wood piece would not create a structural problem in sound production. Connor soundport design is fitted with a cover, made of the same wood as the back and sides of the guitar, and this cover utilizes a magnetic lock. Thus, the performer can have the cover open or closed. When closed, the sound is projected only in one direction (through the top tonewood towards the audience), and when it is open, the sound is projected towards the audience and the conductor (or ensemble players).

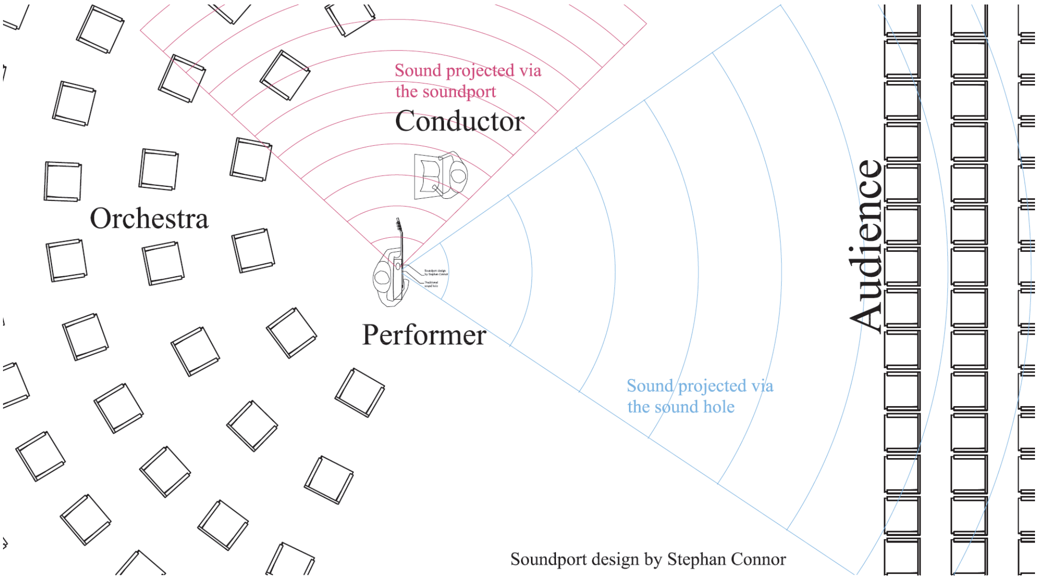

Figure 123 Soundport and projection in a concert hall

Figure 124 Connor soundport, open and covered (Source: Stephan Connor, personal communication, February 20, 2015)

4.4.3. Performer Wellbeing and Instrumental Adaptation

The responses of the interviewed performers regarding muscular and skeletal disorders parallel the health issues learned from the literature. There is substantial evidence to believe that an important of number classical guitarists suffer from various disorders such as carpal tunnel syndrome, tendinitis or tennis/golf elbow. The amount of performers who developed a muscular or skeletal disorder at a point in their career is strikingly high (DL, EB, HM, IR, JM, MD, OH) and it was not expected to encounter such a high amount of health problems before interviewing performers:

> *"In any case you will have them, but at least less. Tendinitis or tennis/golf elbow… many guitarists have because they fight against the frets…. I heard that almost 90 % of guitarists have encountered an injury throughout their career, because we are athletes, we are warriors, instead of our body we use fingers and wrists." (JM)*

Some performers express their concerns that playing guitar is quite unnatural to human body (EB, OH) and therefore many performers encounter injuries throughout their career (DL, EB, HM, IR, JM, MD, OH). Two performer participants explained that they sought for medical help and went into preventive mode after the injury (EB, JM). If a performer has a guitar which requires high muscular torque, they should intervene their unnatural movements and should eliminate the pressure they apply (EB[29]). An example is that, renowned Classical guitarist, David Russell injured his left wrist, after which he had to make a change in his left hand technique to decrease the need for torque (MD), which in turn proved productive and reduced the risk of developing an injury again. To sum up, "*[h]ow to activate and use muscles in the most productive way is a very important point for concert artists*" (EB) thus "*[i]t is very much related with a performer's skill*" (MD).

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[29] So, in short using our body ergonomically. In fact, playing an instrument is quite unnatural to human body. These unnatural movements should be intervened and eliminated as much as possible.

According to the findings, an important quality of performable guitars is that they often require less energy -although there are exceptionally performable guitars which do not require less energy (see Section 4.4.1. Sonic Appeal). Concerning muscles and torque, central to double-top and lattice guitars is to diminish the required torque by elevating finger-string energy transfer. That is, good design may supply performers with some guitars that require less muscular torque, thus can decrease the risk. Eventually, elaborately designed guitars are healthier in the long run (EB, IR, JM, MD). A performable guitar that requires less power was associated with "*coping with the inevitable*" by a performer (JM), because it is comfortable but may lack timbral richness (IR, MD). Well-being of a touring musician is vitally important, therefore these comfortable contemporary guitars are considered "easy" by many performers. Some touring concert performers prefer to play on easy non-traditional instruments, not necessarily because they are better or they have a richer tonal character. These performers prefer contemporary instruments simply because they are scared to have injuries due to extensive practice (JM). It explains the expectations of a touring performer from a playable concert guitar:

> *"[I]f a performer has to give hundreds of concerts a year, they have to have a playable guitar" (IR).*

If a performer decides to play on a traditional guitar which is not really very easy, then they should learn how to minimise the torque they apply somehow by re-learning how to decrease the stress (DL, EB, JM, OH). Seeking for the most comfortable position for body, arms and fingers is crucial, therefore one must know how to activate and use muscles in the most productive way (EB).

Table 10 Dataset for code "Performer Wellbeing and Instrumental Adaptation" and related codes

Codes & Sub-codes	Luthiers	Performers	Composers	Average
Performer Wellbeing and Instrumental Adaptation				
Making Music vs. Performing	*4.3*	***8.2***	*1.4*	4.6
Muscles	*4.3*	***5.5***	*0.0*	3.2
Energy Economy and Muscle Relaxation	*1.4*	***2.7***	*0.0*	1.4
Fight against the Instrument	*1.4*	***2.7***	*0.0*	1.4

It can be drawn from *Table 10* that the third cluster encompasses codes regarding relaxation of muscle groups (v=2.7), elimination of torque (v=5.5) and injuries (v=3.6). In other words, these points pave the way to performability; that is, an easy guitar satisfies a concert artist giving many concerts, or otherwise, performers should develop special methods to prevent muscular or skeletal disorders. However, there is no common view shared by all participant groups as to how much these special methods can help. It is important to understand that a playable instrument can only be utilized in its full capacity by a performer who is able to apply the necessary techniques. Interview series with performers show that, performability of an instrument demands its performer to be well educated in order to utilise the whole potential offered by that instrument. Performable guitars offer many advantages, however, one needs to know how to incorporate, modify and benefit from them (DL, EB, JM, MD). For instance, a guitar with superb projection, say Dammann or Connor, offers a lot of power when plucked softly, but increasing the attack proves counter-productive (IR, MD). Therefore, one should spare some time to learn how to get used to these new instruments (McLellan, 2013), otherwise, performability falls even on the most performable guitar.

4.4. Results Unique to Composers

The third part of the semi-structured interview series was realised with a subgroup consisting of seven composers to bring their insight to this study and evaluate performability from their perspectives. Since the interviewed composers write music for numerous orchestral instruments, as well as the Classical guitar, and it is hard to know each instrument, they have general ideas about the Classical guitar, rather than in-depth knowledge on the manufacturing details. Composers' views were significantly important to shed light on performative qualities of musicians. In order to understand and theorise various performative concepts, i.e. virtuosity, heightened state of performance, mastery and artistry, they made a huge contribution to the analysis phase of the research. What is of greatest interest in their responses is the acceptance of the Classical guitar in the form it has existed since Antonio de Torres.

Generally, they are resigned to the possibilities of this instrument. However, it does not mean that they are closed to improvements, at least six (v=8.6) of the composers consulted, did not act rejective. Taking into consideration Libin (2000), whose studies show that composers are the agents who prepare a fruitful and secure environment where new instruments or modification to existing instruments blossom, the duty of composers became faced with many challenges. Composers' responses were somewhat positive towards the '*design for performability*'. They frequently mentioned their views that technical difficulties should be solved by performers, instead of the aid of an instrument itself. However, five (v=7.1) of the composers expressed a positive attitude towards design for playability and those guitars that offer improved playability.

The analysis of the composer interviews showed unpredictable signals towards re-evaluating the guitar design. Although composers make a good target to prepare an environment where new musical instruments can grow and luthiers can dare to design new instruments often mentioned in the literature most notably Libin (2000), the research has shown conflicting signals. Composer interviews indicated mixed responses towards a deviance from instrument making traditions. First of all, four composer participants (v=5.7) stated having no voluntary intention towards understanding or looking out for unique qualities of different guitars, meaning they try to understand neither various slight differences in strutting or wood selection, nor comparatively more important fundamental differences between guitars concerning the production methods (i.e. traditional vs. contemporary techniques). Four composer participants (v=5.7) expressed that they saw no remarkable differences between various instruments; and the differences they realise were, they stated, arising from the performer's touch and technique.

As opposed to the general thought, all composers (v=10) stated their opinions that discard product qualities of an instrument from their privilege list (CD[30], CS, EBa,

[30] *I don't consider different guitars when writing for it, I believe this is the final result of Classical guitar traditions and I am very happy with that.*

EK, FK[31], OT[32], TE[33]). Arguably, they ignore product qualities of instruments for which they write. They put a so-called ‘artistic creativity’ in the first place when composing, rather than caring for the *playability of their music*. Reasons why they approach the Classical guitar as an archetype and do not intend to care for some subtle differences between guitars are twofold. Firstly, they have their own privileges and obligations, i.e. being creative and original (EK, FK OT, TE) and secondly, being equally distanced to each and every Classical guitar design and system. Having said that, composer participants stated that some of their compositions might sound ‘better’ or are ‘more performable’ on either traditional or contemporary guitars, and explained having tried to compose for different guitars, but this did not lead to fruitful results (EK, EBa), and in fact, they stated that it was not really an important point for them (Eba, EK, FK, TE, OT).

> *“We have a conception of the classical guitar, those changes can't change that conception. As a composer, I tried, as if I was a luthier, to compose with different approaches for different guitars. I agree that there are differences, but I believe they are not noteworthy differences.” EK*

On the other hand, three composer participants (v=4.3) stated that variations in instrument quality across different guitars emerge distinctive timbral colours, and particular qualities affect them when they hear their music played on these instruments. Nevertheless, all of them described that they would not compose for specific instruments regardless of whether they appreciate certain qualities of some

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[31] *I believe I shouldn’t be doing so. I hope my music will be played by many artists, thus, I prefer to write in a way that it can sound pretty well even on a low quality instrument.*

[32] *Well, not actually, for me that is the ability of the performer, I don't care whether they have a high-end guitar or not. I ignore the guitar, personally.*

[33] *[W]e, composers, don’t know very well that an elevated fingerboard makes it easier for higher registers, and actually we don’t care, because it is the performer's issue, they should be in charge of it. I don’t want to compose keeping their difficulties in my mind; I have my own difficulties like being unique*

guitars or not. However, three of them (v=4.3) mentioned to have worked with performers to study and try different guitars, various fingerings alternatives and their compatibility to their music.

Some composer participants stated that their privilege was not inhumanly hygienic performances, which contradicts one of the –seemingly– important priorities of contemporary performers; that is reaching an exceptionally precise technique. ‘Flashy’ solos and a *hygienic* playing technique became the mainstream virtuoso performance towards the end of the 20th century (Berio, Dalmonte, Varga, & Osmond-Smith, 1985), but the interview series indicate that this is not the case for the appreciation of composers. Additionally, they stated to have taken into account the differences between various guitar types –i.e. baritone guitar or electric guitar (FK, OT). An interesting point derived from the interviews is that playing '*correct*' is at least as important as playing 'technically advanced', or 'flawless' –if not more. In composers perspective, playing *correct* might refer to courtesy to composer's ideas, historically informed, dynamically and emotionally appealing performative qualities (CS, EBa, EK, FK).

> *[I]f my music is played, I listen and I care for the result… Sometimes, I come across very well executed renditions and interpretations played on a humble guitar. That’s very inspiring. And sometimes there is a nice voice but not interpretation, in other words, there is no singularity. (EBa)*

4.4.1. Concert Hall

Composers expressed a certain sensitivity concerning the concert hall quality (CD, EBa, EK, TE, FK). Although performers, too, mentioned venue-related concerns (v= 3.6), the groundedness of composers’ Concert Hall code family is significantly higher, therefore this code family is listed under Results Unique to Composers subtitle. It is curious, and was unexpected prior to the analysis phase, that luthiers did not put forward qualities of a concert venue as a dimension of performative quality. Luthiers did pronounce concert halls, but not concerning their acoustic quality. They mentioned venues to explain the projection concept (see Section 4.2.9), which is an instrument quality to push the sound forward in a closed space, but not necessarily a concert hall. Here, it may be helpful to quote a comment coming from a performer participation about the lack of consideration given to concert halls in his perspective:

> *I often regret that soloists are very critical about their choices, from their instrument to strings, but are not that selective and critical about the concert venue. (MD)*

Concert hall is a space where an instrument can reach its potential ceiling. Therefore, an important aspect that makes the interaction between a musician and their instrument, that is *performability*, is the concert hall acoustics, design and size. The concert hall code was mentioned by v=7.1 of the composer participants. Since the Classical guitar, including the contemporary instruments, is not capable of filling a large venue without amplification (CD, EBa, EK, OT, TE), a good concert hall should be relatively small in size. This exemplifies that performability is not limited to an instrument, and there are external factors. However, there are drawbacks caused by a Classical guitar and prevailing cultural phenomena that guitarists are precluded from giving concerts in large halls. Unfortunately, great masters of the Classical guitar history did not really succeed in taking the instrument into the mainstream of classical music (CD). There is inertia and an obvious prejudice against the Classical guitar in Classical Music communities.

> *[T]he real problem is somewhere else. It is the concert hall. Music for the guitar, venue for the guitar and the listener of the guitar. Guitar audience has never been as few as this in long time… Guitar audience is young, has low culture and little knowledge. And it is getting worse. Performers play in worse and worse venues day by day… Not even 700*

or 800 listeners attend guitar concerts today. So, making more a powerful guitar is somewhat meaningless. (CD)

Table 11 Dataset for code family "Concert Hall"

Codes & Subcodes	Luthiers	Performers	Composers	Average
Concert Hall	***0.0***	***3.6***	***7.1***	**3.6**
Acoustics	*0.0*	*1.8*	***2.9***	1.6
Size	*0.0*	*2.7*	***4.3***	2.3

4.4.2. Constraints of the Instrument

Every instrument, be it a guitar or a harpsichord have constraints (CD, CS, EBa, FK, OT); in other words different resonance areas, brighter-darker sounding parts and unique idiosyncrasies. (EBa). For a composer, getting familiar with these phenomenais a *'volunteer activity'*, because, the Classical guitar is not a 'typical' orchestral instrument they are taught during their conservatory career. Five composer participants (v=7.1) mentioned constraints as a concept that needs to be mastered for writing performable music. For a composer, being aware of these constraints, and then writing accordingly is their part in such a *democratic* concept. Then, the music becomes playable (EBa), and sounds well on a particular instrument. In other words, there are circumstances where it is the composer who makes a piece of music more performable (CD, EBa):

The composer should keep the limits in mind. For instance Heitor Villa-Lobos preludes. This legendary musician often played on three-year old strings, which were worn, almost flat. And his guitar had a very low action. In his case, playing, say his famous 12 etudes, wouldn't pose much difficulty. But a concert guitar today creates so much friction sound during the performance of this music. (CD)

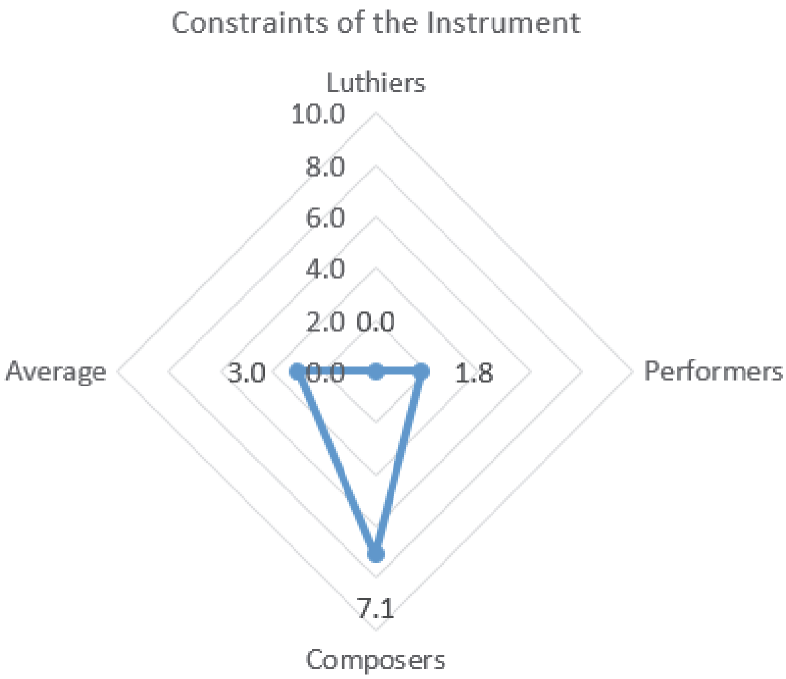

Figure 125 Distribution among participant groups for code "Constraints of the Instrument"

An important aspect of such instrumental constraints is the harmony. Composer participants mentioned '*harmonic structures*' and '*hearing the harmony*' fairly often during the interviews. Besides constraints, the Classical guitar is a difficult instrument to predict positions (OT), there are always multiple alternatives for various chord structures available to the player (FK) and this is what makes it powerful, as it supplies with different harmonics and effects (OT). Another constraint is the harmonics[34]. Some guitars give it out louder which is usually considered a sign of high quality; but this feature sometimes creates difficulty for a performer, because these instruments tent do make relatively more *finger noise*, or *nail noise*.

4.4.3. Amplification

As opposed to luthiers and performers, who are too enthusiastic about giving concerts in large halls –without amplification– and contemporary luthiers try literally

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[34] *Harmonic is a special sound effect usually performed without pressing the strings onto the fretboard. Harmonics are usually used for musical effects rather than the main melody or harmony.*

every method to increase the Classical guitar's sound power, composers argue that these large venues dictate any means of amplification (Eba, FK, OT). In that sense, the composer's opinions are fairly different from those of performers and luthiers. They care much about the polyphonic structure of music. They want to hear it clearly and evenly.

> *"I think, the Classical guitar, including the double-top guitars, can't be played in large concert halls without amplification... It's happened to me, I was very unhappy about a concert performance, but later I listened to the concert recording, and in fact it was very good. The question is "can the Classical guitar overcome the volume problem without microphones?"... I mean, either venue or the instrument has to change." OT*

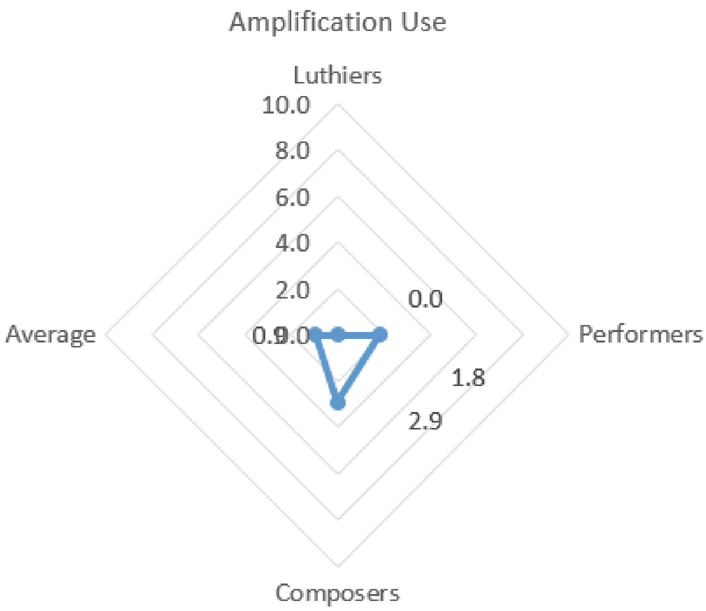

Figure 126 Distribution among participant groups for code "Amplification Use"

Although luthiers and performers prefer –as much as they can– to stay away from any type of amplification, volunteer wish of composers to use a 'written system' of microphone and amplification was a curious phenomenon described during the interviews. An amplification system that is written as 'musical notation' in the scores is striking in its adherence to notating dynamics and has rarely been done. There are very few examples in the "new music" but can significantly improve the performability. In fact, the microphone also has a psychological effect, and there are quite a few musicians playing concerts with 'hidden' microphones and speakers (e.g. Los Angeles Guitar Quartet, Sharob Isbin). These invisible miking solutions incorporate magnetic pickups and wireless monitors. Amplification was mentioned as a means of performability by v=2.9 composer participants. What is of greatest interest here is that it can be used as a qualitative aspect of music towards performability rather than a tool to solve audibility problem (OT):

> *I think, the microphone feature is more important than the structure or quality of the Classical guitar. I believe that composers should focus on that… Microphone is vitally important for the "new music" composers; since we make "sound centred music" the quality of sound (dynamics, timbre etc.) is in the centre for us… If I write music for the guitar again, it will be for an amplified guitar, for sure. I am very sorry for not scoring a microphone system in musical notation… I believe that should be the path to follow. (OT)*

CHAPTER 5

DESIGN FOR PERFORMABILITY

Industrial design and handmade bespoke musical instruments do not come together very often. Argumentatively, musical instrument design is not a natural field of study for product designers; design alternatives are probably best developed by luthiers, and not by product designers who are not actually involved in the business of making instruments. However, a product designer's eye can open up new horizons for crafts oriented artisans, and these opportunities can be turned into novel developments simply by refining ID input with specialist luthier knowledge and experience. Design for performability could be realised through three objectives: (a) improving the player's training (by training aids), (b) improving the instrument (design implementations), or (c) improving the so-called habitus (eco-system) surrounding the instrument (by elevating the mentality of related stakeholders). Therefore, the search for design implementation in this study is essentially two-fold. Firstly, it aims to support the education of aspiring students (5.2.1. Left-thumb Tool and 5.2.2. Piezochromic Guitar Neck), and secondly, it is about the live performance context in front of an audience (5.2.1. Fret Buzz Removal and 5.2.2. Action Height Adjustment).

5.1. Redefining Playability, Performability and Virtuosity

Contrary to what is often believed, virtuoso guitar performers frequently prefer guitars made by makers who might be considered "inexperienced" in luthier terms. Quite often, these performers are the ones who help their instrument makers rise to prominence. Many examples could be given. Famed makers of today, for instance José Romanillos, Greg Smallman, Robert Ruck, Thomas Humphrey, Matthias Dammann, Michael O'Leary or Jim Redgate were largely unknown prior to their star virtuoso guitarist clientele such as Julian Bream, John Williams, Manuel Barrueco, Sergio-Odair Assad, David Russell, Sharon Isbin or Ana Vidovic (respectively). Many virtuosi play rather special instruments that do not sound particularly charming when played in a normal sized room. They often have a harsh and nasal tonal colour which is not considered pleasing by many (Huber, 1994). They literally are concert guitars, and as the name suggests, these guitars reach their full potential in a concert hall when played by a virtuoso performer. This is an example that gives an overview of how performability concept relates to playability.

Here, the question arises as to how performability differs from the playability and conceptually why there is a need for the term ‘performability’. Observations made during the interviews necessitated the use of a new term which bridges the gap between an instrument and its performer. Therefore, the word “performability” was coined and used throughout this PhD thesis. In short, the concept of playability is related to the product qualities of concert guitars and it has no relation with the performer interaction, whereas performability is a part of the musician-instrument interaction and relationship. Personal skill can improve an instrument’s capacity, meaning a skilled performer can do “more” with it; or playability of an instrument can ensure comfort irrespective of personal skill. A combination of both (Figure 127) brings in the performability concept.

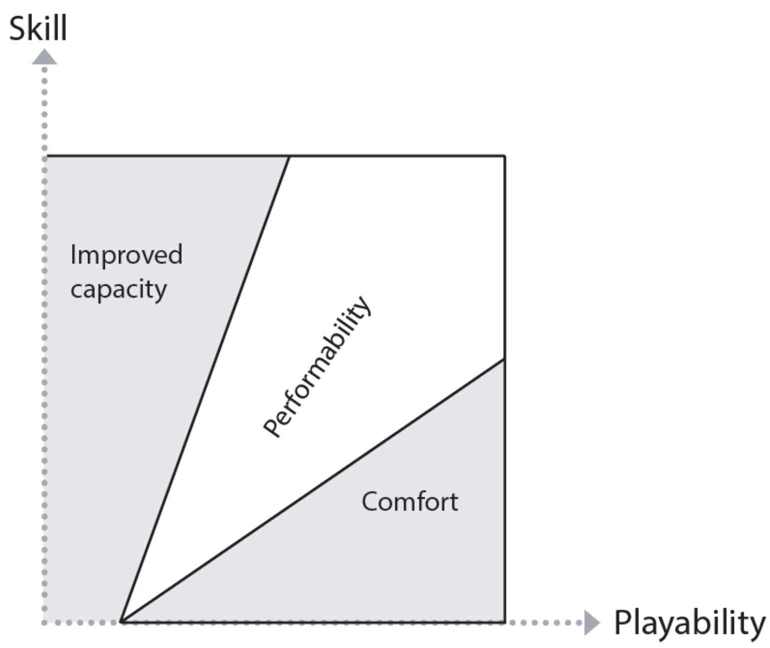

Figure 127 Playability, Skill and Performability

Playability is the aid of an instrument that decreases the difficulty threshold of dealing with technical issues, and thus, helps the player focus on musical aspects. A playable guitar is an easy instrument to make music on, concerning its action, loudness, tension and so on, while performability is an interaction quality which is dependent on various interior or exterior factors such as an instrument's dynamic resources, player's technique and nail quality. Performability depends on the playability of an instrument and the degree to which playability can possibly be utilised by a performer. On the other hand, it should be noted that playability is a subjective term; a very playable instrument for a specific player could be less playable for another:

> *[Luthiers] take anthropometric data into consideration, but what they do is not really scientific… It is rather an approximation… That's like the difference between a tall guy and a tiny girl. I believe that, in the future, we will have made-to-order custom made guitars, manufactured based on precise body dimensions measured with the 3D scanning technology, or even made with 3D printers. And I am sure, we will be able to define the sound; you will tell the qualities you want in the sound; sweet, deep, nasal, thick, penetrating, percussive, etc. (KT)*

Although playability is directly related with an instrument, performability defines the interaction quality between an instrument and its performer. Therefore, it is closely related to what an instrument offers and what a performer is able to bring out of that instrument (CS, HH, HM, PB, TS); that is, a performable guitar reveals its *magic* in the hands of an experienced player in wonderful acoustic. Performability encompasses different stakeholders together with a shared concern to reach the top of musical performance, which applies to other instruments, as well. Training may boost what a performer can get from a particular instrument. Performability becomes clearly visible when a playable guitar is played by a well-educated performer; because it requires a certain level of ability and skill which is gained through their training.

Playability is a product quality, in this case an intrinsic quality of the Classical guitar. This capacity makes it less difficult and more comfortable to interact with the product in terms of sound production and expressive resources. Playability can be inspected, at least concerning some of its aspects, by touching or measuring its specifications, preferably in a concert hall –to be able to understand its projection quality. The way luthiers try the playability of an instrument supports this view; they are able to understand this quality outside of a musical context, because, a musician-luthier is a rare phenomenon and a high percentage of luthiers do not play, or play as a beginner guitarist (personal observation). They often inspect a guitar simply by plucking open strings and checking various parts, measuring and touching without really playing that instrument. It is safe to argue that, they might be mis-assessing the projection quality, as it becomes evident in a concert hall. They should consult (and trust) their knowledge, i.e. back plate thickness, tornavoz (if any), geometry of the sound box, to have an idea concerning the projection quality.

As already mentioned, the full potential of a performable guitar could be understood only in a concert venue and by a player who knows how to produce good sounds from it. This point was underpinned by EBa[35], KT[36], HH[37], HM[38], and IR who shared their experience on concert halls and projection capability. A performable guitar is able to teach a student, and in turn helps to make them a better performer (HH, HM, TS, SE); a student "*will catch them (different colours and timbres) maybe*

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[35] *The projection is a fairly different phenomenon. An instrument may sound well up close, but might not carry the sound forwards.*

[36] *I select a guitar, and I ask a friend to play for me in a hall while I have a seat in the audience side and listen in a concert hall.*

[37] *Considering Andres Segovia playing in Munich Hercules Hall to 1200/1400 listeners, even though it is not a hall for classical guitar concerts but Andres Segovia played there. In the last row, you could hear him clearly, each note sounds separate even in the last row.*

[38] *[A]n Altamira guitar, worth 800 Euros and it was a really hard work to make it sound well because I played directly after a Friedrich... That was a radical change, but if I know which sounds I want, I can get them out of a cheap guitar with some effort but a beginner can just get out of that guitar what the guitar offers. Then you are very limited in timbral colours because, you have to ask more than the guitar knows and she is able to do.*

by accident every now and then… [but a professional performer can say that they] want this and that colour effect, [and] force how to do it… [whereas] a very good guitar can offer things [one] did not know that [they] wanted them” (HM). Performable guitars teach players and improve their artistry in many ways (HH). For instance, the skill of a player can be elevated by “*challenging them to find out what is there in a new and radical instrument design*” (HM):

> *I think if you give them (beginners) a good guitar then it can start to open their mind. And I've heard many people who had played other guitars before Hauser, they acquire a Hauser guitar and they see what they have beyond, that level is "beyond" their sound world. They often say "I didn't know that this level even existed", "it opened my mind, it makes me a better guitarist at the next level", because they have the voices which they had never noticed before. (HH)*

Mention has already been made of unappreciative opinions concerning the playability voiced by a number of respondents (EBa, CD, IR, KK, SE). They described the search for playable instruments as one of the “*serious problems*” (EBa), and claimed that truly successful guitars are usually not very playable instruments (CD):

> *For instance, nowadays I believe that there is quite substantial uniformity between classical guitar performances. In Classical guitar competitions one cannot see too much originality. In most cases, their approach to sound is quite similar. I believe this is arising from remove the the performers who look for playable instruments, which I don't criticise. But, unfortunately, they forget some other important aspects of making music. (IR)*

There is a one-to-one relation between Csikszentmihalyi's *flow* (1975) and performability; playability-performability transition is in essence like the difference of "playing an instrument" and "making music". The transition to performability allows a player to forget the instrument (AE, CL, HH, PB, CS), then it recedes to the background and becomes a body extension. In that sense, playability-performability duality has common points with technical mastery-virtuosity transition.

> *I think this is the whole secret; if a musician is in trance, like in another level, in another world, he doesn't hear the mistakes, he doesn't hear the noise coming from the audience be it a mobile phone or coughing… [H]e is outside of this world. He is a virtuoso. (HH)*

One striking measure of performative quality expressed in the interviews is the extent to which a performer can be flexible to reshape themselves to get a grasp of the piece as seen through the eyes of its composer (AK, EP, KK, KT, OT, SE): "*How one can get into the "world of timbres", how they forget what they had known and start over again and re-learn with a fresh mind and fresh eyes. Actually how "flexible" they are, how much effort they put in order to get into the composer's world*" (OT).

Musicology has some theoretical framework concerning how musicians can reach a virtuoso level, but only a few. Virtuosity is, by nature, quite a difficult phenomenon to define. Interview participants proposed side definitions or related phenomena concerning virtuosity, and various concepts about related qualities aiming to uncover the relations amongst (i) high level of performance (AK, CS, DL, EBa, EK, EP, FK, HH, HM, JM, KK, MD, OT, SE, TE), (ii) technical mastery (CS, DL, EBa, EK, EP, FK, HH, KK, MD, OT, SE, TE), (iii) flow (EK, HH, MD) and virtuosity. These concepts include musicality and emotions, personality, expression, spiritual richness, communication, stylistic coherence, courtesy to composer's ideas, interpretation, musical form and structure, musical meaning, details, articulation, singularity. To sum up, a virtuoso performer should possess the technical mastery; but that is not enough. In order to reach virtuosic and masterful high level performances, their playing needs to encompass the performative qualities mentioned above. Besides, virtuosic performance level is beyond technical mastery and it starts after a technical level is achieved (CS, EBa, EK, EP, HH, IR, OT, TE). Therefore, how performers can incorporate their technical skill in performing and what they can do musically is the thing that matters (AM, CL, CS, EP, FK, HH, HM, IR, KK, MD, SE, TE). However, it is known that virtuoso players have good days and bad days, and their performance is not a straight line (KK[39]). They may exhibit high level performances, whereas some of their concerts might be less masterful (AK, AM, DL, EK, IR, KK, SE).

There is quite a consensus among participants that virtuosity, on the contrary to the common belief, does not only mean playing flawless performances. It requires two performative qualities in particular. First of all, a virtuoso instrumentalist is a performer or musician –rather than a technically correct term *player*– who is capable of imposing their musical sensitivity into their performance through dynamics and expressive techniques (CS, EBa, HM, JM, KK, MD, OH, OT), their phrasing and articulations (AM, CD, CS, EBa, HM, JM, KK, MD, OH, OT) and communicate these qualities (DL, EBa, EP, HM, IR, JM, SE). A virtuoso performer is a knowledgeable interpreter (AM, CS, EBa, EK, MD, TE). The word "interpreter" is the dictionary definition of "performer" in some languages i.e. Spanish or French. In that sense, the interaction between an instrument and its performer could be described as *migration of soul* from a musician to their instrument. Here the words *musician* or *performer* were used strategically. Without any doubt, anyone involved in an instrument-playing activity could be called *player*, but a virtuoso musician never exhibits an act whose only aim is play. That is, their fundamental goal is making music, rather than instrument playing (AE, AK, CD, CS, CL, DL, HH, HM, IR, JM, KK, KT, MD, OT, SE). Secondly, singularity (EBa, IR, OT), which might be associated with originality and uniqueness, is an essential characteristic towards a progression to virtuosic mastery. A virtuoso musician is one and only in the sense that they have a special idiosyncrasy which makes them different from the rest. Singularity necessitates a performer to have personality in articulation and phrasing, and a special autograph sound quality (EP, HM, IR, JM, KT, MD). For instance, we

[39] *I think that virtuosity and high level of performance are not usually directly proportional.*

like both Arthur Rubinstein and Samson Francois play Chopin "*for their different styles; [e]very virtuoso has idiosyncrasies and unique characteristics*" (EBa). They become successful in creating their signature sound interwoven the fabric of music. If an audience is able to predict who is playing based on what they hear, that is believed to point out to a presence of personality and thus virtuosic quality (AM, CS, EBa, EP, HH, KK[40], KT, MD, OT, SE, TE). Especially composer participants expressed their expectations from a virtuoso performer to add their personality (AM, CS, EBa, EP, HH, KK, KT, MD, OT, SE, TE), which, if succeeded, adds the sense of belonging of the performer to a certain piece.

> *What I want is not clean and hygienic performances, I'd want them to put themselves into the guitar with all they have; sweating, like an actor, his body becoming a part of the scene, part of the world. I don't expect elegant and clean performances. I want to see a sweating actor, giving out all what they have. (OT)*

Interview participants expressed accounts that are in line with the literature findings as to whom recognises the proficiency of a performer to be counted worthy of a so-called virtuoso status. In parallel to Gooley (2004) and Howard (2008), some participants state that the judging depends on whether the audience is qualified enough to realise and appreciate a virtuoso performer's refined ability (AK, CD, HM, KK[41], KT) which is quite often beyond the prevailing sense of art and political circumstances.

Lucio Berio's Sequenzas became successful in introducing a new definition of what he calls the *new virtuosity* (Berio et al., 1985). As explained in Section 2.1.3, his definition of virtuosity does not encompass an unrivalled agility that does not bring

[40] *When an audience hears a performance, if they are able to say "this is Kürşad, and he is playing composer X's piece", that means you are a virtuoso*

[41] *[V]irtuosity actually depends on who is listening and judging the performer. Listener should be qualified enough to put the virtuosity stamp.*

about artful music. He built his approach upon the intellectual difficulties of music that a virtuoso should accomplish. In other words, he attempts to put the focus on the limits of mind, rather than the limits of an instrument. Interview participants shared similar opinions underpinning the intellectual sides of musicianship as opposed to physical. In that sense, musical meaning (EBa, EP, HM, KT), how performers approach musical forms and structures (CS, EK, EP, OT, TE), their spiritual richness (AM, DL, EP, HM, KT, MD, OT) and stylistic coherence (AK, EBa, EK, FK, JM, OT, TE) are important qualities towards virtuosity in new music (OT).

To sum up, virtuosity is a musical quality that indicates reference to intellectual and historical aspects in performance as well as mechanical and physical parts of playing. It is a complete freedom of tension, thus an execution without fight against the instrument in an attempt to communicate emotions and personal intellect of individuals and historical references in the service of music. Since virtuosity level is not only related to mechanical aspects, technically unprecedented but intellectually or emotionally weak performance is not a manifestation of virtuosity. Great masters of music history have distinct qualities in their performance that make them one and only; history has witnessed only one Rubinstein, who can be recognised from his style and tone. In this sense, virtuosity is unique, whereas the technique that underpins virtuosity is somewhat universal. Eventually, technique rises when repeated, virtuosity falls when imitated.

5.2. Design Considerations for Educational Tools

The study indicates evidence to support that a seriously high number of performers suffer from musculoskeletal disorders (see Section 2.2.5. Muscular Torque and Precision). 6 participants (CL, DL, EB, EP, IR, JM; v=2.16[42]) mentioned long term musculoskeletal health problems. It is mainly caused by extensive and, more importantly, incorrect practice especially when a beginner is not supervised by high-

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[42] *In this chapter, in line with Chapter 4, 'v' stands for the normalised number of responses as if a particular phenomenon has been mentioned by v participants out of 10 participants –instead of the real number of participants. The aim is to be able to compare each phenomenon on a scale of 0 to 10*

calibre educators or specialised experts who can anticipate possible beginner mistakes. Even when beginners have good teachers at their disposal, they may still develop these disorders.

These problems basically arise from two main areas. Firstly, some positions –especially higher *barre cords*[43] beyond the 9th fret– require a player to apply a strong left hand pressure on the frets. If they do not apply enough torque the strings buzz. The string buzz is an unattractive noise and might be considered a mistake in competitions. Although the prevailing attitude towards buzzes is that the overall quality of the performance defines the quality of a player, and not these little mistakes (AM, EK, EP, HH, SE, OT; v=2.16), playing flawless and clean is still important and counts in competitions. Therefore, players refrain from making buzzes, and they apply a greater force with their left hand. However, these tense conditions are relatively few; and apart from that, normally a player does not have to press hard on the frets. The tense conditions should definitely be terminated and "*muscles should relax*" (EB) when the necessity is over. Unfortunately, many students, and even advanced players, cannot comprehend that they actually do not need to –and should not– apply unnecessarily high pressure. Probably, that is the teacher's mistake (DL, HM, KT, PB, SE), but in the end the ones who suffer are the learners.

Secondly, interviews and self-evaluation forms indicate that many players, including students and advanced performers, do not have correct habitual mechanisms of muscular movement regarding how to source the required muscular torque. Human shoulder and upper arm muscles are much stronger than finger muscles. So, the correct source for the left hand pressure should be the upper arm and shoulder (EB, HM). However, these are good habits and they require to be acquired, and it is the teacher's duty. In other words, many players make a mistake by applying left hand pressure on the frets sourced from their left hand finger muscles rather than upper

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[43] *Left hand positions where more than one string are pressed down onto the fretboard by the left hand –usually– index finger*

arm and shoulder muscles (HM, SE). Finger muscles are weak and prone to injuries; eventually, many players face musculoskeletal disorders and sometimes are forced to quit playing (EB, JM, MD).

What is of greatest interest here is that there seems to be a lack of anticipation by players and educators that they do not have to press hard. This is even worse when students are concerned (personal observation). Therefore, there seems to be room for two design interventions. One of them is a simple tool (see Section 5.2.1.) which is used for a period of 15 hours to develop empathy, and the other is a conceptual design proposal (see Section 5.2.2.) which is not technically feasible with the current technology and the material's properties but still bears potential.

5.2.1. Left-thumb Tool

It can be drawn from the expert opinions that unique design features of a particular Classical guitar can supply its player with ease and playability that requires less energy. However, this guitar will lack sound power and timbral colours (see Sections 4.1.1. Timbre Quality, 4.1.2. Action Height, 4.1.4. Effortless, 4.1.5. Volume, 4.1.7. Comfort and 4.3.1. Sonic Appeal). Therefore, a performer should ideally learn how to get comfortable with "less easy" guitars (EBa, IR, KK, KT, SE). At the same time, they should learn how to play with less pressure (DL) which requires minimum tension (OH). When the torque-required position ceases, a player should relax these muscles (EB). If players do not learn the necessary habits, they will get used to this tense condition and it will become their normal. Some guitar pedagogues use various methods to educate their students as to how they can decrease their left hand stress. One of them is to start with very light pressure on frets and play a note. In this case the guitar does not produce sound because of very light pressure on frets. Then, they increase the torque incrementally until the guitar starts producing a tone. This way, they aim to comprehend where the guitar starts sounding, what is the threshold they just should pass and eliminate the extra unnecessary torque (DL, IR, OH).

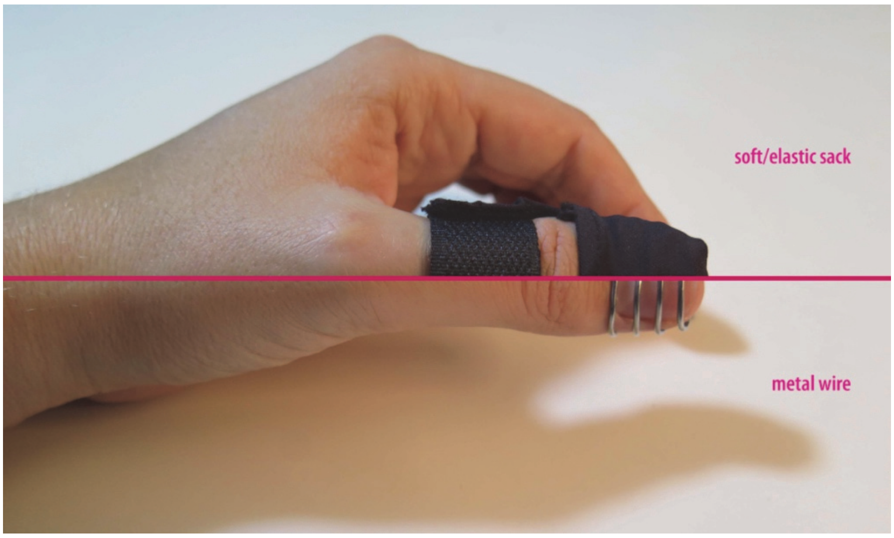

Figure 128 Left-thumb Tool

The proposed design offers a way to empathise the left hand over-force problem and aims to face up with the issue right at the beginning. It was designed as a training aid (see Figure 128) which can be used for a relatively short period (presumably 15 hours) to draw attention to the problem of exerting too much neck force. So, it can be termed "*design for player self-awareness*". As an empathic model, the tool functions in line with *Empathic Design* approach. The aim is to create controlled discomfort in order to become conscious of the overused muscular torque in the left hand, and it is believed to dissuade the player. It is made with a piece of elastic metal wire (made of 60 % tin and 40 % lead) and stretch fabric in order to save the guitar finish from scratches. The tool has a flexible metal structure and is adjustable. Therefore, it can be modified to fit different hand and finger sizes. 3D printing facilities can offer advanced methods to custom produce this thumb tool tailored to individuals. The tool can be introduced and commercialised through online stores (i.e. Strings by Mail, Strings and Beyond) where various educational aids for instrumental training are stored, sold and publicised.

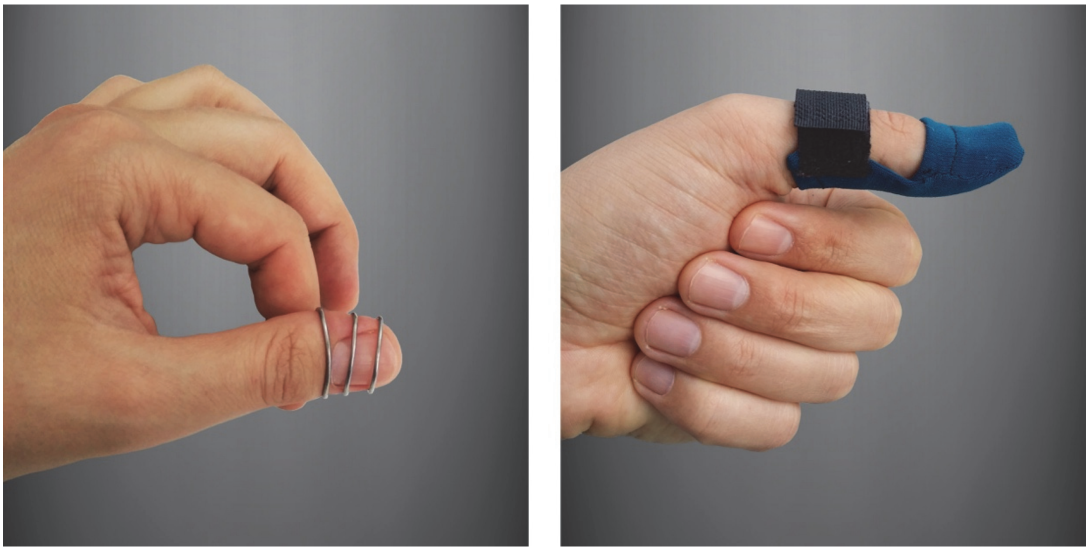

Figure 129 Left Hand Tool

In order to test the proposed tool, eight prototypes were distributed to students and professional concert performers[44]. Different level players (two students, three new graduate performers and three instructor-concert players) were selected to increase the variation in responses. They tried the tool for 15 hours and were asked to fill in the Product Self-Evaluation Form (see Appendix C). Their feedback was sought to help understand and reshape the thumb tool. Self-evaluation forms were used to understand (i) whether they had (or experienced-observed) previous musculoskeletal disorders, (ii) how they cope with health issues, (iii) which methods they used against such problems and (iv) measure their reaction to the perceived discomfort as well as their suggestions and criticism concerning the proposed tool.

Based on the data gathered from the self-evaluation forms, 7 participants (v=8.6) mentioned over-used torque problem as a response to the question concerning "*identified left hand issues before using the tool*", and 1 participant (P_8) mentioned postural problems. The participants provided first hand information, but, in the case

[44] *Players who tested the tool and supplied self-evaluation forms will be referred to chronologically with a P letter (player) from this point forward. That is, P_1 is the first player to submit the self-evaluation form. Please note that, two of the testers (P_1 and P_4) are among those who took part in semi-structured expert interviews. Abbreviations stand for: P_1: Ender Bilge, P_2: Ege Toron, P_3: Cemal Sönmez, P_4: Soner Egesel, P_5: Erkan Mehmet Karagülle, P_6: Altuğ Tozan, P_7: Tunç Ataç, P_8: Sanberk Uçar*

of professional performers, "*having encountered these problems*" means (i) they encountered in the earlier stages or (ii) they often see these issues in their students. Having said that, professional performer explained that they did not have this issue currently. 5 participants (v=6.3) mentioned "*discomfort*" and "*strange feeling*" upon the inquiry regarding their first impression when they tried the product.

All respondents (v=10) agree that the feel of discomfort caused by the tool made them (or can make a beginner) realise the over-used unnecessary muscular torque clearly. "*It makes you feel clearly how much pressure you apply, when applied too much pressure, the metal wire warns you. It gives signals by creating discomfort*" (P_1). All participants (v=10) agree that "*[r]esetting (and then re-applying) the stress –especially for unfretted tones– in the left hand, arm and fingers gives many advantages regarding energy efficiency and improving a performer's condition and energy. The design proposal might be beneficial in that sense*" (P_1). That being said, post-tool-use is of great importance, and it was stressed by players. "*We should pay attention to what we have learned… like the mirror… we should try to remember what we have learned from the mirror, if we forget… then it is useless*" (P_4). Respondents argue that even if the player does not have this problem, the tool seems promising: "*Before this tool, I was already aware of my over-force, but the tool let me see it clearly*" (P_2). "*We solve it somewhere in our training, but I believe, someone who has this problem can really use it to understand that they should decrease*" (P_4).

Participants expressed that (v=10) the proposed tool can create *awareness* towards decreasing the neck force. However, a criticism coming from two participants (P_5, P_8; v=2.6) is that the tool would separate a player from the touch of the guitar which deprives them from the feel of the guitar surface. The reason is that "*[t]he sack cloth is very smooth and slippery; it is good and bad at the same time. It slides easily, so comfortable to slide up and down the fretboard, but this makes it a little hard to feel the neck surface*" (P_8). Another criticism is that the tool may hurt the player if s/he is not careful (P_7).

It was expressed by all of the player participants that the tool fitted their thumb ergonomically. A problem mentioned by 2 participants (P_4, P_6; v=2.6) is that the tool fell off during use, and 2 participants criticised it that they did not succeed to wear the metal wire at the beginning (P_1, P_5; v=2.6), but later figured out how to adjust the flexible wire. Two players (P_4, P_6; v= 2.6) suggested that the adjustment should be refined; rather than a piece of wound wire, they suggested to use a more uniform shape, and produce it to three different sizes for small, medium and large fingers ((P_5, P_6; v= 2.6). One suggestion is that the sack should have been bigger to cover the whole thumb (P_7), because some performers press with their thumb's middle part instead of the tip.

5.2.2. Piezochromic Guitar Neck

Piezochromism can be summarised as a tendency of certain materials (i.e. piezochromic and mechanochromic polymers, liquids and pigments) to change their colours upon various forms of applied physical force. A novel design proposal that relies on pressure induced piezochromic illumination is proposed as a feedback against the wasted force on the back of classical guitar neck (*Figure 131*). The term *Piezochromic polymer* is often thought to be a synonym for mechanochromic materials, but in fact, it defines "*the subset of mechanochromic materials*" (Weder, 2013, p. 1). The proposed conceptual guitar neck aims to provide visual feedback to eliminate the above mentioned health issues (see Section 2.2.5. Muscular Torque and Precision), which performers face up throughout their career, by creating awareness to educate individuals. Apart from the Classical guitar, reversible colour pigment could be a potential development for similar string instruments such as lute and mandolin. The idea relies on the visual modality; it provides metachromatic (change in the colour) visual feedback regarding whether a performer’s actions exceed the safe boundaries or not.

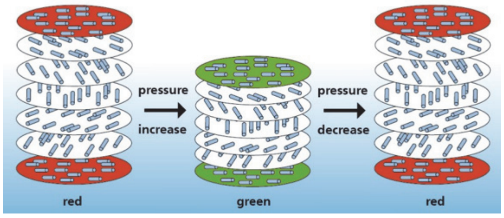

Figure 130 Pressure and colour change (Seeboth, Loetzsch, & Ruhmann, 2011)

The piezochromic and mechanochromic pigments create colour changes under various types of stress, such as pressure, stretch or tension. The change of the luminescence of *organic solids* by means of physical stress is done by "*altering the mode of molecular packing*" (Fasani & Albini, 2015, p. 209) and is realised through "*changing the chemical structures containing opened/closed cyclic forms and double-bond E/Z configurations*" (Luo, Li, Song, & Pei, 2011, p. 10515). These rapid, reversible and repeatable chromatic transitions can be between various colours, such as red to green or green to blue (J. Zhang et al., 2016). Formation of soft assemblies in these materials allows for a change in the emission colour by pressure, thus gives them reversible properties (Allampally, Strassert, & De Cola, 2012), therefore recover their original colour when the pressure is ceased. Some types of piezochromism can create degraded tones such as from green to orange and red depending on the amount of pressure (J. Zhang et al., 2016) .

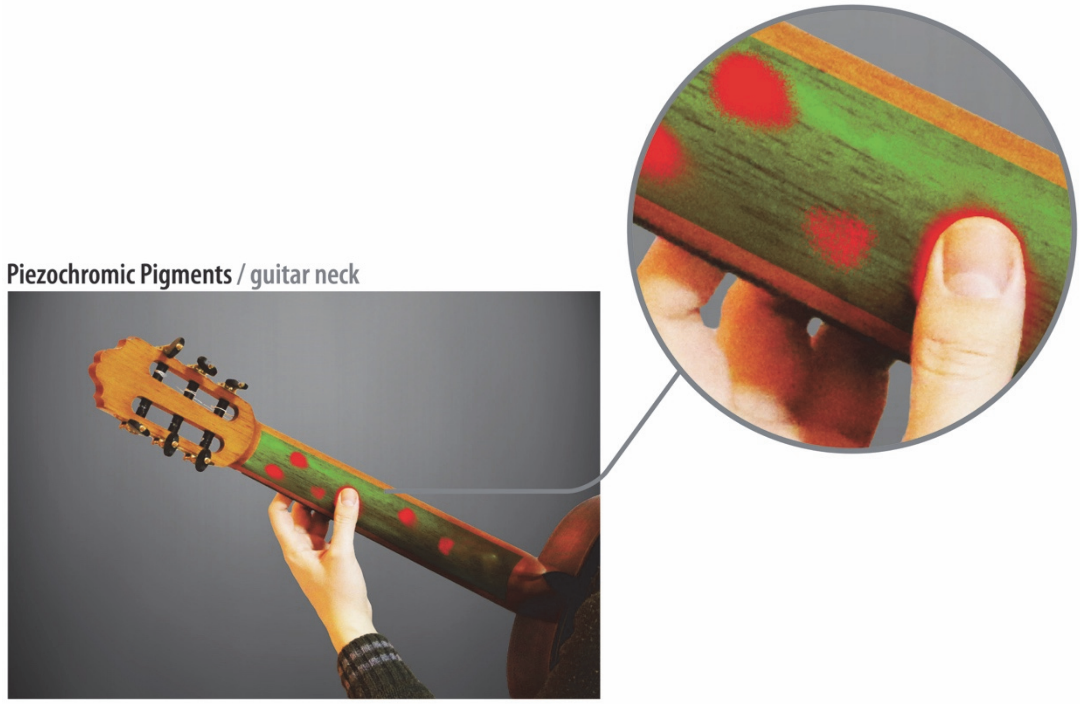

Figure 131 Piezochromism concept on Classical guitar neck

Central to the design proposal is to increase player awareness of excessive applied force on the neck, such that players can make adjustments to their technique that puts less stress and strain on the left hand. Piezochromic or mechanochromic material production is available in the forms of inks, resins and polymers and supplied by innovative smart pigment manufacturers such as OliKrom (France), Fraunhofer (Germany) and Luminochem (Hungary). The design proposal makes use of colour pigments available in the form of inks which can be applied as colouring agents on wood surface. Colour pigments change their colour at a defined pressure (P1) and after the pressure drops below the defined pressure (P2) the colour restores back to its initial colour. The difference between these P1 and P2 pressure levels defines the memory effect and allows the player to inspect if the product has exceeded the threshold pressure intensity.

Figure 132 Some applications harnessing piezochromism (WEB 69)

Mechanochromic polymers have found new application fields (see *Figure 132* and *Figure 133*) and their usage has increased for the last decade. Stress sensing, security and failure detection are possible fields. This material offers promising potentials in different product such as (i) sensors (Ding et al., 2014; Fang et al., 2015; Y. Zhang, Fu, & Ge, 2015), (ii) smart displays (Fudouzi & Xia, 2003; Ge, Goebl, He, Lu, & Yin, 2009), (iii) textiles (Finlayson et al., 2011; Yuan, Zhou, Shi, & Zhang, 2015). *"[They] are further woven into well-designed patterns and fabrics for potential application in smart wearable textiles*" (Zhang et al., 2016, p. 2127).

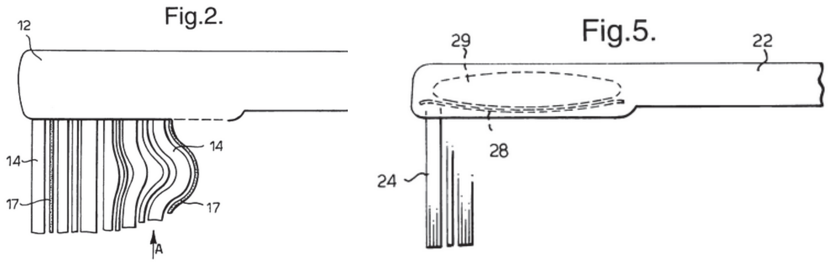

Figure 133 Unilever patent applications (Davies, Savill, & Jones, 2001; Savill, 2002)

A patent granted in 2003 that incorporates mechanochromic material as a medical instrument in jaw surgeries to provide a surgery physician with information regarding engagement of the tissue-engaging surface with the targeted tissue (Truckai & Shadduck, 2003). Apart from that, Unilever has two patents granted for their stress-sensing toothbrush in order to minimise the over-force applied on teeth by providing feedback in the case of excessive stress during the brushing (*Figure 133*). The pressure sensitive piezochromic material is a "*liquid crystal cholesterol* *ester*" (Davies et al., 2001). Although mechanochromic and piezochromic materials offer amazing possibilities, these materials have not received much attention which can be understood from patent applications. At the time of writing, there appears to be relatively few patent applications. A quick search in the US patent database yields 10 results for the term "piezochromic", and 6 results for "mechanochromic". That is, there are only 16 patents granted in the fields of mechanochromatism and piezochromatism as of January 2017 (the first patent being from 1994), which is strikingly rare in such a promising field. It is mainly because some features of these materials can be considered as a drawback in such systems. First of all, the pressure sensitivity is still poor, thus relatively high mechanical force is required to initiate and promote chemical reactions and activate the reversible colour transition (Luo, Li, Song, & Pei, 2011). In other words, the threshold of the material is too high to realise the design proposal in the present day. Mechanochromic or piezochromic colour transformation generally occurs at high pressure range such as 0.1 – 10 GPa[45] (Su et al., 2013). However, piezochromism technology is making a speedy progress and some piezochromic materials with higher sensitivity already exist. One such example is the nanometer voids made of inorganic ISOH nanometer powders which have proven to be more sensitive so that they can be promoted at some pressures as low as 0.002 – 0.01 GPa[46] (Su et al., 2013). In addition, Seeboth, Loetzsch, and Ruhmann (2011) mention their piezochromism experiment under 0.4 bar (0.407 kilogram-force/centimetre^2) pressure. FujiFilm has launched a sensitive pressure induced film, named Prescale (see *Figure 134*), whose piezochromism can be promoted between 0.00005 – 0.3 GPa[47]. But, Fujifilm Prescale is in the form of a foil, therefore, its adaptability is not very promising for the proposed product. In addition to the above mentioned sensitivity issues in the present day, the material's poor reversibility is another drawback (Luo et al., 2011) and most piezochromic materials lose their reversibility after 100 switching cycles (Seeboth et al., 2011). In

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[45] 0.1 GPa (gigapascal) is equal to 1019.7 kilogram-force/centimetre^2

[46] 0.002 GPa (gigapascal) is equal to 20.3 kilogram-force/centimetre^2

[47] 0.00005 – 0.3 GPa (gigapascal) interval is equal to 0.509 – 3059.1 kilogram-force/centimetre^2

fact, it is safe to argue that mechanochromism and piezochromism are still in their infancy and, but has a great potential that can be considered for future projects.

Figure 134 Fujifilm Prescale (WEB 70)

5.3. Design Considerations for Nylon Strung Acoustic Guitars

The modern Classical guitar is in the category of an archetype, which is expected to be a certain way by performers, with hardly any deviation from traditions. Therefore, the present day musical life shows some reservation over whether an *archetype* could or should be improved, or there is enough room for improvement. On the contrary, unconventionally designed guitar examples can be found among international concert guitarists. Furthermore, some Classical guitars produced in the first half of the 20th century reveal even more courageously designed examples. That is, novel ideas, 'alien' materials and non-conventional methods are welcome and adopted by many, although the majority of related stakeholders do not wish to move over to these 'radically different' instruments. That is, an effort in "design for performability" might jeopardise the recognisability of that instrument, or might not meet the criteria what Classical guitarists recognise as being a *Classical guitar*. Therefore, any design activity concerning musical instruments should be realised through discretely used parts or materials.

5.3.1. Fret Buzz Removal

Interview data indicates that expert participants showed considerable interest in left-hand musculoskeletal disorders and energy minimisation. The proposed fretboard attachment (see *Figure 135*) introduces a new concept which aims to minimise the energy consumption in guitar performance. This project aims to decrease the necessary force for barre chords and the risk of making mistakes (caused by buzzes) during the course of performance. In guitar playing, the overused force results in physical stress and strain, therefore a soft touch is crucial. However, playing with a soft touch is not always feasible, because it might bring the buzzes to the performance. The buzz is caused by the string vibration as seen in *Figure 136*.

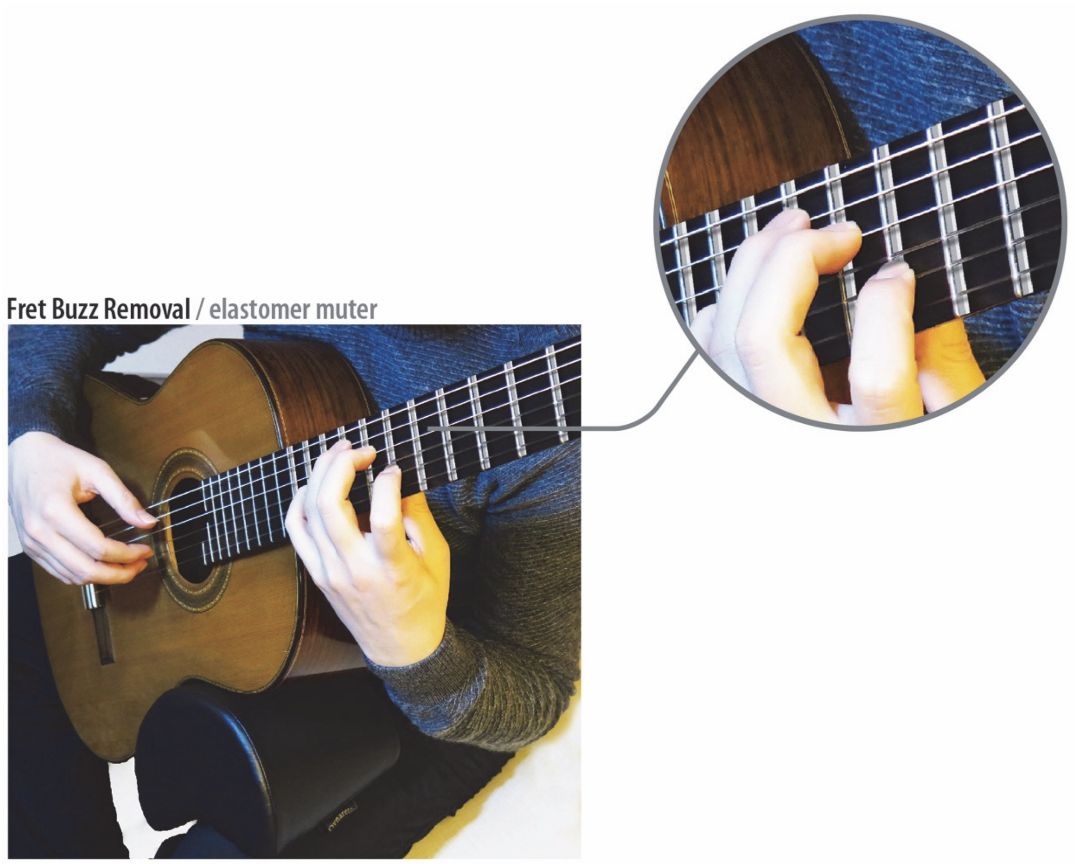

Figure 135 Fret Buzz Removal

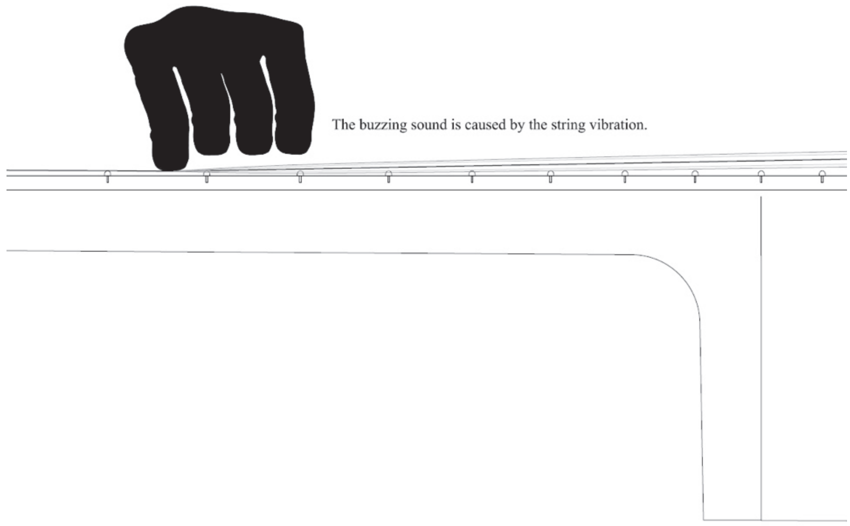

Figure 136 Fret buzz

String buzz can be eliminated by a stronger left hand pressure. However, if a performer applies greater torque, then they encounter the risk of repetitive stress injuries especially in their left hand. That is, performers who have developed these health problems might be forced to give up performing and quit their career. Sadly, there is a great number of musicians who have been forced to quit their career due to these health issues. The proposed project intends to reduce the required force applied by the left hand, and eliminate the above mentioned health problems as well as reducing the risk of making mistakes in live performance settings. The design project may supply guitarists with a guitar which boosts their performative skills and enables them play without mistakes arising from buzzing sounds.

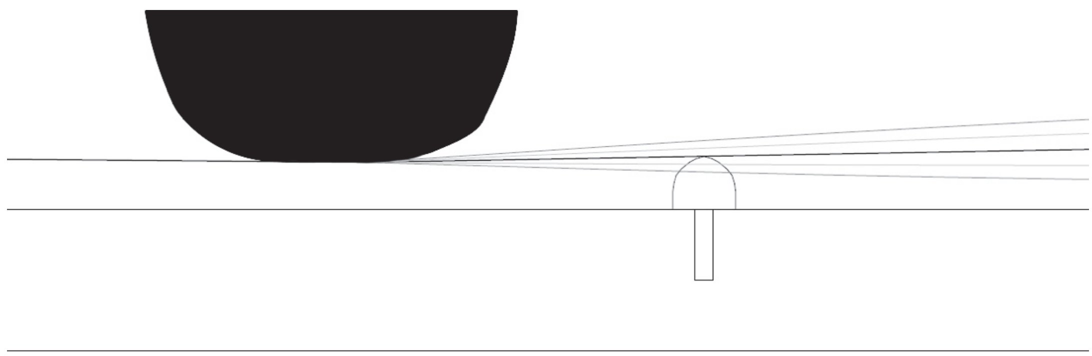

Figure 137 String oscillation causing the buzz

A zoomed view of *Figure 136* as seen in *Figure 137* shows the mechanics of the string buzz. The vibration of strings causes the buzzing sound. When a player can't apply enough pressure, the oscillating string hits the metal fret at a certain frequency causing an unpleasant sound. The buzz problem can by eliminated by (i) pressing closer to the fret as seen in *Figure 138*, (ii) applying greater force with the left hand or (iii) a weaker right hand attack. However, these solutions are not always feasible to apply. Especially, complex left hand positions sometimes make it impossible to get closer to fret locations.

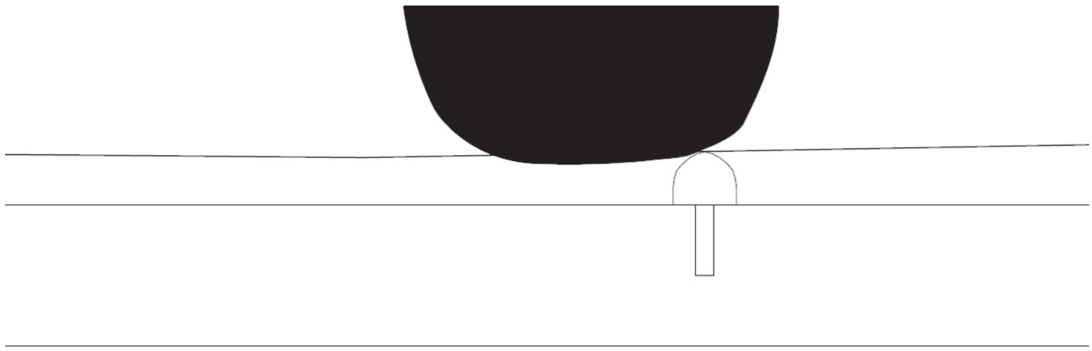

Figure 138 Pressing nearer to the fret above

The conceptual *elastic fret buzz mute* aims to remove fret buzzes caused by metal string oscillation that hits metal frets. It compensates for *bad technique* of a guitarist, because it makes the finger position and amount of pressure less critical. Additionally, some difficult positions do not let performers fret properly. Reasons are (a) hand span isn't large enough to cover and get closer to the fret (b) due to a difficult position, one cannot apply enough muscular power (c) finger knuckles make it difficult when barring across several strings. The proposed buzz removal tool doesn't cause any tonal change or dampening as long as the string is fretted -by the left hand fingers- properly. If the performer cannot fret the string properly, due to any of these a, b or c reasons, the guitar produces a little dampened sound but it does not buzz, or it buzzes less than it would otherwise.

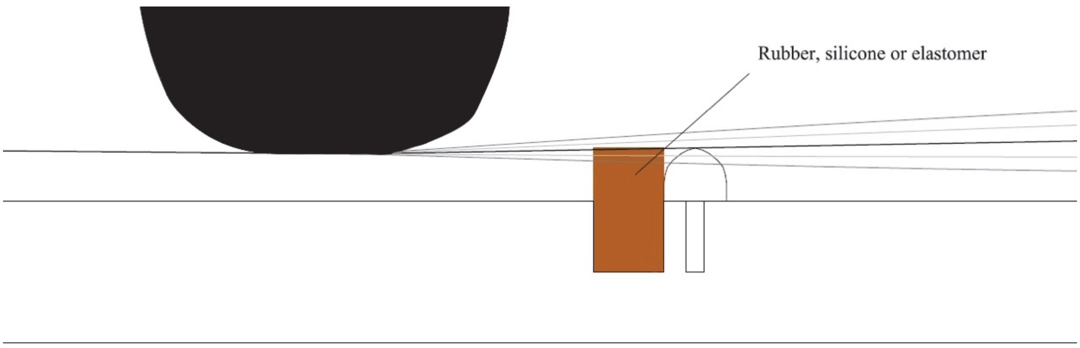

Figure 139 Elastic fret buzz mute

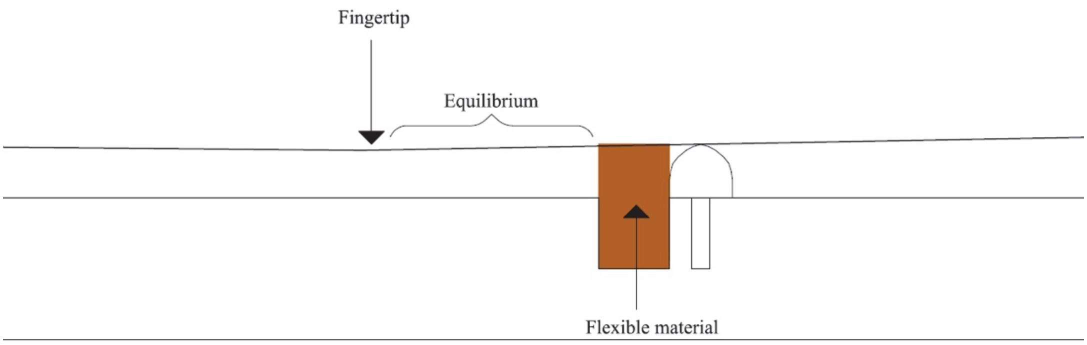

Figure 140 Soft materials creates a zone free of oscillation

Soft material, i.e. rubber, silicone or elastomer, has the same height as the metal fret (*Figure 139*). It controls the string vibration, as it functions like human flesh and it helps the finger by limiting the vibration and preventing the string from hitting the fret. Fingertip and the proposed flexible removal tool create a territory where the string does not make an "*unwanted vibration*"[48]. Eventually, this stable territory eliminates fret buzzes and offers a cleaner sound (*Figure 140*). Mention has already been made that, this is a conceptual design proposal which demands further testing and development. Theoretically, the design concept appears to work on paper. In other words, it seems that an oscillation-free equilibrium area can be realised using a type of silicone or elastomer material. However, it should be noted that a performer on a guitar fitted with the Fret Buzz Removal tool would be battling compromise to get some benefit over timbral quality. That is, this tool may stop rattling strings, but

[48] ***unwanted vibration:*** *this point is out of the string's used part which is between the bridge and the fret (see* Figure 141*)*

it will inevitably cause a certain amount of dampening in the tone. Additionally, direct observations made during the research and design process imply that an important criticism against this tool is that it may create sloppiness, if not laziness, in the left hand technique of performers. Rattling strings and fret buzz is a natural sound –not only for guitars– created by musical instruments and strings, and thus is acceptable. That being said, it is considered as a mistake especially in competitions. User tests need to be carried out to explore the extent to which string rattling could be eliminated without causing harm to music or the performer's technique.

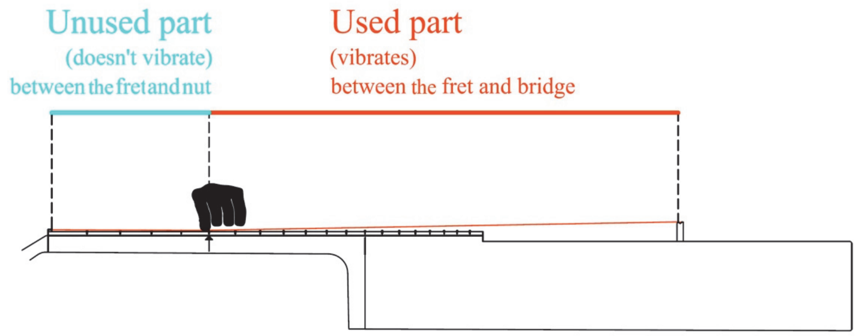

Figure 141 Used and unused parts of a string when fretted

5.3.2. Action Height Adjustment

The action height is one of the most frequently quoted attributes that makes a guitar performable during the expert interviews and was directly mentioned by 18 participants (v=7). As explained in Section 4.1.2., low action makes a guitar more playable but causes a decrease in power, whereas high action allows for a loud volume but is not as comfortable. In other words, just by changing the action, a guitar can become more playable at the cost of volume. Therefore, it requires a very fine balance (AM, CL, CS, EP, EBa, HH, IR, MD).

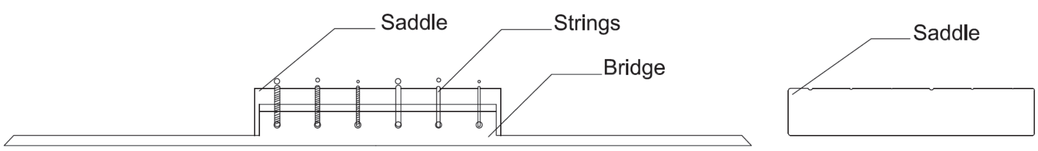

Figure 142 Standard bridge and saddle

Adjusting the action requires craftsperson skills and it is usually reserved for an experienced luthier. However, sometimes players have the obligation to modify the height due to climatic changes or different string tensions. In addition, touring performers suffer from extreme climatic changes. Especially hot-cold and humid-dry climate changes pose serious problems that has to be handled by the player. These changes can affect the action height or may oblige a player to change the height. However, sanding or filing the saddle bone (see Figure 142), or replacing it is not easy and requires tools and precision. An alternative saddle design may help a player adjust the action as they need. That is, if high volume is necessary, the action height is increased easily, or in a situation where volume and power is not substantially important, the player can decrease the height to increase the performability of the instrument. As can be seen from the *Figure 143*, the proposed bridge saddle has three levels for high, mid and low action height. Level 1 is the highest action that aims high volume, and the level 3 is the lowest action that aims comfort.

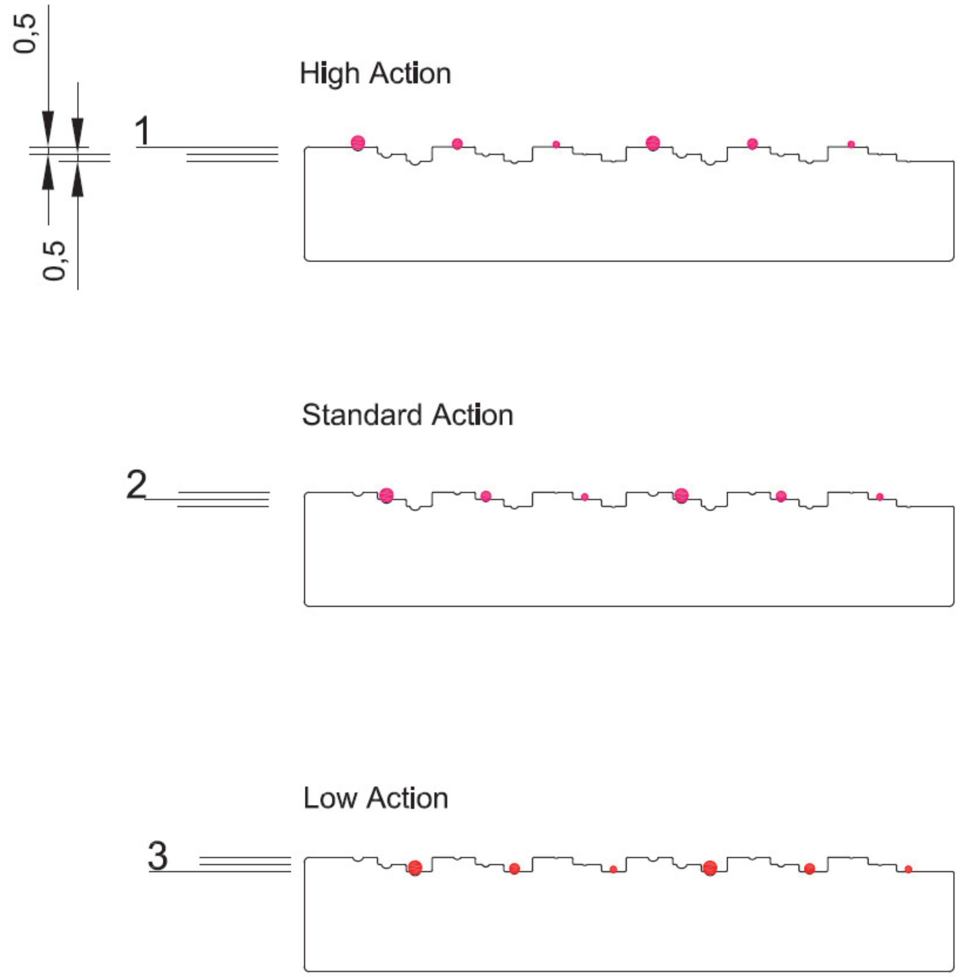

Figure 143 Proposed saddle design

CHAPTER 6

CONCLUSIONS

This PhD thesis has documented a journey through musical communities, realised to unveil the role of industrial design in defining the dimensions of performability, playability and virtuosity. The study has sought to understand factors that contribute to a high quality interaction between a soloist and their instrument, with special regard to product qualities of an instrument. Eventually, the thesis study proposed four design implementations with an aim to improve the performability. However, it should be noted that these design alternatives are not the main findings of the research. The main outcome is believed to be the analysis of different perspectives of various stakeholders in music production business concerning product qualities of musical instruments and performative qualities of musicianship. The proposed design implementations are currently suggestions that need further testing, except the left hand tool which went through a preliminary user testing. They were conceived on a theoretical level to help solve various playing-related health problems or performer mistakes. Having said that, these design suggestions may lead to useful outcomes for Classical guitars or other plucked instruments once they are tested, evaluated and redeveloped.

The sheer diversity of luthiers and evident multiplicity in Classical guitar manufacture methods and materials in the present day have caused a move away from the instrument's Spanish roots. The shift from traditions has shown conflicting indications. Both supporters and detractors of these technology-bound new guitars can be found in famed performers, highlighting controversies towards the evaluation of musical instrument design in the present day. A significant number of makers have developed their own techniques. Eventually, performers have a plethora of high quality concert instruments, thus a wide range to select their best fit. On the other hand, this very competition among luthiers seems to have made it impossible to bring the Classical guitar manufacture to a finalised state. It is safe to argue that Classical guitar luthiers, unlike violin or cello makers, will still be trying to improve their methods and instruments over the coming decades.

Direct dealings with different stakeholders have unveiled a curious finding; it seems that making a guitar to the satisfaction of all stakeholders is a myth. It explains the general belief that "*the perfect guitar does not exist*". Although it is a desirable goal, it is not realistic, as each stakeholder group has different privileges. The mechanism seen in *Figure 144* resembles a sort of co-design practice. Participatory engagement with users and/or consumers, as the core of co-design, aims to include those 'clients' in design process with flexible degrees of involvement to benefit from their experiences. In parallel to co-design practice, different stakeholders in music production, i.e. performers or composers, as the experts of their own domain, become active parts of design for performability.

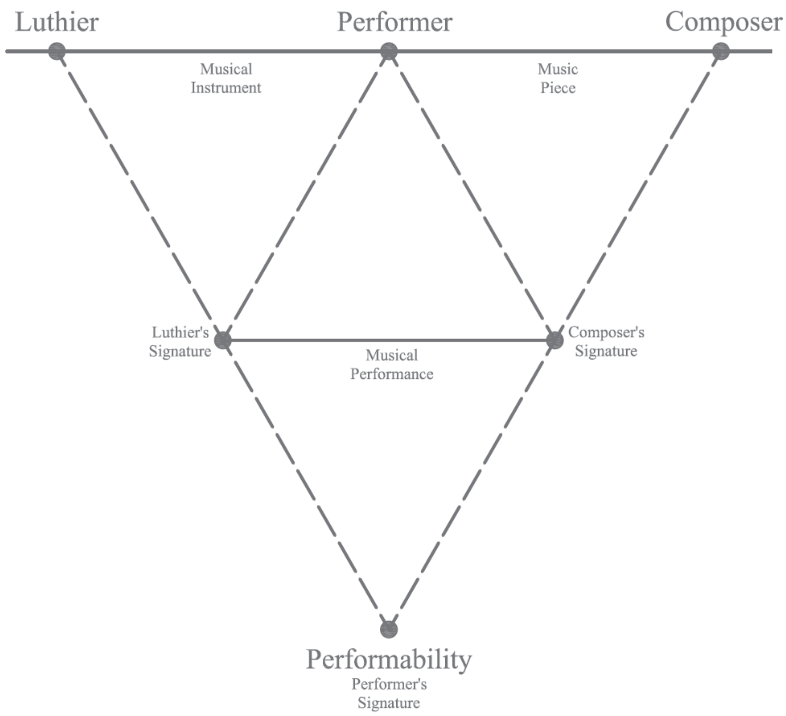

Figure 144 Relationships of stakeholders

Their inclusion, however, is different from co-design practices of consumer products or social services. Due to the rapid development in technology, products and services become obsolete in significantly shorter periods. On the other hand, inclusion of participants can occur in different eras and locations when instrument design is concerned. *Figure 145* is an interesting example. Taken from a video, the image displays a player, Jack Sanders (b. 1957), performing music of Luis de Milán (1500-1561) on a Santos Hernández (1874-1943) guitar made in 1933. In this video, we encounter three works of art, not one. Each 'artist' execute their task to the satisfaction of all, although they never saw each other, and in fact they all lived in different times and locations. The product, in this case the Classical guitar, is a product of a process which is similar to co-design produced by different stakeholders existed and worked in different times and dimensions.

Figure 145 Jack Sanders playing music of Luis de Milán on a 1933 Santos Hernández (Guitar Salon International, the Russell Cleveland Collection, WEB 71)

However, this participatory engagement has a shortcoming which makes it impossible to be a sustainable development: there is a lack in the communication because the *circuit* is not *closed*. Luthiers communicate with performers, and performers communicate with composers. However, luthiers do not communicate with composers. This is the shortcoming in their dialogue. Co-design in instrument design and manufacture seems to have run into trouble as these stakeholders do not reach a consensus. These participants talk about their own personal sound 'signature'. Their relationship should be replaced with a 'closed-circuit' communication as depicted in Figure 146. All parties should put their personal privileges aside and strive for the overall satisfaction of the audience.

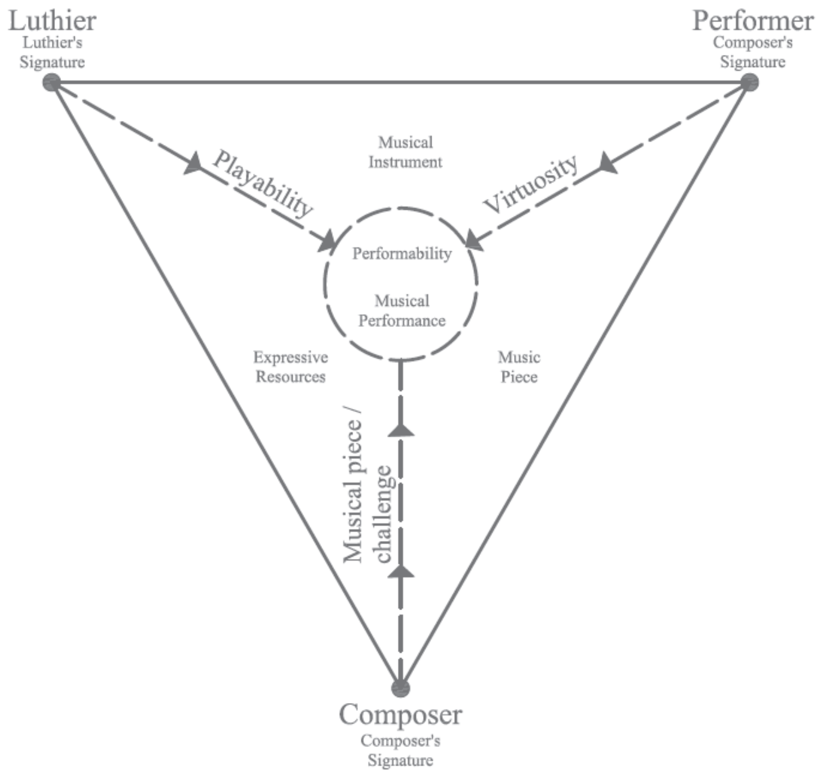

Figure 146 Co-design applied relationships of stakeholders

Here it might be helpful to review the playability and performability concepts with special regard to personal skill and the interaction of actors who work in co-operation to ensure enhanced performative qualities. Playability is an instrument phenomenon which is related with the artisanship of the luthier; technical maturity and musicianship –a technical and expressive phenomenon– depends on the skill of the performer; and domain of music imparted by the composer. Performability arises from an interaction between these actors working together for an aim to facilitate the art of interpretation. As seen in Figure 147, personal skill of a performer can enable them to perform with an improved capacity on a certain instrument. Or, a playable guitar will be 'easy' or 'playable' irrespective of the performer's skill; meaning, playability ensures a relatively easier performance regardless of technical capability. However, the performability concept utilizes both qualities for an ultimate aim to reach the maximum of a musician's performative skills.

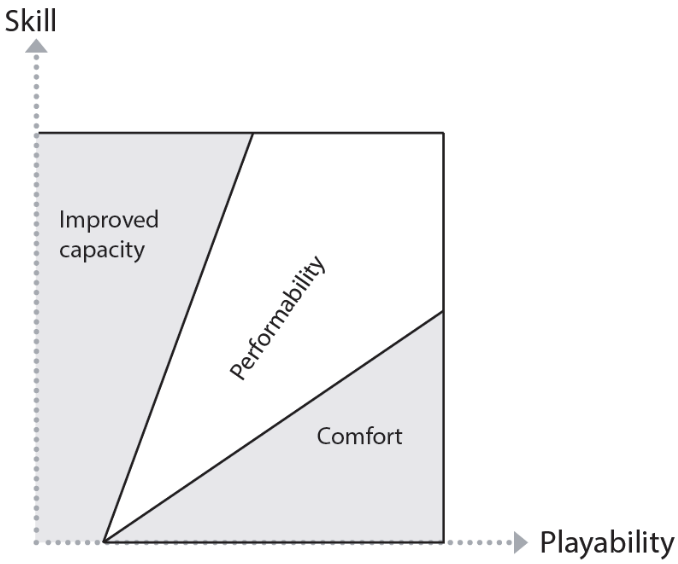

Figure 147 Personal skill and its effect on playability levels

6.1. Summary of Work Undertaken

The research has unveiled how the product quality of an instrument is of great importance on musical production. While a good player can make music on any instrument, it is certain that a sonorous instrument would greatly help. However, this ‘helping hand’ was defined in different ways by participant groups. Each stakeholder group expresses the aid of an instrument around various concepts using somewhat different terminologies. Luthiers and performers stress rather technical and instrument or audience-centred attributes, whereas composers tend to underline different phrasing qualities such as articulation, integrity and unity. Playability was an often used term by the luthiers and performers. It can be exemplified as the height of a potential ceiling of an instrument. Performability, in this metaphorical example, would be the height –or extent– to which a guitar allows its performer to reach musically. That is, a guitar can be deemed playable, or less playable, in the absence of a musical performance. Hence, playability can in fact exist without the act of "playing".

Emotional and intellectual sides of musicianship are considered important towards the enchantment of musical performance. Musical qualities arising from spiritual richness and emotions of a performer, dynamics, and colours of performance, and finally audience recognition were mentioned by all of the parties. The heightened state of performance along with emotions, expressiveness and audience appreciation make a master performer qualify to be considered for virtuoso status. Having said that, a virtuoso musician might fail to perform at the same level in each concert. It was mentioned by numerous participants that live performance is affected by the response of listeners. That is, their appreciation greatly affects the player, and it is believed to pave the way towards a heightened state of musical activity, termed 'flow' in the literature. It can be claimed that virtuosity is a state of trance when a performer forgets everything on stage, but music. A direct analogy can be drawn between flow and performability; they both point to a transition from "playing an instrument" to simply "making music". In essence, the transition allows one to forget the instrument such that it disappears into the background of consciousness.

"Design for performability" is the notion that performability can be obtained or improved through design. It requires the contribution of all the stakeholders for an instrument to reach a high level of performative expression. In order to bring out the true potential of an instrument, it should be manufactured with great attention to detail, to play sophisticated music pieces, using an advanced technique and musical sensitivity, in a hall with wonderful acoustics before an acknowledged and appreciative audience. Therefore, it is a more "democratic" term than "design for playability". Performability becomes visible through the interaction of a player with their instrument, if indeed the interaction satisfies some aspects like physical competence or state of mind. Design for performability can be realised or supported through two objectives: (i) designing training aids to improve the performer, which elevates the Classical guitar eco-system surrounding player-related stakeholders and (ii) developing design implementations to improve the instrument-performer interaction.

The Classical guitar is a *new* instrument surrounded by relatively less conservative environments. So, the degree to which the Classical guitar environment is open to development can be defined by a wider boundary of design novelty compared to tradition-based instruments. A quick inquiry over the present day Classical guitar manufacture would yield many radically designed guitars used by concert artists, including the Brahms guitar. Therefore, proposing design, material or methodological changes to a tradition-bound product is feasible and welcome by many, but at the same time meets with inertia from the majority of the stakeholders involved in this field. Instrument manufacture conventions are difficult to break and alternatives take a long time to blossom. This effect is even greater where instruments which have been surrounded by strict traditions are concerned. For instance, the Cello, Harpsichord, Viola, Violin or Harp are considered 'finalised' or 'fixed' by many today. Makers would not attempt to change the soundboard of a, say Cello, partly because the great makers of it have succeeded to make this instrument an 'archetype'; and we have inherited wonderfully composed music written for it by great composers of history. But the Classical guitar is not. Various reasons can be found; most importantly the Classical guitar did not have a '*Stradivari family*', and it has a relatively *fresh* repertoire. Considering catalogues of music publishers in the present day, original works written for the Classical guitar has not culminated in a well-established repertory. There are less than ten guitar concertos frequently performed in concerts today, whereas dozens of Piano concertos are performed or recorded every day. In addition to quite few orchestral composers who wrote 'serious' music originally for the Classical guitar, most frequently performed music consists of transcriptions of music written for other instruments and traditional dances, ballads and songs. Eventually, in the second half of the 20th century, some makers and performers were in search of a '*better*' guitar against its perceived shortcomings. The solutions they came up with were louder, easier or simply more ergonomic instruments. They did not feel the oppression that a violin maker would feel manufacturing in such a tradition-bound environment where iconic Stradivarius or Amati violins had long existed. The reflection of this *conservative inertia* in instrument manufacture is that new designs or innovations seldom enter production, hence, novel design ideas do not evolve beyond bespoke implementations and, very often, these inventors cannot apply for patents. Design interventions can be introduced and they could be technically beneficial, but traditions usually oppress these novel constructors and alternative conventions take a long time to blossom. Nevertheless, being a relatively new instrument and having been surrounded by a dynamic eco-system whose members have proven to be more open minded towards novelty, the Classical guitar is relatively open to improvement by design. This research has offered some plausible ways to achieve 'design for performability', in an attempt to (a) help improve Classical guitarists' awareness on wellbeing and (b) facilitate their playing by eliminating instrument-centred noises.

6.2. Research Questions and Definitions Revisited

RQ1. How can we define the links among virtuosity, playability and performative quality for the Classical guitar?

Although a virtuoso performer can make music using an ordinary instrument, the product quality of an instrument affects their performative skills. Playability means an ease in playing an instrument – originating from various factors – which helps a performer to focus on musical aspects of playing. In the end, it increases the performance quality. This research has provided evidence that design features of musical instruments are important factors in music making, and a vast number of luthiers have struggled to find the 'best' design for more than a century.

RQ2. What are the shared and unique views of different stakeholders (those who have direct dealings with the Classical guitar) on the instrument quality, playability and virtuosity?

Luthiers, performers and composers shared different, and sometimes contrasting, views regarding an instrument's qualities. Luthiers tend to be precise and mathematically right in their perspective. They are instrument- and player-centred, which means that their main privilege is not actually listeners,. In contrast, the audience is the centre for performers: the guitar becomes a tool for musical satisfaction of both performers and audiences. This "tool" and its long term effects on human health gain serious importance for performers. Hence, instrument qualities concerning health and well-being are also important aspects of instrumental quality. Composers care for *respectful* or *correct* interpretations which necessitates certain product qualities like expressive facility, timbral variety, power, projection, colour and dynamics. However, intellectual aspects, personality and understanding a composer's ideas are also important aspects besides the aforementioned product qualities.

RQ3. Which instrument qualities (generally) and Classical guitar design qualities (specifically) are associated with performative skills and dimensions of virtuosity, and why?

The research has shown that stringed musical instrument design in general and Classical guitar design in particular have an important effect on the performance of musicians. A musical instrument is the product in this case, and its various qualities affect performers. These are (from most to least important): timbre quality, action height, neck, volume, required effort, physical balance and proportions, comfort, top tonewood, tension, projection, fingerboard, sustain, string quality and material, interior structure quality and bracing system, craftsmanship, back and sides, response and sound holes on the sides. These dimensions of Classical guitar design and interaction were rated in this order through semi-structured interviews with stakeholders. They are all important for two reasons. First, each decreases the difficulty threshold of an instrument, which in turn, saves energy for the true aim of music, that is communicating one's musical ideas. Second, each is a means to an end of musical production which is emotionally and intellectually valuable and original (i.e. dynamics, colours).

RQ4. In what ways do various stakeholders have different views on instrumental qualities towards improving performative qualities?

Different views of related stakeholders point to a quality in musical performance which is lacking in the current terminology. It was termed *performability* in this study. This concept is a property of the musician-instrument interaction. It means the extent to which playability is used in the service of music. Playability is a product quality which makes an instrument less difficult and more comfortable to interact with, regarding sound production and expressive resources. While playability is an instrumental quality, performability is about the interaction quality between a performer and their instrument.

RQ5. In what ways might it be possible to elevate performative skills through industrial design?
Outcomes of this study indicate that the performability of the Classical guitar can be elevated through various design avenues explained in the Fret Buzz Removal, Action Height Adjustment, Left-thumb Tool and Piezochromic Guitar Neck sections. These design contributions realise two objectives: (i) designing training aids to improve the performer, (ii) developing design implementations to make instruments more performable, and mistakes less critical.

(a) Left-thumb Tool is a practice aid intended for empathy modelling in order to create consciousness for the overused force in the left hand thumb. The tool aims to create controlled discomfort which makes a player conscious of the neck force exerted onto the fretboard; which in turn will teach them decrease the overused muscular torque and decrease the risk of developing disorders in the left hand.

(b) Piezochromic Guitar Neck utilizes piezochromic or mechanochromic illumination as a feedback mechanism upon the waste of force applied by the left hand onto the fretboard. Based on visual modality, the material changes its colour when the applied pressure exceeds the threshold level. This visual feedback is thought to be an important *guide* for learners, especially for those who do not have access to instrumental education. This neck attachment aims to create correct and healthy habits that will save a promising performer's wellbeing through their career.

(c) Fret Buzz Removal is a tool that makes player mistakes less critical aiming to mute the fret buzzes caused by a low muscular pressure onto the frets. In principal, an elastic (elastomer or silicone) muter creates a soft buffer to stop the string from rattling on the fretboard, aiming to stop the buzzing of strings with less left hand pressure

(d) Action Height Adjustment is an alternative saddle design which enables the performer to decrease or increase the action height for comfort or higher volume. Central to the design idea is the change in the action height touring performers encounter on their instruments due to different weather conditions across the world.

6.3. Reflections and Future Direction

This research has been conducted for strummed string instruments in general, and the Classical guitar in particular. Unfortunately, it is one of the very few academic research studies aiming to shed light on assessing product qualities of musical instruments and create a roadmap as to how performative quality can be understood and improved. Design implementations introduced in this study can be tested and developed in further studies. Applying modifications of these design alternatives to other musical instruments can make a valid contribution. Using the methods and terminology exemplified through this thesis, similar studies can be realised for other musical instruments.

In the present day, precision machinery and CNC technology are used in anything, including concert instruments. This study through direct dealings with various experts, has supplied first-hand information that even in the tradition-bound practise of instrument making, high-precision machinery has a role. In fact, the connection of instrument making traditions and design is deeper and stronger than it is believed to be. A possible future direction might be unveiling this connection in an attempt to find out the differences and similarities of tacit knowledge of luthiers and the fundamentals of mass-production. Another future direction can be the well-being of guitarists. There are academic studies concerning the musculoskeletal disorders of pianists or violinists; however, this knowledge is lacing regarding the Classical guitar.

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APPENDICES

APPENDIX A

PERSONAL COMMUNICATIONS

Barnett, Kris. (September 6, 2016). Personal Communication

Connor, Stephan. (February 20, 2015) Personal Communication

Hepple, David. (September 3, 2016). Personal Communication

Stevenson, David. (September 3, 2016). Personal Communication

Teppert, Johannes. (September 11, 2016). Personal Communication

Varney, George. (September 4, 2016). Personal Communication

APPENDIX B

Table B.1. Interviewed luthiers, places, the interview language and dates

LUTHIER INTERVIEWS				
Name	**Abbr.**	**Place**	**Language**	**Date**
Ejder Pamukçu	(EP)	İzmir, Turkey	Turkish	10.06.2014
Paulino Bernabé	(PB)	Madrid, Spain	English	01.08.2014
Ana Espinosa Rodríguez	(AE)	Granada, Spain	Spanish	07.08.2014
Andrés Daniel Marvi	(AM)	Granada, Spain	English	08.08.2014
Casimiro Lozano	(CL)	Albacete, Spain	Spanish	14.08.2014
Hermann Hauser III	(HH)	Reisbach, Germany	English	22.07.2015
Theo Scharpach	(TS)	Groessen, Holland	English	21.01.2016

Table B.2. Interviewed performers, places, the interview language and dates

PERFORMER INTERVIEWS				
Name	**Abbr.**	**Place**	**Language**	**Date**
Ender Hulusi Bilge	(EB)	İzmir, Turkey	Turkish	12.06.2014
Jose María Gallardo	(JM)	Valencia, Spain	English	30.01.2015
Marcos Díaz	(MD)	Ourense, Spain	Spanish	01.02.2015
Ignacio Rodes	(IR)	Alicante, Spain	English	03.02.2015
Daniel López	(DL)	Madrid, Spain	Spanish	06.02.2015
Oscar Herrero	(OH)	Madrid, Spain	Spanish	23.03.2015
Heike Matthiesen	(HM)	Frankfurt, Germany	English	09.08.2015
Kürşad Terci	(KT)	İzmir, Turkey	Turkish	25.12.2015
Ahmet Kanneci	(AK)	Ankara, Turkey	Turkish	11.01.2016
Kağan Korad	(KK)	Ankara, Turkey	Turkish	16.03.2016
Soner Egesel	(SE)	Ankara, Turkey	Turkish	16.03.2016

APPENDIX B (Cont.)

Table B.3. Interviewed composers, places, the interview language and dates

COMPOSER INTERVIEWS				
Name	**Abbr.**	**Place**	**Language**	**Date**
Ertuğrul Bayraktar	(EBa)	Ankara, Turkey	Turkish	30.12.2015
Ertuğ Korkmaz	(EK)	Ankara, Turkey	Turkish	30.12.2015
Turgay Erdener	(TE)	Ankara, Turkey	Turkish	11.01.2016
Carlo Domeniconi	(CD)	İstanbul, Turkey	English	13.01.2016
Ceyhun Şaklar	(CS)	İstanbul, Turkey	Turkish	15.01.2016
Onur Türkmen	(OT)	Ankara, Turkey	Turkish	14.04.2016
Füsun Köksal	(FK)	İzmir, Turkey	Turkish	06.06.2016

APPENDIX C

Table C. Product Self-Evaluation Form

Name: Date:
1. Did you have left hand issues you wanted to solve before starting to use this product? If yes, what were they?
2. How did you feel at the first time you used?
3. How did the feeling of discomfort force you to move?
4. How did you feel about the torque you apply with your left hand?
5. Do you think this tool can create an awareness and help you to reduce the left hand pressure?
6. What are the aspects you believe this product cannot do good?
7. Does it fit your ergonomics?
8. How can this product be improved? What are the missing parts? Do you suggest form and/or material changes?

APPENDIX D

INTERVIEW TRANSCRIPTS

Ejder Pamukçu
10.06.2014

What does playability mean to you? What are the product qualities of a Classical guitar that promises improved playability?

In Classical guitar making we use two different methods: one of them is the traditional Spanish method, and the other is the French method. The Spanish method is my preference in guitar making. In short as a summary...

Is it a method that the famous French maker Bouche developed? Can it be the French method?

No, actually it is a method that's been used in violin making, it became a term. French method in guitar making or violin making means: acoustic box is made first and the neck is constructed and attached to this box. This is called the French method. In the Spanish method, the neck is constructed first, and remaining parts are attached later. The neck is followed by the top (soundboard). After that, back and sides are attached. In the French method, sides are followed by the top soundboard and back. And the neck follows this process.

Actually some makers claim that the back and sides do not produce sound vibrations, and therefore in order not to absorb vibrations, some makers use a double back and side layering.

Well, actually no, they produce, we can simply prove this. The whole instrument is a unit, hundreds of pieces (tapping a neck, back and sides). Put your ear and hear the sound. When you give vibrations, the resonance of the neck also vibrates the instrument (soundboard). Naturally these parts, like every single piece, affect the final tone. If you laminate them, the glue between layers affects the tone negatively. It is for practical production. Giving this shape to thin layers is easier, but if you are working with thicker pieces (2.4 or 2.6 mm.) it gets more difficult. It is not possible to say "*this piece does not contribute to the guitar tone*". Even this (showing a headstock) affects, sides have even greater effects on the timbral quality.

As I said, my preference is the Spanish style, and in this construction style, the construction starts with the neck. As you can see this heel (showing a heel), it has a key coupling, and you slide into the key coupling. The traditional Spanish system does not permit a structure that elevates the fretboard (elevated Humphrey fretboard). But the French method makes it possible, and many more things, but especially the fingerboard base support. So, this construction method is more flexible, in that sense.

When talking about a 'good' guitar I think there should be three things. Firstly, comfort is important. Comfort means proportions. The neck on the body, the action height on frets, the action height on the body and their balance. In addition, comfort on frets. In addition, producing the tone on a fret well. Namely, that instrument should be good when dynamics such as piano, mezzo forte or forte levels considered.

The guitar I played was very 'fluent', I don't know what is necessary for that, but it was very fluent.

It is also related to the person you make one specific instrument.

Before making an instrument, do you observe performers?

Yes, sure. Long term contact is important. You need to know his expectations. You need to inspect how s/he plays.

Maybe their fingers, the amount of force, the size of their hands and fingers.

Also the technique s/he uses, attack angle, holding posture. In addition, what sort of tones s/he produces. Especially hand and body structure. On the neck, at the 1st and 9th frets, there we have some values which may vary plus and minus. These definitions are shaped according to the performer, but you need to know them well. For instance, the 1st fret is 21 mm. thick including the fret. The 9th fret needs to be 23 mm. If their hands-fingers are large I should make 23 mm. by 25,5 or 26 mm. Or 22 mm. by 24 mm. can be okay. These measurements also give the dimensions of frets. 52, 52.5 or 50 can be used. Or the 12th fret can be 62 mm. In other words, the thickness influences the width. According to their hands I balance the width and the thickness. Because performers should be able to produce sound easily, they need to produce a good tone. A good timbre depends on comfort. If comfort is succeeded, both physically and sensorially, the comfort is meant to be succeeded in all its sub-entities.

What I found comfortable was the tension and response of the strings. The strings were soft and fast.

And that guitar has hard tension strings. Fan struts that we use under the hole, harmonics, and the top plate curve... None of them is straight. All have curves and radiuses. If your top is very soft, then you need to increase the tension, namely the top's curve All of them affect the tension. The soundboard tension provides background to the guitar which in turn yields the tension and comfort. All of them are '*designed*' depending on the mass (soundboard), or back or neck (wood quality). The way they come together ensures that ease of play. The comfort and weight of a guitar... A good Classical guitar needs to be between 1.4 and 1.6 kg. Because the weight, at then end, becomes a torture for a performer.

Smallmans are very heavy. Partly because of the lattice bracing?

Inside the guitar it has a criss-cross lattice bracing system. This makes 700 or 800 gr. of weight. In order to satisfy, one needs to organise and plan a great construction. Too many pieces of wood need to be constructed together and attuned perfectly. A perfect guitar should feel like a single piece. The Classical guitar is made of soft, medium and hard woods. Their response to glue, vibration and movement are different from each other. Attuning these different properties, once succeeded, brings about the comfort.

As a luthier, for me, one of the most important aspects is the physical beauty, and aesthetics. Visual, materialistic and structural harmony, and an overall sophistication in the construction. A good Classical guitar should serve for long years. A good guitar’s life span is relatively short in comparison to a violin, but a guitar should normally be playable for 40 or 50 years without serious problems and maintenance - if you are in contact with its maker. A very good guitar can be performed even a century later.

Segovia and Bream changed their guitars more or less in every 25 years. Violin is carved out, therefore it lasts longer.

The Classical guitar does not have a long life compared to a cello. Violins can be used for centuries sometimes partly due to its form. And the Classical guitar has so much body contact. Chest, arm, hands etc. Violins do not have contact with human body thanks to its pillows etc. And they do not have polish on the neck. Sleeve should be used against sweet. The summary is: comfort (physical comfort and tone richness, acoustic harmonics, bass-treble balance), physical endurance, aesthetics. Spanish method was finalised by Torres but if you go further, vihuela etc. were made in the same way. Namely the Spanish method.

How can you define the virtuosity on classical guitar?

Actually virtuosity is something that needs to be asked to musicians but it means to me: a skill to perform using the best techniques within the constraints of an instrument. As a summary, the guitar is played with an energy applied to the string by nail, instead of a bow or hammer. At this big body, since we apply the energy using our nails, and we fret the instrument by using fingers, we can say that the sound is produced by our body. Virtuosity means knowing the boundaries of an instrument, playing with clean sounds, moving to the deep down of music pieces with great tones. It is not playing fast or without mistakes. It means conveying the musical ideas correctly within the capacity of the instrument. Technical capacity alone is not a manifestation of virtuosity. Paco de Lucia was able to convey the meaning beneath the technical difficulties, such as speed and tempo. Spiritual richness and perfectionism... Musical emotions and correct tones with a clean sound, correctly... Musicians may comment on posture, how to act on stage, how to handle the guitar, as well as visual and technical aspects, but to me it means this.

How do we realise when we hear? Do we always feel?

We for sure understand and feel promptly. When you hear them live, especially. That musician's personality, self-confidence, identity... The moment they hold their instrument, and they play, you feel the magic. If the soul of a guitar is not combined with the soul of a piece, but the technical aspects (articulation, rhythm, notes) are correct, they do not qualify to be accepted as a virtuoso in my opinion. There are hundreds of good players, but very few, one or two of them play very different. Aranjuez is a good example, Rodrigo says that Paco's performance was the best, but he isn't a classical musician. For me, virtuosi have their own smell, and I think that this explains it.

In your production do you aim to boost and improve the virtuosity of a player? Do you think it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Yes, affecting a player's virtuosity; the thing I associate with comfort. Whatever your material is, you arrive at a result. Sometimes only one out of ten guitars gives you 100 % of what you expect, and others 70, 80 or 60 %. There may be a lot of unpredictable reasons to this. What I want to do at the first place is to give tone richness to a performer. What affects their virtuosity is this, I mean one of them. If the instrument leaves him on the way, this gives him insecurity. That instrument can run him into trouble. That's why the guitar should not create any question marks at any registers. This is important, and looking from this perspective, yes, it affects the virtuosity. All the frets should to be tough. It should produce sound easily upon the applied energy. If playing piano (nuance) creates difficulty, it is obvious that forte will be problematic. For a Latin guitar player a hard-core classical guitar might be a little different. Baroque players may need slightly different instruments. Sustain might be as they need. Should fit a performer acoustically and physically. It is like a tripod, for any musical instruments, i.e. percussion, wind etc., a good instrument, player and composer are the legs of a tripod. None should be missing. If in a country there are no composers, an instrument never blossoms in that country. Buying an instrument abroad damages that performer, as well as this tripod. This is a living organism. If periodic maintenances are not done, the sound quality of an instrument decreases. Due to the humidity or any defect rooting from a performer mistake, an instrument may develop failures.

What is it that makes the act of performance less difficult on an easy-to-play guitar? Lets imagine that a virtuoso plays with his/her own guitar, and then s/he plays on a medium-low quality guitar. Do you think he can reach the same performative level?

Psychological aspects are very important. Sometimes these psychological sides is more important than the instrument itself. So it might not be the instrument's fault. For instance, there are many experiments with violins especially. These experiments were done between Guarnieri or Stradivarius violins. These violins are claimed to have been the best instruments especially in concerts. These experiments include psychologists, musicologists, composers, acoustic physicians, and musicians, as well. They test four violins: one Stradivarius, one contemporary violin and another two old violins, presumably from the 20th century. Eyes shut, a player performs on these instruments and this experiment is recorded and filmed. In the experiment, players perform the same pieces on these four different violins. And after all, these musicians are asked to select their favourite instrument in terms of the sound quality and performance. Obviously, it is expected for the Strat to come in the first place. However, the Stradivarius violin, although it is accepted to be the best violin by many players, got the 3rd place in the experiment.

This sounds like the experiment in which two José Ramírez guitars were introduced as new-found Torres guitars in very good condition. Participants were totally amazed by their quality, but at the end, the organiser removed the Torres label, and under the Torres label, there was the Ramírez label.

These are '*interesting*' experiments (laughs). At the end, the musicians were told that the violin they selected as the best instrument in that experiment was not a Strat. And they go like "*A Strat is very good in a concert hall but not here in this saloon*". This is a great conditioning, and psychological sides have a big importance. So, today there might be better sounding guitars than the most appreciated guitars. On the other hand, doesn't matter how great one particular guitar is, eventually it is the performer who will make it sound great. For instance, one guitar is played by ten performers, ten of them will create different sounds out of the same guitar. The feel and comfort a guitar offers to the performer, the engagement of the performer, and knowing its limits, producing the cleanest and most beautiful sounds out of that guitar... How much a player can force a particular guitar without causing unclean sounds... Or which angle (between the strings and hand) will lead to a better sound needs to be tried, worked and studied. Sometimes I hear a different magical sound from the same instrument played by a different musician. Tens of players sound differently, and one performer sometimes produce some timbres never heard before from other performers.

I remember seeing a video of Pepe Romero playing a student's guitar. He plays differently and lower than his usual. Is it because of the tone, or is it something to do with the tension, response, ergonomics etc? What are the difficulties of student guitars (medium level quality) that can create difficulties for a performer?

Yes many things. For instance, an Italian guitarist came earlier this year for a concert and workshop but, he couldn't bring his guitar. Kürşad Terci, music department head at Yaşar University, asked me if I could offer a guitar. I showed him several guitars, and the guest guitarist liked one of them (spruce - cocobolo). But he asked me to change the bridge, as he was used to a higher action. And I changed the action, but actually that instrument wouldn't create any unclean sounds even with that low bridge height. However, he preferred to change, because he was used to that and he feels more secure and better.

How can we explain?

Between the saddle and nut, the twelfth fret is the reference for us. A maximum of 3,8 mm. action height (between the string and fret) which doesn't exhaust a musician aspiring to be a virtuoso -who is required to study 6 or 8 hours a day. This is very serious. If the action height is more than that, left hand muscle groups and structure start to exhaust the performer. An ideal height allows a player to perform with ease. In treble strings, there is an ideal measure. If you increase the action height, the volume and energy increase, and the performer doesn't take risk (of buzzing noise). However, the same level of sound volume (that is produced with wrong technique) can be acquired with the right technique, attack angle and correct position.

Traditional guitar timbre has been changing. There is an argument that contemporary instruments do not have the singing and charming quality of traditional guitars. Who do you think triggers it and how does it affect the art of performance?

The musician triggers, I believe. Their expectations and tones shape makers. What are the roots of double-tops? If we played the Classical guitar with a bow, it would produce a bigger sound, almost like a cello. But we pluck with nails. With the correct technique a guitar can produces the correct tones. Double-top need roots from this: competing with the string and wind instruments. They are powerful and their energy is higher. But the nail is fragile and disadvantageous. That's why the double-top construction boost this finger-nail energy. Who demands it? The performer. Luthiers try to find a way forward with many fails because we always need to learn in this profession. And no one should say "*I know how to make a perfect guitar*"; they always need to learn new stuff. And there is no 'perfect guitar' or maker on the planet yet, I think.

Thanks a lot for your time.

Ender Hulusi Bilge
12.06.2014

What does playability mean to you? What aspects make it more playable and what do you expect from that guitar as a concert artist?

First of all, the comfort in general, keyboard comfort in specific are of great importance in my account. Finger touches should be with ease. Apart from that, the guitar has its own tension resulting from the bracing system and material. In addition, string selection has an effect. Firstly, a keyboard and string set which allow for a normal string pressing on the fretboard. Later, the balance of timbres and tonal colours. For sure, this is a matter of preference, but the first string should have a singing tone, second string is a little damper. The 3^{rd} string is strong and focused. Bases have different characters. A playable guitar should have a balance of bass and treble tones.

Traditional instruments have been partly replaced by contemporary guitars. How does it affect the guitar music?

Hauser, Fleta, in other words traditional guitars offer very sweet tonal qualities, whereas contemporary guitars do not sound very charming to me. Seems like they are designed for projection and power. And they are super balanced. They are so balanced that they don't offer a colour palette to me. I observe that upon playing double-tops. They arise from the needs to perform contemporary music, I believe. It's become almost a different instrument, not really a Classical guitar. I am exaggerating (laughs) but, what I mean is that, obviously there is a big change between them.

Is it the reason behind?

Yes, considerations for sustain and balance where we can hear the bass, mid and high ranges separately. Actually it also depends on the performer. Hearing a melody among several melodies is also an important feature. Action height gives a good deal of comfort. Some luthiers increase the action height in order to increase the volume but that costs compromising the comfort. If comfort-volume balance is exceeded, that instrument diverges from a traditional guitar.

Also the response of strings is partly related to the string quality, but the guitar *itself affects this feature, doesn't it?*

Yes, I use standard tension strings. But every guitar has its own tension defined by the material and bracing. Therefore, some guitars may require high tension strings. And sometimes lightly built guitars offer great volume when it is close to audience. Those light guitars are very week in concert halls, as their sound power diminishes dramatically at distance. Therefore, maybe low tension strings can be used on these light guitars. Guitar shouldn't be either heavy or light, needs a balance.

How can you define virtuosity on this instrument? How do we understand it, what makes them qualify for this status? What are the qualities in a virtuoso musician's performance?

I can confidently say that they seek for the most comfortable positions for their body, arms and hands. How to activate and use muscles in the most productive way is a very important point for them. During the course of the performance, we apply forces creating tension. After we finish that execution, muscles should relax. If we don't relax them, in time they will get used to and this tense condition will become usual and normal. Indirectly, using our body, the tension needs to be followed by a relaxation. I think this relaxation is very important, as it creates a correct path to benefit from our muscles. Otherwise it starts to limit our movements and we try to overcome this very limit which had been created by ourselves. So, in short using our body ergonomically... In fact, playing an instrument is quite unnatural to human body. These unnatural movements should be intervened and eliminated as much as possible.

In addition, after some time, technical and repertory studies will need to be done. Actually, virtuosity is about developing and perfecting one's skills to the greatest degree in my opinion. How those skills will be reflected on music... While performing music on the guitar how I press, how I use my fingers, which finger will be in charge, when and which finger will silenced a sound… all of them need to be under my control. Once I can control them, I can create the music I want in the way I want. In the left hand, the thumb can be seen as the pivot point without applying too much stress and working in balance and collaboration with other fingers. Some finger exercises intend to give independence and coordination to fingers. Thumbs of both left and right hands are very determinant, their movements affect other fingers positively or negatively. Like the left hand thumb, the right hand thumb should be very comfortable, too. If it doesn't relax, than the performer learns incorrectly and gets used to that. At the end, it becomes a habit. It requires a long term learning. Other fingers should move inwards, index, middle finger and ring finger seem like they do two-phase movements, but in fact they do four-phase movements. 1. Reach, 2. Plant, 3. Pluck and 4. Recharge. After reaching at a specific level, one should focus on learning new music and etudes.

I see a parallel between Torres who reshaped a musical instrument based on the facts of his era, and our day's Smallman or Dammann. They do the same thing: reshaping this instrument depending on our current demands and needs. I accept all of them as being different tastes. Actually, time will tell the correct path. But traditional guitars and contemporary guitars have different characters.

Who directs it? The performer demands from the luthier, or vice versa?

In fact, this is like a tripod. Composer, performer and luthier. They all are necessary. We direct each other. But those star virtuoso guitarists probably direct luthiers. They have a great part. For instance John Williams introduced Greg Smallman to us. If he didn't, I am not sure if we would have known this maker. Luthiers should be supported by performers. This brings about development.

Is it possible to boost a player's virtuosic level by design?

The instrument is very important, obviously it does. Practising on a high quality guitar is very important even though many students do not have this privilege. Otherwise, one may give up, or hurt themselves. Even at the beginning, it is important. A well-made instrument supports a performer and performance.

Many thanks for your precious contribution.

Paulino Bernabé
01.08.2014

How can you explain playability?

Playability depends on a player, and his/her harmony with the ergonomics of the instrument. A guitar is very personal, it needs to satisfy the performer.

What makes a guitar more playable?

The general belief is that the action height is the most important aspect which makes a guitar playable but, in my opinion, neck contour has a greater importance for playability. A player's hands and fingers can get used to different string heights, though neck contour is not something one can get used to easily.

I guess, the wood tells a luthier something about its quality. The distribution of age circles can provide clues about the climate change prior to the process, is that correct?

The distribution of age circles is not an important matter. Some luthiers prefer a denser pattern but I prefer wider age circles in a finer pattern. Wood is important, needs to be old. That's one thing, but that's not all. In the past, the materials they used was fairly different from our material today. CITES procedures are painful for some species but I have a very old wood inventory from my father. I use over 40 year-old wood in some of my guitars. Aging and longevity are very important concepts, a good guitar should sound as good some fifty years later.

What else do you take into consideration in your guitars?

Wood needs to be old and good, but it is the luthier who makes a musical instrument from that wood and who needs to deal with different characteristics of wood. I sell guitars, not wood. Each wood species requires a different touch. That can be explained with the tacit knowledge we have. I mean, we treat each piece of wood differently, we turn them into guitars.

What can you tell about the guitar making?

Strings when plucked do not only move back and forth. They rotate making circular movements. That’s why they tend to chatter. A precise left hand technique is necessary in the first place.

Left hand stress often becomes a problem in guitar education, right?

This is not a problem to be solved by luthiers. It is the technique of a performer and virtuoso performers do not have that problem. They overcome it somewhere in their training. Their hands accomplish very fluent movements.

How can you improve playability?

Each guitar is different. Once a guitarist asked me to replace the neck with a thinner one, and I said that I could do that but it would become a different guitar. A guitar has a fine balance, you can't just change anything (one parameter) without altering the others.

How can you compare contemporary guitars (double-tops, lattice guitars or composite-tops etc.) and traditional guitars? There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars.

I think that the analogy of driving a Rolls-Royce as opposed to a Porsche can also be applied to traditional-contemporary guitar comparison. Contemporary guitars are usually very light. If they are not light, for instance, lattice guitars in general and Smallman guitars in specific are not light, their top plate is very light. Neither are some double-top guitars; but again, their top plates are very light, Two extremely thin layers of wood... It is light. Eventually they have a fast response. They have explosive, sort of purcassive tonal characters. However, they get tired after some time. But traditional guitars are like a Rolls-Royce or a Cadillac. They are comfortable like a classic car. You don't feel the road underneath, you feel secure. They have a big voice, but not that fast. And you can be sure, they are manufactured for a lifetime. I believe, that is the real quality.

Thanks for the interview

Ana Espinosa Rodríguez
07.08.2014

I enjoyed trying your guitars and I found them to be of extreme high quality. Do you make double-tops?

No, I don't but Rene (Baarslag) makes.

You mentioned your hybrid model?

A good guitar can help boost virtuosity, because it makes the performance easier, so that the performer can focus on making music. It greatly helps. A performer should definitely not fight against their instrument. Expressive qualities that high quality concert guitars can offer, for instance different colours, mean a lot for the sake of a performance. If a guitar's tension is very hard; or that instrument is fitted with a very high or very low setup, the guitarist would definitely have hard time to play and make ornaments, such as legatos.

What are your preferences when making a guitar? Does it depend on a specific performer? What do you expect? Clear or round tones, loud or charming?

For me, the loudness is not the most important thing. I care for a wide colour palette and playability more.

What is it that makes a guitar easy to play?

The tension of the top has a great importance. All of the interior measurements, design and organisation (fan-struts i.e.) are important.

The action height?

It's not just a matter of height, but also about a specific performer. They can suggest if they want higher or lower.

How was your hybrid guitar?

I chose the wood for Flamenco, and I made a Classical guitar system in its top. Fingerboard is somewhere between Classical and Flamenco guitars. A

fine balance.
What do you take into account when making guitars for someone?

Measurement of fingers need to be taken into account. Also the strength is useful information. The distance between the strings at the nut is important to make shorter or wider depending on finger span and size of a performer.

Is it possible to influence the virtuosity or technical skill of a performer by better guitars?

Yes, it is possible to affect virtuosity. If you are more comfortable with that instrument, then you can improve faster and better.

How do you try to elevate-improve the virtuosity?

Volume is one part. High registers are important. Ease of access facilitates the musical production.

Thanks a lot Ana!

Andrés Daniel Marvi

08.08.2014

So you were explaining the different parts which can make a Classical guitar more playable.

First, of course the tension of the strings, what you feel. I don't mean when they are too loose… (showing how to tighten the strings using machine heads). What you feel when you push against the strings. Depends a lot on the construction of the, say the angle of the headstock. I can't give the end results but I can explain how I work and what is better for my production and how I make. Normally a guitar you'd have, you see here (showing a guitar) the neck is just elevated a little bit, but not too much. Some other guitar makers do this, as well. Some of them prefer much higher elevations. But in my theory, I believe that 4 mm. is the best for my guitars. 4 mm. height on the 12th fret. This is one, and the angle of the headstock (showing the headstock). It causes the string to have more-or-less tension. Also on the bridge, one can have very different angles from the string where it comes out from the box and passes through the neck, you know. So this angle is also an influence on the string tension. And finally for me what is also very important and really valuable is the fingerboard. I spend two days working on a fingerboard. It is on the neck, so this must be precise with frets, I look for the, uhm, you know what I say (showing a steel square) this must be precise. It gives you a better feeling and then you can go for a much lower action height. Because it is very precise and you can lower the action height. At the end, you can play with a stronger attack. And it is not chattering at the end. Then later, when you fit the fretboard with frets, you need to make them very precise, not only with a file, you also need to polish and smooth out the (metal) frets. So, it takes two days, minimum.

One month for one guitar?

It depends. Normally I spend 120 to 140 hours.

Which type of guitars do you make? Your standard Classical concert guitars, you don't make double-tops, do you?

All solid of course, Spanish Classical guitars and Flamenco guitars. I don't make double-top guitars.

Do you have one concert guitar model or several models? Elevated guitars like Humphrey guitars?

No, I don't. I make Flamenco guitars in the same system. I elevate the fretboard and I give the neck slightly more angle compared to the top soundboard of the guitar. The neck has an angle compared with the top. If it is completely flat, I mean the part where the neck connects the top, it would be a little more difficult to reach high registers, but in my guitars it is about 4 mm. higher. So this gives the whole neck another angle compared to the top. This also means that the string pulls the top out, and it is not only a law of balance, it makes pressure on the top creating a curve. It also pulls out and I can go thinner in this region. And it gives a better sound in my opinion. Not only pressure there, it also pulls out so it is not necessary to have a strong top plate there. I make it very thin. It's better for vibrations.

Some of your guitars have double-sides and thicker back parts.

This is a Flamenco guitar, this one, Flamenco negra. So flamenco guitars have special necessities for the sound. And I didn't make it double-sided, I made it a little bit thinner and lighter. But for Classical guitars I prefer a tough, strong case and a light vibrating top. So especially in my Brazilian rosewood guitars, I use double-sides because when you buy it, you can buy Brazilian rosewood in very thin layers, so I can't get the necessary thickness with a single layer; that's why I use double layers. For my Classical guitars made with Indian rosewood, I use a single thick layer. In addition, I use a little thicker back (3 or 3.2 mm.), and I use four bars to make it tougher and stronger. This is one reason, another reason is that, it becomes stronger; it does not move or crack easily.

Can we also say it doesn't absorb energy and the energy goes to the top of the guitar?

Well, more correctly, it doesn't absorb the energy so much, but it always absorbs. Everything absorbs, the neck, as well. If it is thicker it doesn't absorb that much. And the energy of the string can be saved. That's for the playability.

What is your preference when making guitars? Which aspect do you give privilege? Sound, playability?

Everything. Everything is important. Well, the sound is special, it is my sound.

You cannot make copies. My guitar production has come a long way. I have my own evolution. Guitar makers should fine their own sounds. Copying a luthier doesn't work in the long run. This is not the way. My guitars from some 30 years ago are different from what I make these days. They (luthiers) should look for high level quality characteristics. Sometimes it is not possible to make guitars at a standard quality. Wood is always different. Different densities, characteristics and qualities of different woods make a big difference. But you have to have an overall quality which is seen through all your guitars over many years. Maybe you can find little softer, deeper, richer sounding guitars, though. Each guitar maker should find their own sound. Some performers like this sound colour some the others appreciate another sound colour, that's why makers should have their own signature sound; not a performer's preference tone.

When making guitar for a performer, is there anything you take into account? Finger size, pressure?

You can variate a little bit. You can make the fingerboard a little wider or narrower. Also the scaling can vary between 6.45 to 6.60. The range to adapt their hands on the fingerboard, at least a little bit...

For instance I am pretty average considering my body dimensions, do you need to take the dimensions of my fingers?

No, normally I talk to the performer. What finger do you have? Big, normal, short, long. And what experience do you have? They can play and tell me that they always play 6.55 or 6.50. That's enough. And then maybe they say "*can you make a little bit narrow because I have short fingers*". That's fine. But I don't measure because, I measure and then, what?

I am curious about the concept of sound stamp. You said that you have found your sound, and performers strive for their personal unique characteristic sound. How does it work? If a performer asks you to alter the sound a little bit (sharper or warmer tones etc.), would you make some changes?

Yeah, this is what I explained before, the sound is special. I have my own sound. If you like it, I am glad to make you a guitar. And performers often create their unique tone with their nail shape and attack as well as other qualities in their musicality such as emotions, interpretation, subtle changes in tempo, articulations and so on, instead of choosing a tone from a maker.

What about the thickness of the neck?

For the Classical guitar you need more thickness, because the angle of the strings pull the neck out more with greater force, and that's the reason I place reinforcement ebony pieces inside the neck. They are not visible on the exterior.

Do you think it is possible to affect the virtuosity of a performer with a better guitar? Lets say we give two different guitars to the same performer, one is easier to play, is it possible to affect his virtuosity and interpretational skills by making even better guitars?

I think a good player can really make music on any guitar, because I saw it; and I saw musicians, I gave them guitars with really thick fingerboards and they played fabulously. So, also the skill of a performer is very important. Virtuosity is a step beyond, it is something completely different. You can have many players, they play really well, but real virtuosity is special. You can see it. And I think it (instrument) should adapt to their style of playing so that he can really perform, I think. Many people can play but it is a mixture, something you feel. Something different. Or sometimes two concerts by the same performer, the first of which is incredible, and the next one is so so. They have good days and bad days.

It's also a mental state, people when they are very sad they tend to be very emotional, it's an emotional state and they play perfect, especially Flamenco players.

It is not important that it is perfect. It is what you receive, what is coming from him.

Is it possible to decrease the friction sound? Some guitars make louder friction sounds and others do not. What is the reason, where is it coming from?

I'm not so sure, I think a really good guitar can produce the whole range of different frequencies; maybe, therefore it produces a louder friction sound.

I asked this question but can I ask again, because I am not very clear. What makes a guitar more playable? You said the tension of strings, the tension of the top, the angle of the neck, 4 mm. elevation of the fingerboard where it connects the *body...*

Elevation has an influence on the tension, but playability is a complete package. A different thing. Yeah, also a perfect fingerboard. But I can’t give you mathematics. It is also a type of experience I have, I know where to look to make it better, but this is not really possible to explain with words.

One question, if the neck has 4 mm. height at the point where it reaches the top, then it means the bridge should also be elevated?

No, actually the headstock end is elevated, it is pulled out the guitar, but since the fretboard is not parallel, the difference between the top and the headstock decreases all the way down along the fretboard until the bridge and the bridge can stay in its normal place, thanks to that angle. It requires a fine balance. I construct my guitars on this model tool, it is a very important tool for me. I chain the neck with the top, and then sides are added, and the back at the end is chained.

Many thanks Andy

Casimiro Lozano
14.08.2014

What type of guitars do you make and which particular type is your favourite?

I make traditional Classical guitars with cedar and spruce tops, as well as Flamenco guitars with cypress in addition to those above. During the past years I have developed my own bracing system creating my own sound. My bracing system consists of curved pieces on the contrary to (the most) standardised Torres fan-strut system amongst others. In addition, it was my son's idea to start making double top guitars and I am very happy to have done so. This is one of the contemporary techniques developed by Matthias Dammann, and it gives a performer a focused and powerful sound, compromising some traditional qualities of the Torres design, though.

Could you please explain the system you developed in Lozano guitars?

I tried to minimise the internal system and architecture in order to balance and strengthen the sound. It's been several years. This system consists of curved pieces instead of straight fun-struts. It is a transversal set of curved struts. The aim is to find the balance. When curving the interior system, a 2 or 3 mm. displacement will result in a change in the sound. After years of experience, I was looking for ways to create a more playable guitar without compromising the Spanish characteristics of it.

What makes a guitar more playable?

It is in relation with a particular way of making the top. Conservatory students comment on my guitars as being very playable. I believe the playability is something to do with the top: it is a fine balance between hard and soft material used in guitar tops. The top tonewood must have a specific tone; however, the final tone may still be different from this top tone, though. Before stringing up I can predict the end result with convergence almost certainly. I care for the density of different woods. Out of 2000 wood sheets maybe 20 or 30 are special, and from those 30, just about 7 are of premium quality. I think selecting the wood one by one is one of the key points. Even the same wood can produce different results. For instance this red cedar (showing two tone wood sheets) has straight age circles but they are not very fine, they are rather wide. It produces a specific timbre. This is an excellent top, age circles are finer and more uniform. We can't say one is better than the other, but they are different. This one (the finer one) produces a sweeter tone, whereas the other is different.

Apart from the top what makes a guitar more playable?

It is the whole guitar that makes it more-or-less playable. You don't only change the top wood and characteristics. After the top, the depth and thickness of the top and interior struts need to be changed.

Thickness of the?

Everything. Interior of the guitar.

I'd like your ideas about the neck?

The stress of the neck is not very important. I've made guitars with carbon neck supports and they were very rigid. But it doesn't mean better, but it is different. So you can play, and the influence is not very important, as long as the neck doesn't displace or break due to the strength of guitar strings. Even in that case, it is not the most important thing.

How about the action height (the height of the strings)?

It is very important because it marks the difference between a good guitar and a standard one. I allow 4 mm. or lower at the 12^{th} fret for the 6th string, and 3mm. or lower for the 1^{st} string, because it makes my guitars more comfortable. But, if a guitar at that action height is played by a guitarist with a normal pressure and the guitar cannot produce enough volume, that guitar has to have something wrong, because at any fret the guitar must pass the threshold and sound. Because, the guitar sounds as a response to action. Some luthiers make it about 4,5 mms. When a guitar needs more height, then I think that this particular guitar is no special; it is just a straight guitar. It also depends on the performer. A good performer is able to control his/her pressure and pluck with greater ease. They can succeed a better attack on the guitar. That's why good performers do not demand a higher action, they do not need that. Indeed, higher action height is more tiring.

How about the thickness and width of the neck?

My normal guitar necks have 52 mm. width (up around the nut), 62 mm. at the 12th fret and 57 mm. between the bridge string holes. The thickness is 21,5 (1st fret) and 23,5 mm. (12th fret), and according to specific performer preferences these measurements can be varied. I've made thicker and more rounded guitar necks (23 and 25 respectively), at the beginning the performers were happy with them but in approximately one year they asked me to reduce.

Do you take anthropometric data -like a player's finger size etc.- into account?

Yes, depending on body size and dimensions of performers I produce wider or narrower fretboards. From the technique and tone of a performer I can understand his/her needs and expectations and I make a guitar tailored for him/her. That custom made guitar, I suppose, would fit their playing style but the tension is given by the thickness of top and bracing, therefore I have to deal with them with special care in order to fit the performer's needs. However, I am open to their ideas and suggestions.
For me the best instrument scale is 6.60 (rather than the standard 6.50) because the tones sustain longer but not many people prefer this size as they are not accustomed to. Upon tapping the neck I can feel the sound that particular guitar can give once it is finished. So, a luthier should be able to sense it in advance and needs to shape that future sound of the guitar. My clients say that these guitars still reflect my guitar sound in the 1990s, but actually it is not the case. My sound has changed a lot, I am not the same Casimiro as I was 25 years ago, I've changed and they've developed. At the beginning I was copying Fletas; well, maybe I'd rather say "*I was making furniture*" (laughs), as Fleta says "*one cannot copy my sound, but s/he can copy my guitars*". I intended to create my own sound.

Is it possible to affect a player's virtuosity and interpretation by better guitars?

Yes, for sure. The guitar is 50% of the whole. A performer would encounter problems in terms of expressivity, even though they for sure can make music on low quality instruments. Performers and luthiers are on the lookout for feeling and expressive qualities, colours and dynamic qualities a fine guitar can offer. In a concert, a well-known guitarist may perform dead-pan or without feeling. Therefore, the capability of transmitting musical ideas and dynamics is an important thing. Consequently, if a guitar is more playable, the performer can "forget" the technical part and concentrate on making music.

How much time do you allocate to make one guitar?

My son, myself and our assistant together, we make three guitars a month.

Thank you very much for your precious contribution.

Jose María Gallardo
30.01.2015

You mentioned about your new guitar as being very playable, very easy to create sound. So, what is it really that makes a guitar very comfortable, easy and playable.

The size of the fingerboard, and the action height. It is very light and the distance that I have between my hand and the frets is much smaller than the guitars I had been using all my life. And also the immediate result of the sound. It is like, you don't have to wait, it's like the sound produced, and (makes a hand to mean fast) projected so easily. And so fast. The response of the guitar is, when you have a lot of wood in the instrument, you have to fill that space before the sound leaves through the instrument. When you have a very flat and small instrument, and not so much wood, the sound covers the space easily.

How about the weight? I guess it is light.

Very light, like a Flamenco guitar. It has the minimum amount of wood that it needs to cover the actual instrument.

Is it spruce top?

No, it is cedar. Brazilian rosewood and cedar. I had been playing all my life with spruce top guitars (Contreras guitars). It is like wine, you know. The spruce needs longer time to be there. The longer, the better. The cedar is very immediate. What you have today, you have today. You don't have to wait, perhaps the evolution wouldn't be so good. In this time of my life, I don't have time for evolution. I need the sound today. I don't have time to invest in the sound. It's like wine. People these days want the results now; the flavour, the aroma… In the old days, people wanted a "*gran reserva*", they would wait for ten years. Now, well… The whole world has changed. And also the Connor (his new guitar, its maker is Stephan Connor) has a very interesting improvement and very unique. It is the only one with it. The guitar has a little hole on the side, so that you can hear the sound directly from the guitar. You can cover with its lid, but I never cover, I always want more sound. And I play with orchestras very often, and the maestro is very happy about that little monitor. He can hear everything, control better. When I play chamber music, my partner, as well, is able to hear the guitar immediately. I also get a sense of the primitive sound of the guitar. So I can look for different dynamics or timbers. I can be more focused on the quality of a sound rather than the quantity which is the main problem of the guitar. We are still fighting against the volume, so we are trying to be heard instead of striving for a better sound. We only produce a beautiful sound when we play solo. But when we are accompanied by other musicians, we have to fight against the sense "*they aren't able to hear us*". It is not like a piano or violin. Consider the violin for example, it is an instrument that 'produces' sound. The guitar doesn't produce sound in the way the violin produces; the guitar 'projects' the sound. A bow makes the action immediately, but we have to fill the space and then the guitar projects what is inside. Therefore, we need a very active and easy instrument. At least in my opinion.

So you said that the action height is very low. It has a fast response, and the tension is soft.

Very soft, and especially very flat here, so you don't have to have a large span in your left hand. Because you know, left thumb and other finger relations bring along a lot of issues related to the arm and wrist (the left one). I heard that almost 90 % of guitarists have encountered an injury throughout their career, because we are athletes, we are warriors, instead of our body we use fingers and wrists. All of us would eventually have problems in the future, because of spending many many hours since 6-7.

Have you used Gitano or similar ergonomic guitar rests?

Yes I used Gitano but wasn't happy with its angle. For me, the standard footstool is the most comfortable, but I know that it is not the best. The position of Gitano is not okay, that's why I think one must do yoga, or sports, or gymnastics. If I were to start my career anew, I would have a couch like Javier Corroto (of La Salud del Guitarrista) about the position, but I started at 7. So, now it is like a little late for me. The Gitano was a little unstable for me, I went down to the "preventive mood" (physiotherapy) I work out every day except Sunday, and when I don't do, I feel it. When on tour, I try to stay at a hotel with a gym, otherwise I can't do my best.
In the old days, the way they used to prevent the movement of the fingerboard was putting a lot of wood in the neck. They may have this thick thing because they though any change of temperature or humidity would be taken care thanks to the strength of the wood. But it makes people so miserable, because you have to fight against it. You should not fight against, you need to cope with. The guitar needs to be on your side, not against you. Because you spend so many hours playing with

the instrument. That's the reason why I discovered that with an easy instrument you are a better player. And this is I briefly read one of your questions, the myth of the soul of the old guitars, Frederich or whatever, same, I think the soul comes from the player. You shape the guitar, you make the guitar. Of course, I always want to play with a guitar from my country, but at the end I have to cope with the inevitable. I need something easy to play. And I recommend everybody to get a very handy guitar from the very beginning. It will prevent you from the future injuries. In any case you will have them, but at least less. Tendinitis or tennis/golf elbow… many guitarists have because they fight against the frets. And I use a little different bar, I use the side of my "I" finger (index finger). Because it is more stable and causes less strength. Instead of pressure, I "pinch" the strings between the side of index finger and the fret. It prevents the "chain of injuries". It is also I think in relation with the Alexandria technique, where you need to be subconscious and you should use as little strength as possible. Nobody thought me how to do it. I believe it should be thought in every school. They just advised me to practice as much as possible; all day, but they didn't teach how to practice and organise my time.

What sort of difficulties do student guitars create?

The same, it shouldn't create anything because the quality of the guitar besides the work of the luthier is just to select the proper wood. But for a kid, you needn't to invest a lot of money in a guitar because you don't know how is going to evolve, because perhaps in two years he would be changing or… Depends. But I think they should go always to find the easiest conception of making the instrument for young people. But I think now the quality-quantity of studio guitars are better and better, everywhere. You can find very good (studio) student guitars for less than a thousand Euros anywhere.

Thanks to the mass production techniques. I had never been before but Valencia is known as the cradle of mass production.

Every luthier has his/her student guitars made here in Valencia and then they put their stamp. This is not a secret any more. Partly because Valencia is the port and all the tropical tonewood first come to Valencia. From Madrid, Germany or other parts, makers come to Valencia for material.

We use the terms virtuosity, playability, technical mastery kind of randomly. What are the differences for you? How would you compare virtuosity, technical *mastery and high level of performance?*

Virtuosity is just the point where you complete forget about the mechanic aspect of music in order to give 100 % of you capability to the expression of music. It means that you've passed the border of fighting against the notes and you are just a partner of the notes and you use the notes to express the best of yourself. Technical ability is just a matter of how many hours you fight with the piece or passage to have the control over the piece. But if you don't pass that border and make the control completely automatic, you're still you know a little slave of the technique, because you have to protect your border. In my opinion, virtuosity and high level of performance are pretty much the same. I know this is not very academic but, I practice my daily studies, I don't mean music, I mean arpeggios, scales, like you know fitness, I call them musical aerobics. Just to be ready to play. Like my warm-up. Watching movies or TV series. To interact the different parts of my brain. If I am able to follow whatever you're telling to me or talking to you and I'm playing scales or whatever it means I made these things automatic. I don't have to be so concentrated any more. For me this is a problem that makes people so far away from the performance. In a concert if you see performer looking carefully on the fretboard, you may come to think: "wow this is horrible, this is so difficult to play, this guy is suffering". It shows how much that guy is fighting against the guitar. Never look at the fretboard. The eye won't help by the way, after many years. You control your fingers by the neurons and the tactile feedback. That's why I created this technique and I call it "telly technique" where I have to play looking on the TV screen. I spoke with a neurosurgeon in Santander, Spain long time ago, he agreed that this was an good way to educate both brain hemispheres. One side is focused on one thing and the other on something else. Plus a big percentage of the memory we use to play is muscle memory, it is not neuro-memory. Neuro-memory goes to another way (language). But the way of recognising movements, brain doesn't have time to observe. It needs to be made by the muscle memory. And the muscle memory is a different thing. For that is what I do for instead if I have to refresh my Concierto de Aranjuez scales, I've been playing these things for some thirty years. I think now I don't have anything else to apply to these scales except my feelings or emotions, but technically speaking I'm set out of that. Instead of being bored, to make that, I prefer to be entertained by some other thing (TV) and just practice. Like the gym, you just do automatically, you don't have to take extensive care. I recommend to beginners to practise in front of a mirror because the mirror will be your teacher, you can observe your technique on the mirror.

If you’re focused on your hand, you can have pain in your shoulder. If you do not, you may not hurt. Plus it hurts a lot.

Superiority in musical expression and virtuosity, I am not sure if it is possible to enhance or boost the level of virtuosity by better designed guitars.

Of course it is possible. The same, virtuosity means a complete freedom of tensions or habits that can bother the true intention of music, which is communication. Many times we forget that the last chain (or. *el ultimo eslabón*) is just communication. That’s the miracle of music. What I play changes something in you, and because that thing is changing in you, you give me back your energy. We are mediums. Whatever thing that makes that miracle be unstable, is not good for virtuosity or for final development of music, which is the miracle of expression, the intensity of expression. That’s why the guitar is not an easy instrument to deal with, it is very difficult. Because it is not finished. You know the violins, pianos, they still play the same thing since Vivaldi, same bow same box. Every ten minutes we discover a new instrument. The Connor, Smallman from Australia, Vicente Carrillo from Spain. Everybody is like making same with us. We change the technique. What do we have? Aguado, Carcassi… But we never had a Paganini or a big school like violin, cello, piano had. So we are still in the process of developing the instrument.

In your music it is obvious you have a lot from Flamenco, maybe we could say classical guitar music influenced by Flamenco.

I can tell that I play the Spanish guitar, a combination of classical and Flamenco traditions all together. Because if you see probably, a very big percentage of the repertoire is based in Spanish traditional music: Rodrigo, Turina, Tarrega… Even the transcriptions of Albeniz, Falla related with Spanish folk and Flamenco. For that I think you can’t be a good speaker of Spanish music if you don’t know the roots, and the roots are in the Flamenco guitar. For that I am a big fan of the Flamenco guitar and I learnt so much from them. So I can apply this sort of identity, touch not only in the music I compose, but in the music I play.

I especially like your Lorca Suite, and California Suites. In addition little pieces for the violin and guitar. I hear some of them, how many have you composed?

More and more every day. Violin guitar with my wife, next week we are going to make our 4th CD. I also compose a double concerto for guitar violin and orchestra.

Your interpretation of Concierto de Aranjuez, especially the 2nd part is a little different, smells like Flamenco.

Because they are based in Flamenco. I have this gift in my life, that I had the opportunity to mentor Paco de Lucia when he wanted to play his rendition of Rodrigo's concierto (in the 1990s). He needed a couch, because he didn't know how to read music. He didn't know how to expose to classical music. And he asked me if I'd want to be his coach. It was like "*of course maestro!*" (laughs). This is one of the best things ever happened in my life. For me it is like this guitar (his Connor guitar): there is a before and after. So when I had to prepare the concerto for him, I noticed how much Flamenco inspiration there was in Rodrigo's music. So I had to build a bridge. Between Flamenco and classical in order to be able to communicate with Paco. It was a beautiful trip to be a crossover of both worlds and perhaps there I understood how important Flamenco guitar technique is for the classical guitarist. Because it is the base, whatever you want to build has to come from there. You don't have to sound like them, but you need to know as much as they do in this kind of music. To recreate the aroma, the spirit of that music.

We were talking about Fleta, Friedrichs, Hausers. And now since maybe the 80s or 90s Smallmans, Dammans, Humphreys, Connors… The sound of the Smallmans for instance

Artificial

Yes artificial, very loud, very balanced

I agree.

It doesn't have the singing quality of Fletas for instance.

I have been to Australia, I met a few people that play Smallman. I think he did a fantastic contribution to the guitar. But he is a scientist. He comes from military and he is a physical acoustician. He is a scientist. Probably it is another step in the guitar evolution but not the final result. Since him people began to think about projection and other materials. But when you use a material other than wood, and if it is carbon fibre, that artificial element the whole nature of the sound changes. Because it is like that, whatever you use has an effect, cause and effect. Therefore I don’t like that artificial sound so much. But I can feel why people was so in love with that, John Williams for instance, for a long time he played Smallmans. Personally I am not comfortable with this non-Spanish sound. We are still in the process or reaching the final product.

How does it change the guitar music? I mean the Fleta-Smallman change.

In the beginning of our conversation I was mentioning this I think the main change is made by the players. I mean we can have this little amount of help looking for a kind of sound but if you don't take care of your fingernails and you don't have the proper technique of projecting no matter which instrument Fleta or a Connor all the same will sound so badly but if you are a top guitarists you'll make any cheap guitar sound like a beautiful instrument. Then it's a matter of taste, and it's a matter of how much space you would need to fill. Fletas or other traditional guitars are used in small halls but when the guitar is played in big concert halls you need to fill the space. And otherwise perhaps you are losing the poetry. But we are in it, that's a part of the solution.

Who causes the improvement? Who is the reason?

I think it's a double responsibility and in the case of Smallman it is his interest in the sound because it's scientific point of view. Because most of the luthiers, they are artisans, handcrafts persons. Like Spanish guitar they are so beautiful because there is a long tradition to shape the wood, the rosette and everything are so beautiful. In guitars like Connor and Smallman they don't care much about beauty. What they care is more like practical aspects like being able to be heard in large concert venues. I think it's a double responsibility. When I came back from Australia, I said to Pablo Contreras, I said look there is that Smallman guitars and he is using this new technique and Pablo made notes about the Smallman guitar and since then he changed his way of constructing guitars because he knew that people were looking for immediate results. Like Smallman, not this long Spanish tradition of making we don't have time for waiting he began to make different models like the Contreras double top and his father put the double tap outside resonator. Pablo incorporated this design in the body of the guitar and therefore that guitar was very heavy.

Actually if I'm not wrong it was Contreras who made the first double top guitar, but it's not a double top like Dammann guitars. It doesn't have nomex material *between the tops, it's just two tops inside the body.*

And I am very proud to be the first who played that instruments' the prototypes in the 80s. He made it for me especially. And then he understood that it was a good idea he realised this, and he started to make it for anybody. I played that guitar for a long time until Pablo made me a new one in 1996. I played on that guitar for 14 years.

Was that guitar heavy?

Yes it was very heavy.

As a composer writing for the guitar, how do you take the limits of the instrument into consideration?

Limits are very important, I care much about them because as a performer I suffered a lot from the pieces in which I had to fight against the guitar. I think there are three types of music for the guitar: Firstly music originally written for the guitar which is made by composers especially orchestra composers who knows the guitar and its limits, then who respected these limits. Second, music compatible with the guitar but not written for it. Very often written for the piano or violin and transcribed to the guitar. This can be problematic sometimes because they don't know the guitar and transfer information to the guitar. Third, music written against the guitar where they totally don't respect anything and they think that it is magic that the music from here and there will be transferred successfully all the way to guitar and it's going to be playable. No way. Even people like Rodrigo or Tedesco, they compose so many pieces for the guitar, which are still not played by guitarists. This means that the guitar sometimes cannot produce that music in its shape. Therefore I take so much care into consideration in this aspect. I try to incorporate those cards then they really project and they really can produce the piece properly. The guitar is whatever it is and sometimes it sounds here but it doesn't sound there (showing different parts of the keyboard). So you have to look for the best position on the keyboard so that it can make a proper sounds and harmonics as a composer, this is really really important to me.

You also mentioned the stress of applied on the neck of the guitar, specialist children and amateurs or beginners that apply a lot of stress or muscular torque. I designed this tool, it is just a piece of wound string and it's covered with a piece of fabric in order not to scratch the guitar. It hurts a little and it creates an awareness, so *you can understand that you apply a lot of stress. After sometime, you get used to apply less and less stress. It's going to decrease the muscular torque on the guitar neck. What do you think about that?*

I need to try, the concept is interesting but if I don't try myself I can't really give you my opinion. But in general I advise you using the hardest finger side, I use the callus. If you use the soft parts, you will be communicating with tension.

Thank you so much.

Marcos Díaz
01.02.2015

What does a "playable guitar" mean to you?

Guitars have to offer great comfort and convenience for both hands and at the same time have a sound response of sufficient quality and volume in the provided space. That is the first thing you look at an easy to play guitar. Both hands should not suffer, meaning that there is no physical overstrain and at the same time, the sound and volume are good quality and adequate for a concert venue. For sure, a good concert hall is taken for granted. Acoustics of the venue is very important.

What aspects make it more playable and what do you expect from that guitar?

The action height of the strings on the fingerboard and accurate measurements of its components are influential for playability. The shape and width of the neck are also important. The height of frets, shape, placement and height of the saddle and nut, and a perfect placement of strings on them are the most important factors for comfort. We must keep in mind that almost all of those contemporary makers, i.e. Dammann, Connor, make elevated fingerboards and that makes it easier to reach the high registers, and also contributes to the treble of the sound. Eventually, these guitars have a better projection quality. The soundboard is another important element, as there are guitars, manufactured with different tone woods which create different vibration patterns and obviously influences the ease of obtaining a 'ringing' sound even with the same attack style. The soundboard, in turn, helps create an easier instrument. There are technical issues that are manipulated decisively to create an influence on the comfort. Another equally important aspect is the sound response; in general, these builders nowadays make innovations related with the introduction of new materials and wood combinations. For example, Matthias Dammann and Steve Connor. The construction of their guitar permits a performer to play with ease, and thus the piece can be better interpreted. Technical skill takes great effort to acquire, lots of practice and search for personal sound. There is another very important phenomenon out there that the guitar has certain limits and they are related with many other factors: the tuning, strings and mechanics of the attack. Guitarists have to work hard to interpret, because, the way they interact with strings changes everything. Their nails and even smallest changes in the attack angle create different timbres. Whereas, these issues do not apply to other instruments such as the piano and violin. A piano builder can determine almost all of the components of the instrument. Therefore, pianists can concentrate much easily on the interpretation since the beginning. It is more standardised, and they don’t have to struggle to find their tonal characters. Guitarist, however, in addition to the above mentioned aspects, must also master the art of sound production.

On the guitar, there are things that haven’t been discovered yet. Due to the characteristics of the instrument, it is not suitable for all venues. However, nowadays there is an attempt to reach that goal. Another important thing is that, there are three major factors that determine the sound production on the guitar: (1) the guitar itself, (2) guitarist and (3) room acoustics. The guitar has some limits and it may not sound good in any room. I often regret that soloists are very critical about their choices, from their instrument to strings, but are not that selective and critical about the concert venue. So far, they have not been built guitars that allow you to play in any space. You cannot compare the guitar with the violin or the piano unless it is amplified. As for now, achieving this is very expensive and requires a sound technician who should be a musician himself.

What does a playable guitar offer you as a concert artist?

What I expect as an interpreter is that these guitars should allow me to make music the easiest way possible, develop speed, handle different timbres, perform dynamics and create my personal sound. Especially developing my own sound and my personal way of interpreting music; great instruments also make it easier for a performer to acquire a special personality. In addition, there must be an interaction between the guitarist and instrument, that feeling helps to make the guitar easier to play. It's like a couple who gets to know each other and in time, the relation takes shape.

What are the difficulties of student guitars (medium level quality) that can create difficulties for the performer? How do you compare medium quality student guitars to high-end concert guitars?

There is no doubt that concert guitars are easier to play than study ones. Usually when we play a studio guitar we employ more strength in the fingers of both hands. Generally they tend to be uncomfortable for the left hand, one has to attack harder with the right hand fingers to get a proper volume, and also have to be more careful how to attack the strings to get a certain tone quality. This strongly influences the overall outcome of a musical performance. However, it also depends on the interpreter. For example, an intermediate level student will not notice a big difference between the two but a professional player is going to notice immediately. When we play a studio guitar, we employ more power with the fingers of both hands. It is uncomfortable for our hands. One has to deal with an excessive care to seek a proper fit to achieve a so-called "*doorbell sound*" which influences directly the final result of the interpretation. If a guitar has good qualities, the interpreter must have a special sensitivity to sound, because the guitar supplies the performer with tools but it is up to the performer to get results from these tools. In other words, a guitarist must be able to understand and employ this special feature of the sound on their instrument. It is very much related with a performer's skill. An amateur guitarist who has a good sense of sound can evoke more feelings than a technically superb performer playing the same guitar. This is also mentioned by Matthias Dammann; according to him, an amateur can produce a better tone from a particular guitar and eventually can evoke more feelings if they improve themselves about their sound quality.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Virtuosity would be the perfect mastery of instrumental and musical technique. Virtuosity itself is having all technical elements of mechanical perfection or the elements necessary for the execution of all technical aspects for a performer. In addition, musical aspects are important for virtuosity. When only mechanical aspects of music making are incorporated, but no emotion is included, we mean only the technical elements by that. In my opinion, it includes the control over those aspects. Technical mastery is the art of employing technical resources at the exclusive service of music. High level of performance is something I am passionate about, because it requires physical, mental and emotional preparation. The physical preparation would be everything related to the interaction of our body with the instrument at a mechanical level. Mental preparation can be summarised as the knowledge related to the program of music that is played, the domain of nervous system and the control of appearance and presence on stage; in other words, what the audience sees on stage. Emotional preparation part connects with the spirit of a music piece for that feeling to flow during a performance. The listening and playing have to be one thing, you have to be emotionally and spiritually interrelated.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Yes, I believe that it is possible; a good quality guitar helps to improve the expression and raise the level of musical performance. I've met many extraordinary performers, but with great instruments. A guitarist with a mid-level guitar will fall short. For example, Barrueco and Russell play Dammann guitars, many fashionable guitarists play on Dammann, Smallman, Humphrey guitars. But the projection of volume is not really enough.

My Dammann is good for recording, in general. The voice is more beautiful and more focused, though. I recorded my first album on my Paul Jacobson guitar. Dammann helps me on my style of attack. I use my nails and part of my flesh. Paul Jacobson has a finer voice, but Dammann has a better timbre character, the instrument improves my own sound.

How is your Connor guitar?

The sound hole on the side, amplifies the sound quality very well. Connor is the most comfortable guitar I've seen so far; the action is very low. But you cannot play it in any way, if you play hard with a strong attack, the guitar becomes unresponsive, you have to play with a very careful attack. In other words, the instrument, in a way, instructs you on how to play in general, and how to attack in specific. There is no limit if you play well with the proper attack angle. An instrument may be easier to play but not for everyone, you need the required technique.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

This is basically closely related to the place where you play. The extraordinary guitars of the so-called old world have been replaced due to the fact that contemporary guitars offer greater power and projection of sound when played either in halls with low reverberation or very large halls which is difficult to fill. If David Russell and Manuel Barrueco play on these guitars, it is because they play in specific places. I do not agree that these guitars have lost their charm, one must know how to approach them. Having said that, traditional guitars have been replaced, or challenged, not because those contemporary guitars are better, but because the venue demands this type of a guitar with a greater projection. If you go to a concert you not only worry about the sound quality, but also about being audible.

Thanks a lot for your contribution.

Ignacio Rodes
03.02.2015

What makes a guitar more playable?

I think that an easy to play guitar is the one that allows all the technical and musical aspects happen in a way that saves effort. Talking about playable guitars, there is also musical goals we should include. Then, in this case, I think that two circumstances often coincide: in my opinion, an easy guitar is the one with less timbral colours. This is what I've seen in my experience, and it is very difficult to find a balance between playable and colourful guitars. In short, playable guitars should not require much effort to get adequate right hand and left hand procedures. Thus should have a fairly low action height and should allow a high tension.

I don't know the exact reason at the bottom but I don't think it is a coincidence; in my experience when I play a very easy to play guitar, it so happened that musical colours and timbre variety weren't there. In an article about Hauser, he mentions about something that kind of supported my opinion; a guitar, he claimed, which offers improved playability, is not possible to be so colourful. At a certain point, you have to create the sound. For sure, you should not be fighting but you need some energy to get the sound. However, on a double-top guitar, say Dammann, you have to reduce your attack, and then the response is so explosive. But, in my opinion these contemporary guitars don't have colourful timbres. I think it is very logical, if one investigates their sounding principles, they would think that it is normal. I enjoy playing my guitar, I like the colours it provides with me. However, on the other hand, if I have to play hundreds of concerts a year, then I'd need an easier guitar. Just like David Russell. I think that the concept of sound is getting lost while many players including students and professionals playing without strong characteristics in their sound unique to them. I think so; or if not getting lost, they are converging into a uniform and standard sound. I still remember at a meeting and workshop after a concert, fellow guitarists looking at my guitar as if it was an antique instrument. It is a José Romanillos from the 1990s (laughs).

What does a playable guitar offer you as a concert artist? What aspects make it more playable and what do you expect from that guitar?

I think the tension and action height are very important. Definitely the distance between the fingerboard and strings is very crucial. In order to balance the distance and the response, I suppose luthiers need to get a certain kind of top. Another important aspect is the string quality. There are carbon strings, I really don't appreciate, but I know many students enjoy playing with high tension carbon strings.

What are the difficulties of student guitars that can create difficulties for a performer? How do you compare medium quality student guitars to high-end concert guitars?

It is very difficult to find colours on a guitar in this range. Therefore, performers on these guitars have difficulty to show musical qualities. It is difficult to communicate ones musical ideas through a studio guitar because the guitar doesn't have it, or barely has these qualities of timbral colours and dynamic expressiveness. It is important to have a high quality guitar for an aspiring student and s/he should develop together with the guitar.

What are the common mistakes that students do?

Sometimes they don't take care of developing a correct posture, especially in the beginning of technical development. The posture is so difficult and crucial. One would have many problems in the future if they don't learn it properly. This is one of the most important things. On the other hand, their conception of sound, considering what they want to do. It is very important. They ought to be clear about what they want to do.

I see that some students, even professionals, have some problems with exerting too much neck force. What do you do against that? How do you solve?

Not many people know that one of the first indications for thumb appeared in the method by Francisco Berau, a baroque Spanish guitar method and it was published at the end of the 17th century. He mentioned the left hand thumb, and he claimed that the thumb had to be the guide (*quilla de un barco*: spine of the vessel). It is important as a guide, but not as the source of power.

I designed a tool for the left hand thumb, it is just a piece of wound string and it's covered with a piece of fabric in order not to scratch the guitar. It causes some discomfort. It is aimed to create awareness, so one can understand that they apply too much force. After sometime, one gets used to apply less and less stress, that's the *aim of this tool. Eventually, the performer is expected to decrease the muscular torque on the guitar neck.*

It could work very well, I don't know, I need to try, probably it would work in my opinion.

Also I suggest using some advanced materials, such as piezochromic pigments. They change their colour when pressured, and it serves as feedback so that it creates awareness for the overuse of muscular torque.

It's a nice idea, I think an idea from a designer can be interesting. That's what we need. Testing it with some students would be very good.

How would you describe virtuosity on guitar? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How do you realise this heightened state of performance? How does it reveal itself? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

I think that all these concepts are very much related because at the end a performer wants to be creative to communicate. A virtuoso performer without a good technique is not possible, it is the basic. For communication and creating a work of art, one needs an advanced technique. About virtuosity, I have seen performers, they are called 'virtuoso players', but, in my opinion they weren't good musicians. I don't know a good definition for virtuosity. Jose Thomas said once: "*I have seen many virtuosi, but only a few of them were musicians*". I agree. I think a virtuoso performer has a lot to do with their technique, but at the same time, a virtuoso is also an artist. A month ago I heard Joshua Bell, he has all the necessary qualities to be accepted as a virtuoso performer.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Yes, in my opinion it would be a combination of a Dammann's playability and a Romanillos' colour and profundity. That would be a perfect instrument.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Contemporary *guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?*

I think that it affects, because the main attraction of a Smallman guitar is not only the playability but also the explosive sound and that is a danger for many young students. They forget some other qualities of making music, that are very important and they should be right there, such as colour, dynamics, and timbre alternatives. I think colour is something inherent of the sound. It is related with the concept of sound. I think in essence, this as a fact, affects the art of music. For instance, nowadays, I believe that there is a quite substantial uniformity between Classical guitar performances. In Classical guitar competitions one cannot see too much originality. In most cases, their approach to the sound is quite similar. I believe this is arising from performers who look for playable instruments, which I don't criticise. But, unfortunately, they forget some other important aspects of making music.

Thanks a lot for your contribution.

Daniel López
06.02.2015

What does a playable guitar offer you as a concert artist? What aspects make it more playable and what do you expect from that guitar?

It is a very personal matter. Also, I think I am very particular, maybe it is because of my wrists, which are quite week. Therefore, I need an extremely comfortable guitar to play, due to this, perhaps, when I acquired a José Ramírez guitar, I found it difficult to play. It was very tiring for me, so I had to lower the bridge. Not only the saddle of the bridge, but the complete bridge instead. Also, I tried various strings at different tensions until I found my equilibrium. The most appropriate was lowering the bridge for me, though. Especially in the neck, what makes a guitar more playable is the thickness of the neck.

How do you compare medium quality student guitars to high-end concert guitars and what are the possible problems of study guitars?

It's a relevant issue, here at this conservatory, students start at their seven or eight. We always keep in mind the quality of guitar for beginners, but this can cause an economic problem to many families. In Madrid, the renowned luthier Ángel Benito constructs very comfortable and affordable guitars. His guitars don’t cause too much resistance and the sound quality is good. In my opinion, one of the main difficulties for a performer (with a student guitar) is the resistance, but there are other issues as well. I think that the height of the saddle essential, but then you have to look for a balance on the strings.

How do you intend to solve these problems? Any techniques?

Yes, I give much importance to the technique, it is a way to reach music. We do excessive exercises in a progressive way. Students have to be conscious about the pressure. We do have an exercise for that. They start playing without any pressure, therefore the string doesn't sound. And they increase the left hand pressure progressively until they reach a good quality sound. This is more complicated while playing a piece but if the student is aware of the force overuse, they learn how to eliminate the overuse of that force. When they understand that they don’t have to press hard with the thumb, the student will improve.

From the first year, I am used to work with a soft technique. I cannot teach each student during the entire lesson (1 hour usually with children aged 8 to 9). The techniques have changed a lot and nowadays we have lots of resources to make our lessons more enjoyable. It is impossible that a child plays good if s/he doesn't have a good technique. I insist on them to get used to the quality of the sound from the beginning (shows some technical tips for left hand thumb), they increase the pressure progressively until we find a good quality sound. Students here do exercises, but since they are not adults, they can get bored easily. What's more, they can get physical damage. Therefore, we do exercises but we also change from the left hand to the right hand in order to prevent boredom and physical damage.

Another important issue is the sitting position and posture. We suggest students to use some ergonomic supports to keep a symmetrical posture; it is better for their back and more comfortable. If a student pays more attention to the discomfort, then s/he cannot focus on playing.

I came up with an idea for the left hand thumb. It causes a controlled discomfort and it creates empathy that shows the user how great the torque they apply on string is. After using the tool, the performer, or the student, becomes conscious and tends to decrease the unnecessary torque.

I would have to try it, but actually the left hand thumb is another issue to count on. I make an exercise with children from the beginning. It is something nobody taught me, I used to apply more pressure than enough and that caused me several problems. Students usually think they have to compensate the strength by pressuring with their thumb so the guitar will sound better. It is a very usual problem. I always explain them that our thumb is a finger which bring us comfort and let us reach all the distances but is not necessary to apply pressure with it. I make an exercise with them: I put my finger between the guitar and their thumb and they can control the strength, they need to get conscious from the beginning. I haven't tried the tool you are suggesting but if it is for decreasing the torque, then we need to try it.

I have another idea that incorporates some advanced materials such as piezochromic pigments that change their colour with pressure. It gives feedback intended to teach how much unnecessary force a performer is applying. So, it works as an educational tool which gives visual feedback to the user.

That sounds okay. Like a nice idea. Why not? I wish we had a prototype to try.

How would you describe virtuosity on guitar? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

There is a thin border between these phenomena. I have always commented that Yamashita (famous Japanese guitarist) was a great virtuoso because he was able to play very fast, like Yepes, but these guitarists are musically sort of cold, at least for me. They surprise me but, that is the greatest thing I get from them. For me, music is something else. It grabs my attention more when a not-so-virtuosic guitarist, but someone who transmits more feelings to me, and "*takes me to other places*". For me, one of the biggest international references, the one who combines all of the terms you've mentioned, is David Russell. Not only through his performance, also with his presence and appearance on stage, the way he looks and acts. He transmits something to the audience. I also accept Manuel Barrueco as a virtuoso performer.

Nowadays there are many wonderful good guitarists around the world, although Spain has always been considered as the cradle of guitar. Virtuosity is a difficult term, I am not very clear if a student without the natural skills but after an excessive amount of practice could one day reach that level. The speed is something that can be trained like sportsmen, but there is a limit, and only speed doesn't make a performer a virtuoso player. Virtuosity requires a very advanced technique and natural skills. For me, a virtuoso is someone who is able to reach all of the terms of technical mastery and high level of performance.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar? Traditional instruments are especially famous for their timbral and expressive qualities. Contemporary guitars are known as loud and powerful. There is an argument that the contemporary instruments do not have the charming quality of traditional guitars. How does it affect the art of performance?

I think it is possible. Quite many luthiers have striven to increase the sound power, more than the timbral appeal. For example Contreras made a double top model in order to get greater projection. The power of a guitar can affect the comfort of its player. If you have an instrument which sounds powerful, then you don't have to make an extra effort and this directly affects your muscles and tendons. It saves energy while playing. In fact, there is something missing in this discussion. My colleagues and students seem to demand amplification for concerts, although human ear can adapt to low voices. The Classical guitar does not sound like the piano or violin. However, the audiences want to hear it more clearly and louder. As a concert artist, I can say that performers need to play louder than usual on stage. On the other hand, how to get a bigger and quality sound from the instrument is something players need to learn; but, for sure there is a limit. That's why, concert performers use amplification. Quite often, the microphone and amplification systems are hidden or invisible. Usually, there appear new products every now and then; they get smaller and yet they offer a better amplification.

During the course of a performance, it is important that the instrument is balanced, because it saves you a lot of work. Whatever the guitar does not bring to you, you have to make an extra effort. Another dilemma is the cut-away guitars. If it's a regular guitar, that part of the body doesn't permit you to reach the high registers comfortably. Luthiers don't prefer to remove that part of the box, and they should have their reasons. One part of the sound box is removed, that's why some harmony and overtones may be lost. I don't know if that part (that's missing in cut-away guitars) seriously affects the overall quality, but, cut-away guitars help a lot to performers. In addition, there are guitars with the famous 20th fret. It is just another thing that improves playability.

Thank you very much.

Oscar Herrero
23.03.2015

What does a "playable guitar" mean to you as a Flamenco player? Is there a difference between the Classical guitar? Which aspects make it more playable and what do you expect from a guitar?

I play guitar since I was a child and one of the main problems with this instrument is that it is not easy to play because all the back, muscles and bones suffer. It hurts. Its form and shape are not ergonomically compatible to human body basically. The Classical guitar, just like the Flamenco guitar, they have very slight differences but they are still different instruments, wasn't really '*designed*' for human body. I don't think there is a posture which reduces the suffering of our body.

What are the difficulties of student guitars (medium level quality) that can create difficulties for performers? How do you compare medium quality student guitars to high-end concert guitars?

What makes a guitar high quality is the quality and beauty of its voice. And a high quality guitar can produce sound easily. However, since everybody has anthropometric and ergonomic differences, one particular guitar can be easy for me and difficult for someone else. So, it is quire personal and subjective. My fingers are long and strong. I can play a larger scale guitar, a guitar with higher tension. If I had shorter fingers, I would need a smaller guitar and lower tension. Every person needs different guitars with different characteristics, according to their physical characteristics.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

We, as musicians, always need a high quality instrument starting from the sound quality, and several other instrumental qualities which are tailored to us. Therefore, yes, if the instrument is easier to play for your body dimensions and characteristics and it produces the tones you want easily, then you can play more comfortable and you can play better, in a more advanced level.

Do you think that the quality of a Flamenco guitar affects your performance quality?

The guitar is an instrument which we use as a channel to express ourselves. Therefore, it is very important that the instrument can make your work easier, so that you can express yourself better. But, we are never happy with our instruments, we are always on the lookout for the perfect guitar which doesn’t exist in my opinion.

I designed a tool for the left hand thumb, it is just a piece of wound string and it's covered with a piece of fabric in order not to scratch the guitar. It causes discomfort, and, therefore it is aimed to create awareness, so one can understand that they apply too much stress. After sometime, one gets used to apply less and less stress, that’s the aim of the tool. Eventually the performer is going to decrease the muscular torque on the guitar neck. Do you have a technique to teach your students how to decrease their right hand pressure?

No, I don’t have any special techniques for that. But you always have to keep your body relaxed and decrease the pressure that you apply with your fingers. Not only the thumb, also the other fingers. You have to play with a minimum tension. And when you have to apply greater power due to some reason, at least the rest of your body should remain relax. I'd have to try that tool you've suggested. But as a first impression, it is not a good idea, because the guitar is something you need to be in contact with, you need to touch and feel it. I think that this thumb tool separates us from the instrument.

What are the most important and common difficulties that students become faced?

Every student is different, but the guitar is an instrument which requires a lot of discipline to get results. I wouldn’t dare to say something general about students, because each of them has different difficulties. In general, what they have to do is to have some discipline and a lot of work to get over the difficulties that the guitar brings because this instrument ergonomically is not a perfect fit to human body.

Well-known traditional instruments are especially famous for their timbral and expressive qualities. Contemporary guitars are known as loud and powerful. There is some argument that these contemporary instruments do not have the singing and charming quality of traditional guitars. Is there a similar case for the Flamenco guitar?

Since I am a Flamenco player and these luthiers don’t make Flamenco guitars, I know these makers and their names but I haven’t tried these guitars. The

Flamenco guitar construction is fairly different from the Classic guitar. Flamenco guitar makers and performers are more loyal or faithful, if you like, to traditions of guitar making; which is great in my opinion. They still make guitars with wooden pegs. They tend to continue this tradition, and flamenco guitar makers do not produce double-tops and lattice guitars. And I am happy with that.

Many thanks Oscar

Hermann Hauser III
22.07.2015

What makes a guitar more playable?

You like to know the playability of an instrument, how important it is and what makes a guitar more playable. All the dimensions should be compatible with the user. For example, if the client has big fingers I need to measure his fingers. Also the distance between strings, that's also very important for the left and right hands. So we have standards and the standards are only for normal sized users and this is the standard but at the end everybody has different fingers, small fingers, thick fingers, sometimes short and thick fingers. Andrés Segovia had long and thick fingers. So it's always a question which way he can touch the strings and the fingerboard, so that it feels comfortable. The feeling of comfort on the guitar is very similar to the feeling of comfort on a very well constructed seat. If you have a good car and a comfortable seat, you can travel longer distances than a smaller car. And this way, comfort makes it you feel good for playing on the guitar and this whole thing which is making the guitar that way, that you look at the hands, which size they are, how high is the action height. But you shouldn't forget that the philosophy of technology about the strings from the top, because that's very important. Because some say "this is not a problem, I increase the action height and so I can press very strong". No, that's not so good, not too far away from the fingerboard. It needs to be close enough to the fingerboard, it is also important.

Any standards you use?

Yes we use some standards. That was a big conversation between my grandfather, my father and Andrés Segovia, especially about the action height and the distance between the strings from one to another. That's not all, because he had very big and thick fingers. Segovia was a big person, not a normal sized, standard person. So that's not always the 65 centimetre standard, for some people 66 can be the standard. He also came to me once in 1979 I made a guitar for him, he needed a thicker fingerboard since his fingers were thick, he unintentionally touches the other strings, the unwanted strings. That's why he needed 65.5 at first and then 66 centimetres scale. That is okay for Andres Segovia but not for a normal, standards person who is average. This is very important for playability. The next is, you should look at the visual appearance of an instrument, I mean, the visual or optical appearance can give an idea about the balance of the instrument. The balance of an instrument is very important for playability. If you have a guitar on your lap, you should not need to hold the guitar, that's why the balance is very important. For a Spanish person, it is no question, just sit and play. It is like in the blood (laughs). For Segovia the posture was very important, as he used to say '*you should hold it in the right position and so you feel comfortable*'. The body size is also important like the fingerboard thickness or width. And this explains why the 1937 Segovia model has been the most copied model so far in the world. Because everything, every aspect is well done and well designed, well constructed. If the guitar is in balance on your lap, you can reach to every position without much difficulty, and you don't have to hold it because it will stay in balance. This is one of the major aspects of playability.

The action height, the distance between strings and the fretboard. Segovia said in the 1920s, he first came to my grandfather, first contacted in 1924, in those years the action height was also a hotly debated aspect. If it is too high you need more power, more action. If it's not that high you have a very nice singing sound colour from the instrument, strings are great to play, very easy very comfortable but you lose the power. In that way Segovia found out with my grandfather that you have a minimum height and maximum height. Within this range, the guitar sounds well. If you are under you will get into trouble because this guitar will start buzzing especially at low registers, if it's too high you will lose the sound quality. It also depends on the right hand technique, if he's a strong player, he needs higher action height, if he is a soft player and he is an amateur, he plays at home then he needs a lover action height because it's more comfortable.

What can you say about the tension of the strings? There are soft tension strings high tension strings, but the guitar body itself has a tension, as well.

Medium tensions stings give out the harmony better. And they have a more rounded and nicer sound. I prefer medium-high tension but it's a question of what sort of instrument it is. If it's an instrument with a very high action you can't use medium because, it's too heavy to play. So it's very uncomfortable. But sometimes people use low tension strings because it's easier to play and it produces a little softer and warmer tone. Carbon strings make a very short and loud voice. Their sustain is shorter. So it's always the question what an instrument brings and what a certain player can bring out of this instrument. This is the question, if you have an amateur player and you give him a high level guitar, he cannot make the most because he needs a lot of time to find out where all the different tones are. Because if he starts using a cheap guitar, anything on the guitar sounds the same, this angle or that angle, this action or that action sound the same, it doesn't matter if you have a very good guitar, it has everything inside so the only question is what do you have to do as a musician to bring out the finest notes, the finest music of this instrument with your fingers. The instrument has the potential. But you have to bring it out. Using a good instrument you can bring it out working your fingers but a cheap one with your fingers, you can go on the limit, but you can never bring it out. This is playability.

The response of strings is great on Hauser guitars. How do you make it? It is fast enough, it sustains enough.

If you see a guitar which is very loud at the beginning, pushing out the quality of the sound she has, you can never have the voice you like to form as a performer, as an artist, as a musician. You would like to make some special things so that, you can form the sound you'd like to have. If an instrument allows them just by touching, the notes are not standing directly, so the notes are going in different ways, they don't stand for the exact frequency. So, the voice has too much disharmony inside. It makes too many overtones. If you consider the piano for instance, if you had a piano without the mechanic internal system which stops the strings as you push the pedal, due to the free swinging of strings, you'd hear humming sounds or noise. This is too much, and if you consider for instance in the literature the "chiterrone" from the Middle Ages which has 1.2 m. string length. This instrument has too many strings on it. A piece made of bird feather is used to dampen the overtones when it is played. Like the piano which has a felt inside that stops the vibrations. So, if you have a guitar, due to the same sort of free swinging, all the notes create a '*swimming*' note picture. And it's not really what a musician or a composer would like. They all sound the same, Segovia says "*looking at all Spanish virtuoso players, everybody sounds the same, so I'd like to make a difference and I should find out how I can make it*". Eventually he found how to make a difference in his sound and he became legendary. This is a small step in the big picture. You have to find out that the guitar is both soft and strong to play and you have a guitar which is bringing the notes in distance very clean very perfect. If the sound is only coming only loud so you have a swimming note picture. And the picture, if it is not sharp, it can be abstract like the contemporary art. Abstract pictures from distance... You can say yes, that can be that. And the musician, and the music is the same. If too many voices from a musician come to your ears, your head cannot really understand the music, and what the composer and the musician like to say this is music. So, you need a guitar which produces separate notes each time for every string and fret, the separation between the basses and trebles, and every note you play must be clean. It must be a single unity of voices and not a swimming picture of music, and this is very difficult. This question is very difficult to answer. Your questions are very difficult to answer. But most people don't talk about these things. Many people would say "the most important thing is the loudness and the response of a guitar, and immediacy when I play". No, this disturbs the music; this is not the soul of music, this is not the life of the music. Living music needs high points and low points. This is the way if you listen to Andres Segovia, Julian Bream or John Williams. The old players of that time, Miguel Llobet for instance. If you listen to him, that is music. And if you see the guitar they play, for instance I saw the guitar which was played by Miguel Llobet, an old Torres from the 1850s, I saw that guitar, if you see the quality of that guitar. This guitar does not push loud music, this guitar is strong at distance, you can hear it very clearly at distance. And that guitar was made in 1859. If you hear the sound of this instrument, it is still playable in concerts. The only problem is the fingerboard, and therefore the playability. It needed to be raised. But the sound quality is amazing. The people at that time knew what to do without technology, only with their ears, and the ears, you cannot lie. If you hear something you like to hear it, you say: "*oh it's great, I like it*". If you use technology to amplify it then it is different. It is only loud but it is not nice. So, this is also the philosophy of traditions from the Middle Ages to today and nothing has changed in people. They are still the same but only the technology is much better now than before. Before, they decided fret positions by ear, nowadays there are machines or computers to calculate. The person who made it should be a genius; now the computer says that the first fret should be here and the second should be there. This is mathematics, but if you trust mathematics so much, at the end you will see that it's wrong to your ears. Because there's a compensation coming from the height of the string and the thickness of the material. Now we have 65 centimetres plus the compensation but this is new. Before, it was a measurement of free swinging length of a string of 65 centimetres and then the ears making the positions of frets including the compensation. So you see how good those people were that time, without our time's technology. Now, we have a much advanced technology, and is this perfect? If you calculate, yes, but in the end you say, no it's not. This is something to do with the playability of an instrument because if it's not clean, you have a big problem. Including the compensation it is not 65 centimetres, it is 65.2 maybe. The first string is 64.8 the second string is 64.9 and for the G string we have exactly 65 including the compensation. This measurement works best for us. We don't need another one. We make guitars in the old style.

How can you compare virtuosity, technical mastery and high level of performance?

Everybody has a different sense about it. Virtuosity is always a little bit confusing and you as a maker, you have material. You have to work with the material and the material tells you this is the maximum, this dimension you need otherwise the construction falls down and you cannot make it since the beginning and calculate, "*ohh the top gets bumped towards the inside*". "*That's not a problem, because the sound quality is like how the client wanted*", but the top gets bumped towards the inside! So, it also changes the string angle, so nothing is working there. You have to look at the makers that you can explain it to the clients, the people, the virtuosi. The material, you need substance, you have no sound. You can take only paper, so it is nothing; if it is paper-thin, even if you're making a cry outside, nobody hears you. It's only a voice but nobody understands. Today you can find so many players, who are perfect, technically. For instance, Segovia makes mistakes, and it makes the music high. For instance, in one concert of Julian Bream, it was fantastic. he made one mistake, two mistakes, three mistakes; but between these three mistakes he had highlights, nobody could have done. And this makes him amazing, if you listen to the sound quality he brings out of his fingers, nobody cares these small mistakes.

A close friend of mine, a Brazilian musician, he is internationally famous; I asked him "*what do you think when you are performing? What do you imagine or feel while you touch the strings?*" He told me "*I feel nothing; I only listen to the music*". I think this is the whole secret. If a musician is in trance, like in another level, in another world, he doesn't hear the mistakes, he doesn't hear the noise coming from the audience, be it a mobile phone or coughing, you are in another world. And that's why this musician is concentrated on music and the sound of the instrument. He is outside of this world. He is a virtuoso. And I think this is the secret about it. But especially young generation and what they understand from virtuosity is in fact something to do with the technique, fast and loud. For me, it is not music and this is a big mistake. In the Far East, they say there are 250 million guitar players. Many of them are technically perfect, fast, amazing. But the problem is that, I know from several Far Eastern musicians' concerts, generally speaking, a number of them do not have distinct characters. I do not know what it is really but I suppose it is their education system. They are so good in a type of quality that arises from perfection in repetition. Very often, they tend to have quite similar playing styles, rather than different personalities. Music is more than that, I believe. Music means listening, maybe like my friend says, "*you have to forget everything else and concentrate on the music you're playing, close your eyes, play your pieces and listen only through your ears and feel it inside*". Forget everything else and you will perform the best concert. Most players never think about this. I hear all of the qualities of a great virtuoso, the technique and musicality. All in the piece... “*How do you do this?*” Many performers cut here and there, they edit the mistakes. He says no! No cuts, nothing! Maybe that's the secret and it can make a performer '*great*'. Maybe... I don’t know.

In your opinion is it possible to increase the virtuosity of a player by giving him a better guitar?

Sure. If you give a loud guitar to a student or a beginner, they'd be happy. "*I don't need to force it, I just touch a little bit and a big sound comes out*". It means they never really understood the music. Only the technique... So I think, if you give them a good guitar then it can start to open their mind. And I've heard many people who had played other guitars before Hausers; they acquire a Hauser guitar and they see what they have beyond; that level is "*beyond*" their sound world. Very often they say "*I didn't know that this level even existed*", "*it opened my mind, it makes me a better guitarist at a level above*", because they have some sounds which they had never noticed prior to that point. So, it is very important to have a good guitar. But it's always important to consider if you'd like to learn the guitar. For example, not everybody can buy a guitar, high-end guitars are very expensive. Okay, we, instrument makers, we all make guitars not for the money, we make it because we have fun to make it. So this is a reason. It's not a question if its a factory in Spain, or a factory in China or a small workshop in Spain or elsewhere in Europe. It's no question, everybody working with their hearts to make beautiful instruments. If a guitar costs 50 Euros in a supermarket, and high-end instruments are not so, obviously. But people have to start playing the guitar, but 50-Euro-guitar is not a 'musical instrument', for sure. Maybe if you like the Classical guitar, you should start from 200/250 Euros. Then you can *talk* about a *guitar*. All under this threshold is not really a guitar, it's only a box with strings. How can you learn the guitar? Sure enough, not with a 50-Euro-guitar, but maybe it gives you motivation, to say "*yes, okay, I like it, I'll give it to a kindergarten and buy a better one*". Because, I'd like to have a wider tonal palette. This is a step towards better instruments: they buy and sell, next step a more expensive one, next step a higher level. Okay, they have invested in a lot of money and come to a point where they can say "*now it's time to have a real masterpiece, a piece of art*". This is expensive, but we need these people who can buy an expensive guitar after they come to this point step by step. Otherwise, we have a problem. You said that a lot of makers copy my instruments, workmanship and design. On the other hand, we need the industry and the industry needs us. So we have to give some input to the industry so that they know what we can do. Those people like to play and we need the industry for these people buying and selling relatively cheap guitars every time coming closer to the high-end level instruments. So, this is important, this is very clear. Playing on a high-level and expensive instrument, players have more fun. So, absolutely, in the end with a good guitar, they will be better players.

Traditional instruments, for example your guitars and those of Fleta are especially famous for their timbral and expressive qualities. There is some argument that contemporary instruments do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

You can talk about two or three types of instruments, nylon strings and steel strings. You have the Vienna construction plus the cedar construction. Now we have a new construction, the double top. But it doesn't mean that one is better than the others. I believe the Classical guitar has completed its evolution and arrived at a conclusion. Even so, some people argue that it hasn't, yet; and some new things, new materials need to be tried. I have to dispute. In the end, the traditional guitar, for example I've heard many times the traditional guitar is louder at distance then double tops, even though people think double tops are louder. The voice of contemporary instruments is not appealing to me. Playing more than 10 minutes gives me headache. I get many emails and letters thanking me for not following this double top fashion. Traditional guitar timbre quality is better, more brilliant, louder at distance and charming and the secret is that it is not loud, but in distance, the guitar is able to project and carry the sound forward. Its projection quality is great. And this is the secret. Considering Andrés Segovia playing in Munich Hercules Hall to 1200 or 1400 listeners... Even though it is not a hall for classical guitar concerts, Andres Segovia played there. In the last row, you could hear him clearly, each note sounds separate even in the last row. This is quality. If you have a guitar which is loud only, and the voices do not stand separately, you have a swimming picture. Loudness is not a sound quality. For the quality, you must listen, and if you listen to the voices, the quality is when you have each voice separately and you hear it at distance. And the brilliance and clarity... I think this is the way which we have to follow. Not the loud double tops. But for sure, you can have ease of playing as a performer. A guitar which is loud, can mask your mistakes. But it lacks musicality at the same time. I think this is what makes Segovia, Bream or Llobet great.

Some luthiers, for instance Michael Gee in the UK, make Hauser copies or Torres copies. How do you feel about that?

Well, yes, we need the industry. We also need these people who copy our instruments because why do they copy? They copy because they like our guitars and they want to make creations, and it works as a copy. For example, if you start making guitars, and you buy a cheap guitar from China, and you copy that. It will sound like that guitar. If you copy a Hauser, then you will have a guitar which is not the same but, they will have some shared characteristics in their sound quality. They imitated the Hauser, because they liked our guitars. It's a trademark, normally they have to ask before, but you know… for instance the Washburn company copied Hauser, Fleta, Ramirez guitars. And sold as Washburn Hauser, Washburn Fleta, Washburn Ramirez models. Their attitude was like "*you can take us to court*". We couldn't. Because it would take some twenty years and lots of money. At the end, you can win, but you bankrupt (laughs). This is the problem. Everybody buying a guitar from us started to ask if they could have a certification which proves that it was an original Hauser.

Many thanks for your time.

Heike Matthiesen
09.08.2015

Could you please give an insight about your opinions on concert guitars?

Actually you can play on any guitar, but if you are going to play in a large hall and you don't have amplification, then suddenly there are other rules. Or if you want to be heard clearly and not '*melt*' with other instruments, you'll want to have sound amplification. I'm very shy, I still don’t own a double top or lattice guitar, because many times when I hear from colleagues it doesn’t sound convincing. They sound so nice, but in a hall if you sit in raw ten, for example there is a big change in what you hear. It is completely different from what you'd want to. All guitars which sound nice when up-close, can be played with a microphone. That brings the dilemma of microphone for stage or microphone for recording. They can sound really beautiful. So, it is about either power or projection of the guitar. For me, this is the biggest thing as a professional on stage: a powerful guitar doesn't mean she has a decent projection.

Would like to start with the definition of playable guitars?

A playable guitar, to me, means a guitar I can play effortlessly without thinking of its material, and it wouldn't be a guitar on which I have to adjust my technique. A playable guitar, at first, matches my technique. And then, it is what is not considered in the questions you've given me, it very much depends on your strings. If your strings have little elasticity, you can have the nicest constructed guitar in the world, but it will feel uncomfortable. So, it is an aspect you can emphasize the power and playability of a guitar. That is, playability and power are also affected by the strings used. It makes a difference when you use super stiff carbon strings on a guitar whose action is very high. The action height at the 12th fret is very high, and this is not fun for your fingers. I know many players who claim that the playability has a lot to do with the action of the strings, and they like it very low. I personally like it very high, but I like it with elastic nylon strings, so it's not uncomfortable. It would be uncomfortable with stiff (i.e. carbon) strings. I also like if the fret relief is not too low. So there is some room where I can work with pressing the string down. If you have something very flat, you have to press a lot to keep it in contact with frets. If it is like this (showing her left hand fingers to exemplify how it is on a higher fret relief structure), you need to use less power. Some colleagues do like guitars that have a very tiny distance between strings and fingerboard, and very flat frets. It really depends on the player.

So you prefer a comparatively higher action level but very soft strings. Are they normal tension or soft tension?

I use high tension but nylon strings. I don't play any of those new materials such as carbon or composite strings. I like when they are like trampolines. I mean if they are really elastic. Especially when I play chamber music or in an opera house I need to play really laud when it is musically appropriate. It means I have to move the strings. It is different from playing fine and sensitive pieces. Sometimes I need to play very rough, but it's like the comparison of an opera voice and a singer. For little songs like Shugart songs, one would need some other voice than Wagner. I like and search for this dramatic sound on the Classical guitar. You need to apply a comparably greater muscle power to strings, you really need to move the strings. Doing so, a low action guitar will chatter. It becomes unplayable, or otherwise you have to reduce your pressure. It is really dependent on where you play and what you play. If it is chamber music, you just have to be heard. When I play sensitive stuff, as a soloist, everything changes. The wood changes. For me it is a mixture of finding the exact distance for the strings to move, the curve of the fingerboard. Personally I like if the neck is really flat. That's also not because I don't use this energy for pressing fingers, I do everything using the power of my arm and I just leave the thumb on the backstage flipping. It just needs a comfortable position. I don't press with this (showing her thumb) because it's a soft muscle and this is a big muscle (showing her arm). I use the big one (arm) to apply force, so I like a nice neck shape where I can leave the thumb. It's not a shape that you can press against, so this again really depends on your technique. If you need to use your arm to build up energy for your fingers and if you just leave the thumb there, you will need a nice rest and this feels much more comfortable with my fingers if the neck is not so thin. Something very personal. When people see my guitars they go “oh it's too high, too fat”. Well, for me they're comfortable because there are a lot different opinions as to what a Classical guitar should seem like. Like today, everybody says "*oh a guitar should have double tops, otherwise she does not project*" for example, or the action should be low for comfort. There is a lot of, we say here in Germany, '*half knowledge*'. This is nothing you can generalise. I also don't use extra tools such as ErgoPlay. I use the traditional footstool. Really old school, you have a perfect example of an old school player (laughs). Really, I'm still doing it like people used to do 100 years ago, but for me this feels most natural. I don't use all this kind of ergonomic supports and stuff. I don't want to handle this kind of stuff on stage. So, once again, it depends on where you play. Whether in large halls or small venues. In a large hall, you need big evening pack; support, leather and so on. I don't like. I just like to go on stage with my guitar. So a combination of the neck size and the action height. I have thin and long fingers, so I can reach quite well but for some people the string width is very important, I mean the distance between low and high E strings (1st and 6th strings). Millimetres count if you are a man with really big fingers. I have seen the guitars built for Aniello Desiderio who have huge hands, these guitars require a bigger distance. Because some guys really have double of my hands and they need space otherwise they will touch some unwanted strings. I have no idea how Segovia managed with his big hands on a normal scale guitar. As a summary I want a fat neck but I don’t prefer a large distance between strings. Because, you always need to do stretches. You have all these movements, vertical moments. Playing Bach gets really uncomfortable at times, especially if you spend hours. Big stretches make your hand very tired and uncomfortable. I like digging deep into strings, it is like massaging them. You have to have space to do that. And then just a *clink* on the surface. It's sort of a Cymbal sound, you know, some guitarists just pluck with nails. I like, it sounds very nice, but personally it is a different kind of playing. Mine is a pure "*homage*" technique of playing the guitar that I learned from Pepe (Romero). Old school Spanish way.

You mention Pepe Romero as being the basic influence, maybe the first influence on you. How about your nail shape. Is it ramped, or..?

There is no secret about it, they are absolutely short. I follow the curve of my finger, so they are not ramped, and I just amplify it a little bit. So they are curvy and short. Right now they are almost too long (showing her right hand nails).

Oh really?

Yes, because I like playing with a mixture of flesh and nail. And if the nail is too long, the nail just catches the string, and you don’t have a choice any more. Changing the angle a little bit, I can change the colour. So, it is also my personal taste if your finger is not that thin, but a little broader, you need more curve. It is one of the nicest things of thin fingers that the nail doesn't need to be long. Because if you want the same curve with big fingers, you need much more nail. This is why all the poor guys who play guitar have huge nails on their right hands. It makes the life easier to have short nails. If a nail brakes, it is there again after a week. I'm not last for weeks and I don’t use, I have the luck that my nails are tough, my genes are so nice that my nails almost never break and I don’t need any nail ping pong ball or something like that. I just file them and eat healthy, and that's all. Something I am really lucky. But it works in combination with short nails.

How can you compare playable guitars and medium quality study guitars? Students in general start with those cheap study guitars. What are the advantages of a more playable guitar?

The funny thing is that, I, as a player, don’t really know what it is really that makes a difference in playability. It is like, you slip into a dress and it fits. If you buy a cheap one, you go "*okay I have to get this part checked*". I don’t really know what the secret of playability is. When you put your hands on a good guitar, you play on the first fret and it feels comfortable, you play on the 12th fret and it is comfortable again. On a study guitar, some parts are nice but others are not. So, it is not balanced. It feels as if that guitar is made for a beginner who just plays around the first 5 frets. A good guitar makes you feel that it is reacting with the same ease at all frets. A guitar with a price tag of 3000 Euros or more should never have dead notes, but if it’s cheaper, you might find some of these dead tones or wrong pitches. But from a level, let's say 3000, usually a guitar doesn't have real mistakes. The fine tuning realised on that guitar so that she responds to subtle differences in attack and nail shapes costs that price tag. The sound is balanced and connected throughout the fingerboard. Everywhere. I'm not that kind of nerd who looks and says "*this is because of that*". I just really take the guitar and say “*okay this feels good*”. When you touch a really well made instrument, you really can’t stop yourself from playing and just play and play. And that is a combination of what I said parameters like thickness, like action height. Everybody will have another solution but there is one type which seems that particular guitar does not want to respond. This is something that happens when there is too much bar inside the top. I mean the soundboard architecture and bracing inside the sound box. The top doesn't feel vibrating where you have a feeling you're working but there's no sound at the end. It really depends on the interior construction and it's also something that depends on personal taste because some people love it. It's really what you're looking for in an instrument but the real playability is when it gets really high-end. Sometimes you don't even know which detail it is. If it is something to do with some millimetres here and there in the fretboard, or in the bridge, you cannot really tell precisely. You should look at a guitar and try to say whether they are comfortable or not and measure all the dimensions, every detail and every little piece. Maybe you can get some clues. I really don't know whether you can find what makes it playable and "*okay that is what feels good*".

How about study guitars and dynamics? Colours of the guitar? Is it possible to do these things on a study guitar?

I think there is an important question if you already know how to do it. I don't know if you have seen but I made a video for Siccas guitars, for that German guitar shop. I said "*give me one cheap guitar*". And they gave me an Altamira guitar, worth 800 Euros and it was a really hard work to make it sound well because I played directly after a Friedrich (laughs). That was a radical change, but if I know which sounds I want, I can get them out of a cheap guitar with some effort but a beginner can just get out of that guitar what the guitar offers. Then you are very limited in timbral colours because, you have to ask more than the guitar knows and she is able to do. This is getting a little philosophical, but I can sound good on a cheap guitar, as well; but a student or a beginner can sound much better on a good guitar than a cheap one. If a student can afford an expensive guitar, I'd always say "*yes yes yes, select that one because the guitar will teach you what is possible, she has the full range and you can learn from that instrument, you can't learn this range from a guitar which cannot give it*". If you have a guitar on which everything is possible you will learn sooner or later. At the beginning, you will use a small percentage of what she is able to offer, though. But it's not a waste of energy or waste of guitar. If you are a student, it is like driving a Porsche instead of a Fiat Cinco Cento. If you want to drive races you will need a real car. Why not have a good guitar if you can? You will learn a lot from that guitar. It can always teach you if you have your ears open. This is the reason why many guitarists have more than one guitar because, you want to have different sounds or sound qualities different guitars can offer. Like the 1st step, have a spruce and cedar guitar for the different sound ranges they have. As a student, you should get the best instrument without making a bank robbery because, if the guitar is much farther than you, she will teach you. It sounds philosophical but it's the truth because colours are there you will catch them maybe by accident every now and then, "*wow that's nice, I want to have that again*". And now, when I play a cheap guitar I can say "*I want this and that colour effect, let's force how to do it*". Maybe I've had something similar but she's not offering it herself, so she is really a student guitar, she just answers what I input and a very good guitar can offer you things you didn't know that you wanted them, so it sounds philosophical but…

Thank you very much. How can you compare virtuosity, technical mastery and a high level of performance?

There are many myths about perfection. We are living in the present time where we are surrounded by perfection. We have CDs which you can *Photoshop* until there is nothing left sounding like natural, you can make CDs where everything is perfect. There are players who are able to reproduce this perfection on stage but some of them get restricted on that. For me, there is a difference between musical perfection on stage and perfection on recorded music. For recording, you can work eleven years until you have found the solution of a piece. But, otherwise you are sitting on stage that evening this moment with this particular audience this unique moment. For a concert, my personal opinion is to touch them and you can touch them if you're a guy walking on rope, this type of magic, you know he's doing something mystery that is fascinating. All you have this concert where somebody jumps and really like a blues musician his soul is open. So it really again depends on where you think. If it is for recording, if it is for a competition. Usually for competitions you will play as clean as possible to win. First step, but maybe not the most touching. And for concerts something else. I am fascinated if somebody is playing completely immaculate, but he must be a genius if it is not getting too buried one day. And I always laugh to tell the story how some recordings of Emile Gilles, Russian pianist, I do love and miss his missing notes when I hear Liszt B minor Sonata played by someone else perfectly. Because there was so much input, energy, love for music, so much will to express something that those missing notes didn’t count. And the sound isn't polished completely, but for sure it needs to be polished if you play live on stage; you have microphones and it is for radio. Then you must play in a different style. So, I must give many answers to your question. When I'm playing on stage, I don’t want to think about the technique any more. I don’t want to think about my own technique, I don’t want to think about the technique of the guitar, I don’t want to think if my footstool is right, if my dress is working whatever. For me, the magic is that you sit on stage and music is there and you're playing and sharing it with the audience. For me, that’s the way I dream to play concerts. Sometimes you reach it like that when you play that evening. Sometimes you have many moments where you reach that and sometimes it is just a concert, a good one, I hope. But, this is the goal for me, it is not just a show that I'm able to do without mistakes, this is when performing in a hall. But sometimes you need it in a competition, because they count on mistakes. If you play that piece ten thousand times, you can take out all the mistakes. But on stage, for me the perfect concert, is the one that connects with music. And I am the player part of it.

It depends on, as a player, where your focus is; in that case, you are not doing sport with your fingers. In order to do sport with fingers, you can reproduce a piece with perfect virtuosity, but there is a level beyond that, where virtuosity starts to have a meaning where you say, "*okay, like in bel canto operas*", they say "*there is a lot of fiora tuba*". But they express something. They can express the joy of life, they can play hysterical, drama etc. and this is the next level where everything technical has a level beyond that expresses something. So, I think technical virtuosity in everything is the base but there is one another I've had. And this is really where suddenly everything you tell with your instrument gets a limit. And not just "*okay now some fast scales and arpeggios*". And it is a piece by Giuliani, or whatever. And Giuliani always has opera, drama, like Bellini operas. Not just "*okay some scales and arpeggios, okay some more scales*". This is the level of virtuosity. For sure, it is nice to have some show pieces, where you show off. Sagreras quotes "*also have show pieces where it is just pure joy of having fun with your fingers running up and down the guitar*" but you don't want to do it 90 minutes in a concert. It should be like an encore, or the last piece before the intermission to have some fun and enjoy the speed, it is like a rollercoaster. But an evening should be a mix of everything in a concert.

How is it in records?

You can polish anything, the question is how far you want to go. If you want to look like a Photoshop pop star, then… It is the same, you can clean everything, so that it doesn't sound human anymore. And you correct everything; you shouldn't say that in public as an artist how much you can cover if you want to, but people don't trust recordings anymore. Now you can do things, which you cannot on stage. You can do inhuman things in recording studios. Personally, I miss the communications of performers with audience in old recordings. This adds something to your playing, if you are playing for yourself, or for thousands, for two persons or five hundred. It changes your playing, because you are not playing from sound hole to your own ear, because you want to play, I always wanna go on stage and think of myself playing for the person in the last raw. So, I strive to reach that person, I want my sound to fill their heart. And when you sit in a recording studio, the microphones in 50 cm. distance in front of you. One may forget this aspect of having a sound like a bubble bath around you with sounds. This is something you can forget very easily in a recording studio, because you just talk to the microphone. And the mic says "*do it again, do it again*". There is something missing then. Of course, you can add this kind of "*ok, nobody is walking in the audience, no phone going off, I can search for perfection*". What you should not do on stage. The search for perfection goes to practicing at home and to the studio. On stage, personally, I always think of rest. Because, the rest is beyond virtuosity. You should have the virtuosity, and then go to what music means to you or what it could mean to the audience.

You acquired a new guitar, it is a Roy Fankhanel. He made three, one for you, one triple top and the other is a special edition.

Mine is pure simple old school. I wanted to have a guitar by him because he has this mix of his love with the old guitars such as Simplicio and a modern touch. I was really interested in the mixture of a modern clear sound based on the old tradition of building. So, again I didn't ask for a double top, triple top or lattice.

Do you think it is possible to boost the mastery or superiority in musical expression with a better guitar design? Is a "better guitar design" possible?

There are many things that I don't know if they stay for eternity. I just saw a guitar at Iserlohn Festival, this part (showing the sides of her guitar) was open, and it didn't have a sound hole. That guitar was amazing, I was told that it was sounding to outside, but you got a feeling like ACDC, you're gonna sound wave back to yourself, the sound hole was on the side. I don't know how it would feel to go on stage with that guitar, because people will look at you and "*what's that guitar*". Novelty in instrument design changes the way people think. If you have a new guitar design, you expect new sounds, so you search for that. If you just get a nice regular guitar, you say "*okay, she will sound like a guitar*" but if you get a guitar with weird sound holes, you open up your ears. And doing so, maybe you will develop something. So, I think it's really triggering the fantasy of a player to having a radically designed guitar. Because as a player, you'd want to discover what it changes in the way you learned it. So I think, this is the first big step because then we are looking for, what I told you before, the concept of sound in our head. When you think "*this guitar has a weird construction, I must find something*", maybe you will find it then. You're expecting something and you're searching for it and I think this is the biggest thing because like the violin, there hasn't been any senseful development in violin manufacture for the last four centuries, I don't know what will stay for eternity in guitar manufacture and design. But playing around with it, you will find out what is triggering the fantasy or maybe what is really improving this sound. I think this is really important because it's a part of the fantasy of the player that they have to wake up. If you like that guitar with the sound hole on the side, you will want to see how it reacts. I don't know how it would react on stage or how I'd feel about it. That's another question, if you really trust that this instrument can fill the venue, then you go on stage. You sit down to play with your curious and open ears. This is the biggest thing that can change you as a player and this is why I recommend people to try as many guitars as possible just to get different sound concepts. For me, guitars, as I always joke around saying that spruce or cedar is like white wine or red wine. This is the first big decision you need to make before your concert. Selecting an old French bordeaux or a Shiraz from the last year. You can have all these different tastes but, you have to know. The more you know about them the more you can appreciate the differences. If somebody says "*I'll buy my first guitar and I'm assuming to pay around 3000 Euros*". Then you have to ask them regarding what they want, which sounds, what music, what repertoire. On a beautiful Torres guitar from the 19th century, you wouldn't play a contemporary piece like Koyunbaba. It depends on the repertoire or which style of music you like. I think in Classical guitar design many things are done, already. Also at a physical level, I mean the exterior of the guitar, like the armrest for those who have problems there; those things are done. All the supports, I don't like them visually. On stage most of them are very disturbing. But, I believe that the most important thing is the top and the top will stay as it is and that's what produces the sound. So, you can discuss about everything else that has something to do with the playability. I think the top plate, the shape of the top plate, nobody would dare to change it for a good reason. Everything else, you can see if it's really changing something. If it's really enough to make a player a better one, by challenging them to find out what is there in a new and radical instrument design. I believe it is not really optimistic for a designer.

One of the problems for beginners, also you mentioned the thumb, left hand thumb. They apply so much pressure on the back of the keyboard in many cases I designed a tool which gives discomfort to the finger and you feel uncomfortable. I believe this helps to learn how to reduce the stress because the stress, as you mentioned, is not...

But that's a question of the teacher. If you have a teacher, you're not learning alone. It's natural as a teacher to me, to check what the thumb is doing there because I know that problem. The teacher is in charge in this case to make someone play in a physically senseful way. If you use your thumb's power, for me, I think that you're doing something wrong because our arm muscles are much stronger compared to our thumb. I use my arm's power and I take away my thumb. I involve my body muscles. For me, this is a question if you have a bad teacher. If you don't know where to source the energy, okay, use that tool. If you don't have the awareness, you have to learn it. If you use it in order to learn, then, it is good. I used to force myself to play with a fixed posture, I invented something like a plaster cast, in order to get the awareness. No matter how well you train and develop awareness for your body, you go on stage and you'll forget it. After some time, I didn't need that tool anymore. For those who have this thumb over-torque problem, this tool can be of good help. Many players encounter health issues with their spine and thumb. Spine problems depend on the posture, so it's not the guitar's problem, it's the player's problem. But, if a guitar would help you to sit in the correct position… Maybe it would be nice if you somehow change the guitar so that one cannot look at their fingers and this reduces the spine problem assuring a healthier posture.

Beside that finger tool, I came up with the idea to insert some advanced materials on the neck of the guitar. There are some materials called piezochromic and mechanochromic. Their colour changes if too much stress is applied. Let's say more than 10 Newtons pressure cause the material to change its colour so that's a kind of feedback to the student, especially beginners.

When I consider how many players encounter problems… Ok it's easy to say "*this is the teacher's fault*", but there are players suffering from these injuries. That would be of great help to them. I always practice with a mirror but your energy, or consciousness, go to your movements, I mean, you forget to look at the mirror. I need to recall myself in these tough moments if I'm doing something wrong. And even myself, as a professional, I can barely monitor it because when you really go into the energy of playing, you forget to check because you're busy with playing. So, those who don't have a teacher, or have a bad teacher could utilise from this tool.

What do you think about contemporary guitars? Traditional guitars and their sound quality are very different from those contemporary guitars.

For me, it is like wine, a fresh wine or a thirty year-old bordeaux. You have another richness in the sound quality. You can have a contemporary guitar with one or five perfect sounds, but for me it's difficult to change the tonal character. Those five sounds are perfect, brilliant, fantastic. But, in my opinion, those guitars don't have this kind of richness of the sound. I hear people say, and I know this is a prejudice, they say "*old guitars don't sound brilliant*". Yes, that's exactly a quality because, these instruments have a deeper voice and it's a voice with a lot of body. And it's not just about very few frequencies which make a guitar brilliant. It's also what's underneath. In the worst case, contemporary guitars might sound '*plasticky*'. They are in great demand, many players ask for it. There is this one perfect plastic sound. In master classes sometimes, I ask my students to play a note which sounds like an *A*, and then a note that sounds like an *E*, and then *U*, and so on. If you try doing this on a contemporary guitar, you will most likely get into trouble. If you want to play the same note but with another sound structure, this is something that old guitars can do easily. So the structure of which frequencies decide the tonal character, say this is an *A* or *G* or whatever, what is underneath is something you can vary more on an old guitar. It is something you have to know how to find it. But it's much more charming. However, in a large hall, when you musically need brilliant sounds, then it's the wrong guitar. Like the example of Carlo Domeniconi's *Koyunbaba*, I wouldn't play it on an old guitar because it needs to have those sounds mixing into each other. If the sound quality of each note is clear and has too much depth and character... You will likely find this mixture inappropriate and floating. These qualities of contemporary guitars really work on some repertory, therefore, it is a matter of taste. When I switch on the radio, there's someone playing classical guitar, make the test for yourself and try to decide if that's an old or a new guitar. You will find the results (laughs). For me, it was always a question because most of my concert repertory consists of old music. So it's never been the question of getting one of those contemporary guitars. And many composers have this type of guitar sound in their minds nowadays. So they will write for it. This is another question. Today they can say "*okay I have a Torres in my head, or a Hauser, or a Smallman in my head*". And they will write differently because they have another sound concept in their head. Some 30 years ago, these types of structures didn't exist and it was for guitar when they write for guitar. The only question was cedar or spruce.

I think this change came when luthiers tried to make guitars sounding like the piano, I mean they wanted to copy the characteristics of piano sound. For me, my wish would be to be able to have a cello sound, or human voice, but definitely not the piano sound. If you want to have that clean so-called piano sound, you'll be perfect with one of these contemporary guitars. They have a lot of power but maybe not such a great projection. Maybe this will be the future of the Classical guitars, players will say "*okay I want this guitar but I need amplification*". Once I compared a guitar from the 19th century with my Gioachino Giussani spruce guitar (1990) and people from the audience said "*don't get surprised but their projection power is very similar*" which I wouldn't expect from a 19th century instrument. I didn't notice, of course, but the audience sitting in that concert hall, roughly some 30 or 40 metres away from me did notice. Those old guitars may not be laud up-close, but they are able to carry the sound successfully, which explains the projection phenomenon. So, as soon as I find a new guitar that has the same projection as its power, I think I may fall in love with that instrument (laughs). When I inspect a guitar, I always try them and the first thing I check is that if it fits my playing; the second thing is what is beautiful in that instrument, that is the next step. If you have a nice little collection, then you have the luxury to have different sounds and that is being lucky. Each time you switch, you bring something back from one to another. I am not just interested in higher frequencies, but I also care much about the body of the sound, like a voice which has a body resonance, and you can hear the resonance. It is a different sound concept, and it is a rather traditional one, I know. But it works. It works in halls, I played in many different places without amplification. And this is where I see the difference and I say "*you high-tech guitar, you don't like it*". On the other hand, I see some advantages of the new ones; they can be wonderful for sound clarity and mixing of the tones they produce. Until now, I haven't fallen in love, though. So, I haven't acquired one.

Many thanks Heike

Kürşad Terci
25.12.2015

What is a "playable guitar" for you? Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

For me, playability is hearing each note of a cord correctly and clearly. Initially, it is not related to being easy or difficult. For me the important thing is to have correct tones. In fact, I like to practe on a difficult guitar, because while trying to master some things on a low quality guitar, one needs to expend more energy, and that is practise. It is like basketball players practising with heavy balls. That's why a guitar can be difficult, that's okay, but its intonation needs to be correct, that is important. Even more important than playability. The tonal balance is also important. In short, correct intonation and tonal balance are important, and so, they are two of the most important qualities of playability for me.

For instance, if you play a D major, it should sound as a D major, that is essential. When I try a guitar, I select one, and I ask a friend to play it for me in a hall while I have a seat at the audience side and listen. Because, the projection is very essential. If you are a concert artist, your criterion changes from playability to 'audibility'.
Firstly, a colourful timbre; volume should be powerful and the timbre should be rich. I mean timbral quality, bass and treble and '*dolce*' (sweet) tones. The instrument should enable me to have expressive qualities and richness. If I pluck with the left side of my nail or the right side of my nail it should respond differently; because I am playing an orchestra, this is an orchestra, not a guitar. Since it is an orchestra, the violin should sound like a violin, the fagot should sound like a fagot, and the guitar should produce all of these timbres.

Second, it should be balanced. There should be a balance between low and high registers, I mean a tonal balance. In addition, it should be able to give out the whole dynamic range from 3-pianos to 3-fortes. Explosive sounds should 'explode' in the volume. And for these ornaments and nuances, it should cost a minimum effort to the performer. Easy... I mean, left hand should be comfortable and the guitar shouldn't exhaust the player and shouldn't create tension on both left and right hands. Action height is important, because it affects your legato. A difficult guitar is like trying to run in a pair of 45 size sports shoes.

The fret work in addition to the thickness, width and contour of neck. If it is too thick, it is a problem; but if it is very thin, that's again a problem. And the front side is flat sometimes and sometimes oval. I think that in the future, they will make custom made performer-specific guitars using 3D printing technology because each performer is different. Their fingers, hand span, and even the body is different. Namely, one guitar that's easy for a performer can be very difficult for another. Scale and size of a guitar is important. Today, master luthiers have very high craftsmanship and they take anthropometric data into consideration when making guitars for specific customers. But, what they do is not really scientific. I mean they don't really measure your hand span. It is rather an approximation, whether your hands have a good stretch or not. That's like the difference between a tall guy and a tiny girl. I believe that in the future, we will have made-to-order custom made guitars, manufactured based on precise body dimensions measured with 3D scanning technology, or even made with 3D printers. And I am sure, we will be able to define the tone; you will tell your preference regarding the tonal qualities you want in the tone; sweet, deep, nasal, thick, penetrating, percussive, etc.

What are the difficulties of student guitars that can create difficulties for a performer? How do you compare these student guitars to high-end concert guitars?

I joined a masterclass with David Russel and he told me that he had a low quality guitar at the beginning. He won a competition and he acquired a better one. So, one shouldn't be worried about it, that's no big deal. And sometimes I use a silent guitar to practice because of my family life and if necessary, I use a practise guitar during my flights on the plane, when we run out of time. And I have a low quality guitar which I use for finger exercises. So any guitar can be used. But for sure, later before the concert, one week before in general, I pick my concert guitar, play on it and get myself comfortable.

How would you define virtuosity? What makes a musician a 'virtuoso'? How do you realise this heightened state of performance? And how would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Virtuosity, for me, is close related with conveying the composer's ideas and the story they wanted to tell, playing that music with the performer's identity; but as a unique person. Say as Kürşad, without degenerating the piece. When a listener hears a performance, if they are able to say "*this is Kürşad, and he is playing composer X's piece*", that means you are a virtuoso. In other words, in harmony with the music piece's period and composer, but with the signature stamp of the performer.

That is virtuosity. And also, playing an instrument as if it is very easy, so that anybody can play. Nowadays in competitions, you can see an extremely high technical level, playing almost without any mistakes, but the spiritual depth isn't there. Ten minutes later it turns into the tic-tacs of a typewriter for me and it makes me feel sleepy. For me, there are two terms: 1) guitarist, 2) musician. The goal and method have been compounded; our goal should be to make music, and not to play the guitar. I play the guitar, because I like its voice. I could have played the violin or piano. There would be no difference, because my goal is to make music, whether on the guitar or piano. Therefore, an adequate technique and high level of performance are necessary but not enough. The important thing is a harmony with the composer's ideas and putting yourself into 'their' music. Virtuosity is the combination of all these things.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Absolutely, it is possible. It is like the difference between two sopranos, one with more powerful vocal cords. Pavarotti has an exceptional throat and vocal cords, but for me more refined music is made by Domingo and Carreras. Therefore, it is possible and important, but not everything.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

It is all about preferences. The volume and sensitivity are reverse proportional in general, but this is not always the case. What I can say is that "*this particular guitar doesn't suit this piece of music*", and that's all. For instance, you shouldn't play Sergio Assad's music on the same guitar as you play Albeniz. There are more than one right in art but only one wrong, and the wrong is the one which is not right.

Thank you very much

Ertuğrul Bayraktar
30.12.2015

What do you think about the preferences of performers on their chosen concert guitars, especially to perform your music?

I think one of the serious problems is that, nowadays, guitarists care too much about comfort. High action can increase the volume a great deal. I've seen all of those double-tops and lattice guitars. My close friend, guitarist Ahmet Kanneci, is also a collector and has all of them, and he showed me their capabilities; but at the end, many performers tend to return back to traditional guitars. They produce a bigger volume and offer better projection, in my opinion. I believe a guitar should produce a high energy. Therefore, high action is crucial; performers should get comfortable with the higher setups.

Do you take into account whom you are composing for and what guitar s/he owns and plays when writing for guitar?

No, I don't. All instruments have areas of resonance, unique specifications and brighter-darker sounding parts and registers. Chosen harmonic accompaniment and voices should be selected accordingly. Otherwise, it means you can't use the instrument properly, or you don't make the most out of it. Therefore, potentials and possibilities of an instrument, areas of resonance should be organised well. For instance a well-sounding harmony (on another instrument) might not resonate well on the Classical guitar. If you know that, you can compose for any guitar. I played the Classical guitar for many years, so I have some knowledge. And, at the end I and the performer -that has always been Ahmet Kanneci so far- work on it together. If there is something that needs to be changed, I change it.

When you hear your pieces played, do you get affected by the guitar's sound qualities itself (i.e. tone, response, sustain of the instrument)?

Yes, it depends on the instrument, but first, a piece needs to be played properly. One piece can be played well even on a student guitar, but a virtuoso performer tries on different guitars, and sometimes you might prefer one guitar over another, because that guitar might be more sonorous. It's like the difference between an upright piano and a concert grand piano. Especially modern harmonies need to be heard well. The guitar has a limit in its resonance and sound potential, that's for sure.

And you believe it will remain so?

I think so; the Classical guitar is a chamber music instrument. If you play it in a venue for 2500 listeners, then you won't be heard unless you use amplification.

How would you describe musical virtuosity? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How do you realise this heightened state of performance? How does it reveal itself?

In fact, virtuosity is fairly different; it is referred to as "mastery" *(ustalık)* in Turkish. It does encompass more than virtuosity. A master is someone who has comprehended a style. But, before that, their craftsmanship should be very high. Therefore, virtuosity is a deep comprehension in a musical style, in addition to high craftsmanship, and the reflection of both in music performance. For sure, playing Mozart requires a different style from playing Scriabin. For instance, a performer who possesses the technique can play both well, thanks to their advanced technique; but virtuosity stars after that point. In other words, one needs to have overcome all types of technical issues with their skilled craftsmanship first, and then needs to execute in coherence with a piece's musical meaning and style. That's the virtuosity concept in my opinion. Unfortunately, many would argue in favour of high craftsmanship capability, agility and technical mastery, but I have to dispute. For me, the virtuosity is not only a high level of technical mastery or craftsmanship, which can be acquired by education. However, a true virtuoso adds something unique to their performance that comes from their nature and personality. That's the difference between an artist and an artisan. A virtuoso performer is a "single" artist. Why does Rubinstein play Chopin different from Samson Francois? But we like both of them for their different styles. Every virtuoso has idiosyncrasies and unique characteristics. What I mean is about the expression. The ones considered for virtuoso status are those who can express their unique character via their performances (but not those who are technically superb artisans -instead of artists). In our day, there are many artisan guitarists, pianists and even composers. But the important thing lies underneath the singularity arising from the style together with one's original nature after reaching technical mastery and craftsmanship. That is the essence of art.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

High level of performance is mastery, in my opinion. A master possesses personal secrets that come from their nature and only they know these secrets. And a master acts according to these secrets. They become artists to share their secrets. High level of performance is an execution done by those who have succeeded in communicating their secrets.

Do you think that your music could be played with less difficulty using a more playable guitar?

I don’t care. I go to a concert, if my music is played, I listen and I care for the result. The guitar's maker, type, construction style or whether it's been amplified or not aren't important for me. These are the performer's issues. Sometimes, I come across very well executed renditions and interpretations played on a humble guitar. That’s very inspiring. And sometimes there is a nice voice but not interpretation, in other words, there is no singularity.

As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument?

Every composer have to possess some instrumental knowledge. They should know the limits and possibilities of an instrument. For sure they can't play well all of the orchestral instruments, but they need to possess the knowledge concerning musical instruments and their historical development and types of resonance in music written for that instrument. That’s a composer's task.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite- tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

Contemporary ideas and search for change affect the composers' and performer's traditional ideas. That’s inevitable. But, I don’t see a difference like the difference of a classical guitar and electric guitar here. The change is very minor. That being said, I believe that anybody can realise the difference of a warm traditional guitar tone as opposed to a powerful tone of contemporary guitars. But, again, it’s the performer who turns 'voice' into 'music'. Ahmet plays my music on different guitars without telling me their makers and I choose one of them. We do this type of '*games*'. A traditional guitar's warmth affects us, in general, for sure. I also like it when he plays on a double-top. But, again, the important thing is the performer. It is them who create the sound. Some performers are able to produce a good tone with their right hand. So, it is very personal. And the projection is a fairly different phenomenon. An instrument may sound well up close, but might not carry the sound forward. Therefore, the projection capability is very important. Sometimes a violin or a guitar might be great for recording, but even the second raw can't hear in a concert venue, or vice versa. These are about the secrets of makers.

Thank you very much.

Ertuğ Korkmaz
30.12.2015

Do you write accordingly when composing for particular players? And what about their guitars? Does it make a difference in your approach to composing?

No, I don't take into account. I write for the Classical guitar, and I approach this instrument in its standardised form which finds its roots in Torres and later his successors, well known makers that you can find almost in any country. If I write music to be played on a specific custom made guitar, then I'll have to leave the format which can be played by any performer, namely it will become exclusive to certain groups or persons.

When you hear your pieces played, do you get affected by the guitar's sound qualities itself?

Am I affected? Maybe. But I don't care. I mean, it is not my purpose to write music that is more meaningful or can be played only on some certain instruments. As a composer, I shouldn't be watching out for the differences in quality of certain instruments. It is like playing some pieces on Steinway pianos only, for instance. I have a Classical guitar concept in my head, and I write according to that. The playability of different guitars might be different, for sure. Some music pieces may require a virtuosic level, while some others may not.

How would you describe musical virtuosity? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How does it reveal itself?

In general terms, virtuosity is attributed to those who possess an impeccable technique, especially in agility, by many. In fact, I'd dispute. If we want flawless performances, we can use electronic devices for that. For me, virtuosity is the ability of a performer to perform music written for that instrument at an extraordinary level. I believe that performance has a lot more than agility. Dynamics, a musically knowledgeable and historically informed approach, interpretation, colour. If any of them is neglected, then we can't talk about virtuosity, even if that performer executes with a high level of precision, in my opinion. Those performers could be considered for virtuoso status once they have all these qualities in their performance.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Virtuosity is an umbrella term, and it has some sub-terms. Technique, interpretation, all of these qualities should be well-structured in order to reach virtuosity, in contrast to today's agility-dependent understanding. Musical details are vanished by speed. If there are no details, in my opinion, there is no virtuosity.

Do you think that high level of performance can be reached always by a musician or do they have good and bad days?

Every artist prepares for each concert well. But there are factors affecting it: (1) personal skill (2) concert venue. Skill can be in virtuoso level technically, but that's not enough. Musical construct should be refined and correct. Music pieces have their flow, from the beginning up until the end. This flow should have a unity, and that unity needs to be present in performance. A virtuoso performer is someone who could realise that musical construct. The musical construct encompasses colours, dynamics, and for sure the structure. To sum up, having high level personal skill and capability, a performer could execute their task properly. Then, the second factor comes into the picture: stage and acoustics. Even though there happen to be disadvantages, for instance pianists can't carry their instruments, a competent performer is able to perform well in any condition.

Do you think that your music could be played with less difficulty using a more playable guitar?

In terms of sound production, yes. However, easy guitars do pose some constraints such as volume.

As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument?

The most important limit is its volume. In terms of polyphony, 6 voices simultaneously, that's quite a lot. I usually write 3 or 4 partiturs, and very rarely 6-voice chords in special moments.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Contemporary *guitars (double-tops, lattice guitars or composite- tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?*

I consider that to be a psychological factor. I believe it is a psychological illusion and I don't agree that. I believe, contemporary instruments don't have seriously different timbres. These contemporary luthiers follow the same -or similar- traditional roots of manufacture. What they add is new soundboard materials and sound hole shapes and sizes; but these aspects do not change the true characteristics of the traditional guitar tone and timbre. They just aim to increase the volume. And actually, I also don't think they really increase the volume. It is like a vicious circle; but for sure, makers have to work on their projects, do some research, invent something new and then offer changes, if any. But, eventually, the guitar is the guitar we know. We have a conception of the Classical guitar; those changes can't change that conception. As a composer, I tried, as if I was a luthier, to compose using different approaches for different guitars. I agree that there are differences, but I believe they are not noteworthy.

Many thanks

Turgay Erdener
11.01.2016

Do you take into account whom you are composing for and what guitar s/he owns and plays when writing for guitar?

I haven't done, so far, but, the performers I work with, or for whom I compose give their opinions. We are very old friends with Ahmet Kanneci and he encouraged, even insisted on me to compose for the Classical guitar. In fact, the classical guitar wasn't my favourite instrument, I didn't actually like the instrument, and still isn't. But, if the performer is so good, then everything changes. Very high calibre performers do encourage composers to write for that instrument. Back to your question, I never put any thinking, but performers have told and showed me how it sounded on, say, Scharpach, Hauser or Ramirez.

What differences did you notice among those guitars?

I saw differences, for sure, but what I saw was basic differences. They were rather related to musicality and volume. For me, the volume is very important, because Classical guitars do pose difficulties arising from the sound power. It gets difficult to hear them in a large concert venue. It's impossible to get a nice sound from a quiet guitar in a large hall. That's why, one needs some sort of amplification. But, I never liked it in my past experience. I write songs for singers, I write orchestral accompaniment at times, or piano or guitar accompaniment. When I write orchestral accompaniment, we need amplification for the guitar at the end. Even so, I consider not using any amplification and decide to embed the guitar sound. The microphone is the last option for me. If I had written electro-acoustic music, the microphone would have been an obligation. But I always write acoustic music. Therefore, volume is of great importance for me. In addition, I care much about comprehensiveness of musical phrases in terms of musicality.

When you hear your pieces played, do you get affected by the guitar's sound qualities itself?

I absolutely do notice, and I am affected by that particular guitar's voice. But I'm not the one who directs. I've never suggested Ahmet Kanneci to play with a specific guitar. He has always offered, showed and tried in front of me. He came up with his ideas. If I were a guitarist composer, maybe I'd have suggested. But, no, since I am not, I don’t.

Ahmet has an idea to play Bach suites on a modified Classical guitar. He changed the tuning on one of his instruments; he lowered the low E to C. So the tuning (from 6th to 1st string) is C, E, A, D, G, B. He got a very satisfactory result from that modified tuning, in my opinion. I am affected by the response and sustain. I remember my childhood, and Ahmet used to ask everything even when we were children. I remember being irritated by over sustaining voices which shouldn’t be; I mean off the tone sustaining voices and overtones, etc. But for me, this has changed in time; sometimes a long sustain is a type of embracing something. Silencing voices sometimes cause bad sounds, for example when you want to stop, the 'nail click' for instance.

How would you describe musical virtuosity? What makes them qualify for that? How do you realise this heightened state of performance?

Virtuosity is a performer's capability to be able to play anything. It is such a high degree that, they never fail to perform and execute their job. Anyhow, I don't associate it with anything like musicality. They are (musicality etc.) rather different in my mind. For me, virtuosity is being able to play anything. Therefore, it is not a stand-alone and sufficient term for making music. One needs to be a '*philosopher*', in addition. What I mean with philosophy is that placing that music somewhere related with themselves and presenting that music together with them. That’s about musicality and interpretation, in my opinion.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Technical mastery and virtuosity are both sort of identical concepts for me. High level of performance is different. Performance has two criteria: (1) performance – music piece overlap (2) reflecting one’s own musical conception –that is musicality. If both exist, we can talk about high level of performance. If one is missing, then the high level of performance doesn’t exist. For instance, this week we will have a great performer here in CSO, a Far Eastern violinist. He performs technically perfect, but is it a high level of performance? I’d say no, because it lacks musical notions. He plays mechanised, like a clock. That’s a true virtuoso, but not a high level performer.

Do you think that your music could be played with less difficulty using a more playable guitar?

I am unsure about it. It is possible if one knows the instrument very well. The Classical guitar is a different instrument. It is never taught in composition education, well, at least many conservatories don't teach it. We have instrumentation and orchestration subjects. We are educated about instruments, but guitar has never been taught to me. But after I graduated and became an academic, some students selected the classical guitar and we made some research into that subject. But, normally that doesn't happen. Guitar is very different in terms of fingerboard positions. It is very rich, but that's difficult to guess and embrace. On the piano, each chord position has one possibility. However, on the guitar, one could choose to play the same chord on many different position alternatives. Let's say one chord might be played on 5 different positions, and each of them has a different richness. This richness is unknown to many of us. But at that point, performers help us to understand, for instance Ahmet has always been there for me. He has played on different positions or strings for me to comprehend.

As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument?

Every composer has a conception in their mind. The guitar scordatura is E, A, D, G, B, E. I always have it in my mind and I try to keep that in my mind. And at the end, the work becomes closer to reality and more playable. Having sad that, it is not a very realistic thing, that a non-guitarist composer writes a piece, and everything remains untouched at the end, because, we don't know the guitar very well, due to its difficulties and possibilities. On the other hand, this is not even a question for the piano. If something I write for the piano can't be played in the end... Well, that must be a very weird thing. That never happens, but it can happen on the guitar. Also the violin, whenever a composer writes for the violin, it is (almost) never unplayable, if it is unplayable, that thing should be really strange. In short, we composers don't know very well that an elevated fingerboard makes it easier for higher registers, and actually we don't care, because it is the performer's issue. They should be in charge of it. I don't want to compose keeping their difficulties in my mind; I have my own difficulties (laughs) like being unique.

Thank you very much.

Ahmet Kanneci
11.01.2016

What does "playable guitar" offer you as a concert artist? Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

First of all, playability is the aid of an instrument that saves a performer from dealing with tiring technical issues a little bit, and lets them focus on music. One should determine those problems and eliminate them. Secondly, each person is different physically. If guitars were made to the same dimensions and proportions, there would be many problems arising from the user anthropometrics point. Fine tuning improves the playability. The type of music we play is also important. And the wood needs to be high quality, but if we use any type of microphone, then all the charm of the sound is blown away. In addition, Humidity causes lots of troubles. It is wet or dry, that makes a very big difference. Secondly, temperature affects the tuning a lot. This is a huge problem. And each string changes differently since their thicknesses and diameters are different. We have to tune the instrument during a concert sometimes. What is more, our guitars sometimes sound nice and sometimes bad. It is because of the acoustics of the concert hall. Can we compensate it?

There is no perfect guitar, but there is a '*beloved guitar*'. And I believe, when guitars start to have inferior timbre qualities, they start to have too much ornaments. The good guitars I have seen so far, were the ones with less material and less ornament. Less and higher quality. Also the material's tone is important. The top tone is important. Varnish is intended to *'insulate'* the wood from its environment. But it also mutes the tone. Nowadays, the guitar performance phenomenon is understood in a way that's equal to perfection and hygiene, but old maestros had a great feeling for tone and timbre variety. For me, art means "balancing sensuality and sensitiveness", and "analysing excitement". If one misses the balance of sensuality and sensitiveness, the artwork tends to become kitsch. In order to do that, performers have just a guitar, the remaining is about how they understand a composer's work.

What are the difficulties of student guitars and how do you compare those student guitars to high-end concert guitars?

These cheap guitars won't create good vibrations. This affects me as a performer, because we are inspired by these vibrations. I sometimes put my chin on the side of my guitar while I play to feel the vibrations. The top has vibrations, and the back should be hard, in order to reflect these vibrations as 'sound'.

How would you define virtuosity and how do you realise this heightened state of performance? And eventually how would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

I cannot define the virtuosity, but the time defines it, and who will remain as a 'true virtuoso'. If a virtuoso performer remains beloved and popular after decades or sometimes centuries, and goes beyond time, that means s/he is a true virtuoso. Persistency and permanence are the key. Only technical ability has no influence on music. You can make music without technique but without music technique is meaningless. Technique is in the music itself. High level of performance starts with discovering the true intentions of the piece's composer: *what did s/he want to give?* I always imagine myself playing to the piece's composer; if my imaginary composer likes the piece, than that is high level of performance.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Yes it is possible. A performer shouldn't fight against their instrument. The instrument should provide with effortless and convenient means so that the performer can concentrate on music. But only a good instrument isn't enough. First of all, a good composition is necessary, and then we should play it with a high quality instrument correctly and in line with the composer's ideas. A concert hall with good acoustics and good audience are also necessary. All of them are very important.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

Guitar is a chamber music instrument. It is not an instrument for large halls. Even the loudest guitar is not enough when it is played alongside a symphonic orchestra. Trying to increase its sound potential, and for doing that compromising its charm and sound qualities is a mistake. Playing with amplification in large halls is another mistake. One can talk softly, but what they say can be meaningful. If you change its nature, it becomes another instrument. And that is a preference. One may want to play on comfortable guitars. Luthiers and researchers should be on the lookout for new truths. I have Fleta (1974), Ramirez (5 different guitars 1962, 1976, 1982, another 1982, 1984), Scharpach, Contreras (the last guitar that Manuel Contreras Senior produced and one guitar from his son Pablo), Ruck, Torres, Kamacho; but I play mostly on my Hauser (1958). That was my choice and I believe the right one. There are many correct answers in art, but there is only one wrong, and that's the one which is not correct.

Many thanks for your precious contribution.

Carlo Domeniconi
13.01.2016

Do you take into account which guitar you will use for that piece of music when writing for guitar?

I might be thinking very differently from other people, my colleagues, performers and composers. The Classical guitar has already reached its top, for me, and I don't see any reasonable need for a re-evaluation, novelty and innovation. I have a guitar, and I like it as it is. Whenever I go to a symposium or concert, many luthiers come and ask me to try their guitars. I say "*look, I have a guitar and I won't acquire another one*". Anyhow, they want me to try their instruments. In short, I don't consider different guitars when writing for it, I believe this is the final result of classical guitar traditions and I am very happy with that.

When you hear your pieces played, do you get affected by the guitar's sound qualities itself?

Not really. I remember an experiment on Stradivarius violins. One Strat, one Italian violin, I cannot recall the builder's name now, but it was an old violin, probably a century old, or so; and one fibreglass violin. But the audience cannot see, they are behind a screen. The winner is the fibreglass violin, and not the Strat. Therefore, if there is someone who gets affected by the sound of one specific guitar, it might be psychological. I don't sense so many difference; they are rather minor differences and could be ignored.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Playing four simultaneous voices with really good articulation requires a great virtuosic level, for example. Many people would put the speed in the first place but I think musical articulation comes first. After that, speed is not so important. And musical articulation is impossible to measure and compare. Speed can be compared, such as 8 notes per second or 6 notes per second.

Do you think that your music could be played with less difficulty using a more playable guitar?

There are many new generation makers producing contemporary instruments using new methods and materials. As a designer you can learn from these contemporary guitars but what I care for is her voice. The last contemporary instrument I played, a Thomas Humphrey, wasn't really a great instrument, for instance. Okay, he elevated the fretboard to allow easier access to higher registers but the guitar's voice and tonal beauty was really affected by the change he suggested. Great instruments are generally the ones that are not very playable; this applies to the violin, as well.

As a composer, how do you understand-recognise the limits of the Classical guitar? How do you take its limits into account when composing music for this instrument?

It is the composer who makes an instrument more playable. The composer should keep the limits in mind. For instance Heitor Villa-Lobos preludes. This legendary musician often played on three-year old strings, which were worn, almost flat. And his guitar had a very low action. In his case, playing, say his famous 12 etudes, wouldn't pose much difficulty. But a concert guitar today creates so much friction sound during the performance of this music. This means that sometimes playability is something to do with the composer.

Traditional instruments are known for their expressive qualities, unlike contemporary guitars that are powerful, but allegedly less warm. How does it affect the art of performance?

These contemporary makers can strive to support technical aspects, and yes, maybe they became succesfull in doing so. But for me, the most important quality is her voice. The most beautiful guitars I have seen were some old guitars from the first half of the past century. Actually, I am not a guitarist. I am a composer and I play the guitar, that's all. Therefore, I am not on the lookout for novelty in guitar making.

In fact, guitar is a simple instrument. I had a guitar, an old one, from the 70s. I paid 35 Euros for it. The luthier wasn't a special, well-known maker. Maybe he was a student or an inexperienced maker. That's why I say "*it is a simple instrument*". I also don't think that good quality wood is crucial. You need good proportions and luck for a good guitar. Luthiers can't create guitars of some standard quality. Some of their guitars are good and some of them are not. They even don't know why. I believe, the contemporary luthiers might come up with new and novel ideas. Mankind never finishes with thinking and inventing. But the guitar has completed its evolution; there is no need to try to improve it.

Manuel Rodríguez showed me his special models back in 1985. He showed me in his workshop in Madrid. He said "*they are giving special vitamins, they are trying to create a 'perfect' instrument, but that's very superficial, I don't like it*". Many luthiers have been trying new ideas and they have caused a lot of changes in guitar making methods since the 60s or 70s. Some of us like them and some of us don't. I personally don't like. That being said, for sure the guitar could be improved, somehow, one day. But the real problem is somewhere else. It is the concert hall; venue for the guitar and the listener of the guitar. Guitar audience has never been as few as this in long time. Redesigning the Classical guitar and increasing its potential means nothing. Guitar audience is young, has low culture and little knowledge. And it is getting worse. Performers play in worse and worse venues day by day. Today Classical guitarists can't play in full venues of 1.000 listeners, except some star virtuosi such as Paco de Lucia. Not even 700 or 800 listeners attend guitar concerts today. So, making a more powerful guitar is somewhat meaningless. Please excuse my frankness, but this is my point of view.

Thank you very much. For me it is important to see different perspectives.

Ceyhun Şaklar
15.01.2016

What does "a playable guitar" mean to you?

I think the most important factor is the comfort of both left and right hands. I believe that the feeling of discomfort could be given to the left hand by the thickness of the neck and the neck contour. If the contour has a big bump on the back of it, the guitar tends to be less easy to play. Secondly, the action height can make a guitar playable and less playable. Generally, guitars of less power and volume are intended to be fitted with a higher bridge and saddle in order to increase its volume capacity; but for sure it poses some difficulties to the left hand. On the contrary, if the action height is very low, than the strings start to chatter. In other words, the action height has to be small enough, but not too close to the fretboard in order to have a decent volume. Right hand discomfort can be related to: (1) low volume and (2) low timbre quality and brightness an instrument. These two factors, volume and timbre quality, require a performer to apply a greater force with the right hand.

What does a playable guitar offer you as a concert artist? What aspects make it more playable and what do you expect from that guitar? What are the difficulties of student guitars (medium level quality) that can create difficulties for the performer? How do you compare medium quality student guitars to high-end concert guitars?

Since the volume is of great importance for concert artists, sometimes they choose a guitar that's not very playable but offers a bigger volume. For sure, that less-playability has to be at a reasonable level. Mid-level and beginner guitars pose less difficulty for performers. They have comfortable fretboards generally (provided that they are not very low quality instruments). Ironically, they pose no difficulty for the right hand, because no matter how hard you try, it is impossible to reach a high level of performance regarding both volume and timbre quality. Therefore, the performer doesn't even dare to force. To sum up, a concert guitar is mandatory for a concert artist. Mid-level or beginner guitars would be inadequate for a concert artist because they don't have enough volume and timbre quality even though they are comfortable.

Do you take into account whom you are composing for and what guitar s/he owns and plays when writing for guitar?

Personally, I've never worried about that. For me, a good guitar (in its general meaning) and a good player is enough to perform my music.

How would you describe the virtuosity on guitar?

Firstly, left hand techniques (hammer-on / pull-off, barre, etc.) and right hand techniques (attack, tone, etc.) need to be accomplished. In other words, having strong technical skills on both hands is necessary. But, everything starts there, actually. What they can do musically using that technical skill is the thing that matters. Understanding the form, theory and harmonic structure of music, phrasing, quality of expression of stylistic character, establishment of personal style and interpretation are important qualities of a virtuosic performance.

How would you compare (a) virtuosity (b) technical mastery and (c) high level of performance?

Technical mastery is the technical skill of a performer over their left and right hands. But virtuosity is what starts after the technical skill, as I explained earlier. High level of performance is the execution of all of these concepts that were explained above, in a performance at the greatest degree with an unrivalled brilliance.

Do you think that your music could be played with less difficulty using a more playable guitar?

Absolutely. If a guitar is playable, then the performance requires less effort, and therefore, it will be easier to reach a high level. But, for sure, the guitar needs to have a certain timbre quality and volume capacity.

As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument?

Guitar is a polyphonic instrument, but unlike the piano it has many constraints. Therefore, one has to acquire a similar tension-ambiance that they acquire from the piano with much less volume. That’s why composing and performing for and on the classical guitar have many challenges. Shorter sustain is another challenge. Composing for guitar means “*creating a big work with few notes*” and “*overcoming the constraint of short-sustaining notes with many methods and dynamics of performance art*”.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite- tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

I think this is closely related with a performer's chosen repertory and preferences, as well as musical style and periods they usually prefer to perform. I believe that the Classic and Romantic period music sounds beautiful on traditionally made guitars. And I believe that contemporary guitars suit very well the contemporary music and baroque music; these guitars give beautiful expressive qualities when they are used in the above mentioned music styles. So, I believe this is not very important. If a performer has developed a decent right hand technique to create a nice timbre and tone, they can get a so-called 'charming quality' from contemporary guitars, as well.

Thanks a lot.

Theo Scharpach
21.01.2016

Please could you explain the carbon use in your guitar construction?

I went away from it completely. But at that time, it was completely experimental. We were doing experiments in different ways. I discussed them with Ahmet Kanneci, he has one of the first models that were designed together with him. That one came out really good, I mean even better than some I built later on, to be honest. So his guitar is really exceptional. I used a special carbon, I have it made in Germany especially for me. So it is not something you can buy, it was very expensive because it was custom made for me. The problem with the carbon is that you have a high modeller and low modeller. The high modeller is used by NASA and for aircrafts, they are lightweight and have high-quality structures, but the price difference between the low modeller and high modeller is more than 300-400%, but it looks the same, you can't see any differences. But you know, it's different, because the stiffness of course and the stiffness to mass ratio is completely different. At that time, I used some of that special carbon for special parts, but I quit doing that completely, I think probably I gave up doing that about 10 years ago. You can often hear the, well, it depends on how much carbon you use in a guitar, if it's fairly less, then you can't hear it. But most of the time you can hear people using carbon in a guitar, because there's some kind of tone, which is always the same which you can't change which is there and it is the tone of the carbon. It has a tone but it is always the same. It has a sound, but at the same time it is dead. It is a very strange phenomenon. And at the same time, there are a lot of players which like this new kind of guitars which I think is a little bit weird. Because, maybe you know the phenomenon, if a guitar has a very strong midrange sound, a nasal midrange sound, our ears perceive it as if it is louder. Objectively, it is not, but it is subjectively. So, we think it is louder. But the interesting thing is, and I noticed this many times when I go to concerts of Roberto Aussel, he plays a Daniel Friedrich guitar as you may know, I've been working quite some time now with Roberto Aussel, I think 6 or 7 years, I showed him my guitars, got feedback, and now he is playing one of mine for testing, hopefully he will change his Friedrich for one of my guitars, he mostly plays on his Friedrich and interestingly he doesn’t play loud. The interesting thing is he touches very soft, and then he uses very rich dynamics in his performances. And he doesn't have any problems with the sound, because it is loud enough. And the other problem, I always hear when people play these contemporary guitars, I get bored after ten or fifteen minutes. It is always that loud sound, which is very boring.

The strange thing about those contemporary guitars is that you cannot play soft on them. It is always the same tone, even if you hit the string very delicately, it is still almost the same volume. And, for sure there are some contemporary guitars that don't have much carbon, but most of the lattice braced guitars have double-glued tops and probably a very thin layer carbon between to get some more strength and make them more rigid. These tricks create high volume, but if one wants to have volume, then they should play the Banjo, it is louder than the guitar and it explains how a guitar top creates volume. Banjo is loud, but it sounds ugly (laughs). If you try to create some colour in your voice, it is impossible. Because, the bridge is glued on some very thin skin. And that skin has only one colour. Anything you try doesn't change that colour. That's almost comparable to very thin tops, you need some kind of wood to get that colour. If you look at the older guitars, they weren't manufactured with such exceptionally thin tops. I mean, Frederich sometimes makes 2,5 or 2,7 mms. a lot of older guitars around 2,5 mms. and a lot of those contemporary guitars have 1,6 or 1,7 mms. thickness. The thinner top gets the more difficult it is to get colours from that instrument.

We need to ask ourselves "*Do we want to hear the classical guitar in concert venue where there are a thousand listeners?*" I wouldn't want that. It doesn't make sense. I mean three hundred people in a good venue is okay. If we go back to that, but we don't go back, because it is hard to go back. But, I believe, at that point a person who had never heard a Classical guitar prior to that day, s/he would go in that area where the guitar sounded beautiful. They would become guitar lovers. But now, if a classical music lover hears the Classical guitar, it is awful, it is ugly. And the way those performers following, it is so wrong.

You explained your carbon usage, how did you work that carbon material when manufacturing your guitars?

I tried and did several things to reinforce the bracing. There are many ways to do that, I think I tried all of them. I mean, you can reinforce it by putting to laminate, you know, wood-carbon laminate and make them a web. You can put the carbon inside the cross to make the cross stronger, you can make a copy of your bracing, make that in carbon and glue the carbon on top of it. I did all this kind of stuff.

There is a paper by Franz Jahnel about developing guitars under repeatable situations especially for the industry. Notice the title, it is especially for the industry. What he claimed and found in his research is that when you glue two very thin tops together, the repeatable quality gets more correct, and achieving the same quality gets easier, because of gluing two different wood sheets. It is the same, if you have one type of wood, you have to select similar type of woods to get a similar type of tone. The minute, however, if you laminate them, make both of the tops and glue together, first of all the risk of cracks are minimalised, which is very important for the industry, but apart from that the sound quality of that instrument is most likely be more repeatable. The reason to that is the process of gluing two tops takes out the original and unique characteristics of each wood and leaves their average characteristics. That's, in fact, the double-top phenomenon. A lot of people think that double-top is something very exciting but I think it is a much industrialised process which I don't like very much. Due to a similar reason introduced by that German researcher Franz Jahnel based on his work, double-top actually kills the original and unique sound of the wood. It is just a cheap laminated pair of tops. It is no joke, that's true (laughs). You can create volume, and that's the only think you can do with it.

Now I use lattice bracing myself, but it is a completely different web than a standard lattice bracing. Again, the standard lattice bracing is boring, in my opinion. It is the same thing again. It is easier to get a mellow, beautiful Spanish tone, classical traditional tone with standard fan bracing, but it is also possible to work toward that sound, it will never be the same, though, but we use a kind of lattice bracing at the moment, but it is much more than that. The way we build is a little bit secret now, because no one is doing it. I work together with Menno Bos for quite more than 25 years now as my colleague guitar maker, we are quite open about a lot of things that we are doing, but this kind of bracing, we keep it for ourselves, because it is quite unique and we have spent so much time to develop it. It took us 5 to 7 or 8 years to get a result we are happy with, and this is also the moment where we multi-show that guitar to great players. At the beginning, we just worked with students but now we are on some certain kind of level that you know it is really extremely high quality.

What does playability mean to you? What are the product qualities of a classical guitar that promises improved playability?

It is a very important and difficult question. Have you ever experienced the phenomenon of two 65 cm. scaled guitars whose strings have completely different tensions even with the same strings.

Yes I've experienced that.

The interesting thing is, good guitars have a comparatively higher tension on that scale. That would feel very strong. The same strings, tuning and everything, both guitars 65 cm., but still, on one guitar, the strings feel stronger, and on the other one it feels weaker. By the way, not only nylon strung guitars, also steel string guitars, that's the same thing. If you have a good steel string guitar, you feel the body, the power of the strings. I am not a scientist, but my idea behind that is that the whole guitar is in a balance; the tension of the top, the thickness of the top, the tension of the back, the tension of the sides, the tension of the neck; everything is in balance. So the guitar doesn't lose energy in some areas. The whole guitar is balancing to create that sound. And I think that creating a good guitar necessitates creating that experience as a guitar maker. I can't say it is made by a certain thickness of the top or so, it is the whole complete items that make it a great guitar or a bad one. And when it is a good guitar, the string tension feels strong, you can feel the energy. It shouldn't be week, unclear and undefined. That good tension is very important for playability. The other thing is the fingerboard. A company called Plek created a machine to work on fingerboards in a very scientific way. Every string has a different vibration. So the first string has a completely different vibration from the sixth string. Then the neck has a curve to follow the vibration of strings. It is a very complex way to do it, fingerboard work takes 2 days. We have a very slightly rounded fingerboard. And to the basses it makes a turn going down, because I want almost the same string height on the first string as on the sixth string. So, if I have a 3 mms. action height on the first string, then my bass may not be more than 4 mms. Because, otherwise, the sixth string height on the bridge would be twice as high that of the first string. And my bass string already has more energy than the first string. I'll have the height on the bridge only 1 or 1,5 mm. more than that on the first string. So I have to work on the fretboard, that's something a lot of Spanish makers do, as well. You can see that the fingerboard on the bass side drops off a little bit. What the company Plek did is that they really studied the vibrations of strings and they've done a lot of research on that. What they do is, once your guitar is finished, you put strings on it. Then the maker expects the neck to get the perfect curve with time. But maybe not, it may move in a way you didn't expect, there may be slight differences. The Plek Company put the guitar in their sensor systems with a simulated string force, and measure the fingerboard for all the inaccuracies, then take off the string simulator and measure again and they correct the whole process on the frets. They can do this with an accuracy of 100 %. One cannot do that by hand. Doing it by hand, we just use files and abrasive papers, we make the frets flat first, and then round again, as accurate as possible. The Plek machine always keeps the perfect curve of frets. With high quality fingerboard and high quality fretwork, the playability of a guitar gets better. For sure, it is two components: the guitar and the fingerboard work accordingly to string amplitudes. If you have a bad guitar, whatever you do will increase the quality just a little bit, but a good guitar and well-done fretwork is crucial.

What is it that makes the act of performance less difficult on an easy-to-play guitar? Do you think that the playability is an asset that deserves all the effort made through the guitar manufacture?

Regarding the action height, it is not really possible to make one general action height. You have to see the player becoming the owner of the instrument. The way performers hit the strings with their right hand will change the string amplitudes. Will it go sideward or downwards, or oval or so. There are some players; I met two in my workshop. They surprisingly play on very low setups. One of them is Daniel Casares, he has full control of his right hand and he plays without a single buzz even though his guitar has a very low action height. Low action can buzz a lot if a performer doesn't have a great control over their right hand. So, it has something to do with the player's technique. Daniel Casares shocked me in his concert; he really hits the strings sideward with a low energy. So the string goes a long time sideward before the vibration stops. That's why it doesn't buzz. Therefore, there isn't a general setup for every guitar. A lot of players use carbon strings these days, and carbon strings and nano-strings can allow for a lower action height. But, you know they have different timbre characteristics and I don't like carbon strings especially for recordings.

What do you think about the fretboard angle in relation to the top of the guitar?

Well, yes interesting, in fact we didn't invent it, it was always there. Humphrey claimed that he invented it but, arch-top guitars have long had it. He is the first one who used it on a classical guitar. It is nothing new; a lot of things we use aren't new. You can play with that angle, because what happens is that the string tension on the top will be different. But then again the angle itself doesn't mean anything. I mean, you can make that angle, you can make the perfect instrument, but it is always in relation to your top thickness, the bracing used; it is the whole instrument. Because playing with this angle (elevated fingerboard), the string tension will be lower, if not elevated, then the string tension will be higher. Then again, this is compensated by the top thickness. Likewise, people think 660 mm. guitars are louder, for me it is nonsense. I can construct 650 mm. scaled guitars which is as loud as 660 mm. guitars because, I need to compensate the thickness of my top. It is a balance, you should try to make everything as thin as possible but strong enough to resist the string tension over 20-25 years. That's another problem the with double-top construction. An extremely thin guitar is expected to get tired very quickly. Then, the glow of the instrument, even when it is there already, vanishes very quickly. A good guitar, which has a slightly ticker top and it is in balance in many ways, will improve in years to come. Maybe the first year that guitar won't sound that spectacular, but maybe a year after or two, it will really grow. So, yes when we are talking about the angle of the fretboard in relation to the top, it has something to do with the playability because it allows easier reach to the higher registers, but in my opinion what is more important is the angle of the strings in regard the top which gives less string tension and needs to be compensated by the building quality of the instrument.

Anything about the fret relief?

I think a lot of people are afraid of using high relief frets, I believe they shouldn't be so. I can say that they are scared because they think that a player would have to press too far when the fret is high. Try it and you will see, you can never touch the fretboard even if you try really hard. If you use higher frets, you will have much more possibilities with the right hand.

What sort of possibilities?

If you listen to Roberto Aussel, he does some fabulous left hand ornaments and effects. Also Philip Catherine has a similar left hand approach. You can use your left hand to dwell upon. If you hit the string and then you just by moving, with your left hand vibrations, you can create a tone that is lasting and growing, but it is very difficult. Roberto Aussel always uses this technique. Actually, he criticised one of my earlier guitars saying it wouldn't allow left hand vibrations. So I needed to change things so that he could do it. You can't do that with a low fret relief.

What do you think about the headstock angle in relation to the fretboard?

I do a lot of secrets but they aren't really secrets. People think it changes the tension. For sure, it shouldn't be flat or too steep, but I don't think it really changes so much. As a standard, it is around 40 degrees, or so. This is my opinion, other luthiers may disagree, it just balances the tension, and doesn't really have a big effect.

Flamenco guitars have a different angle, though, especially if they are fitted with wooden pegs.

What type of difficulties can a mid-quality instrument cause?

Most of them suffer from good fretwork and string setup. Most of those average guitars are mass-produced, quickly made. String setup and fretwork take a relatively long time in guitar manufacturing process. We see that average instruments have a fairly bad string setup. If you improve these features, then the guitar improves a lot.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

For sure, no doubt. For instance, we sold a guitar to a student who had his masters exam. He had played on another instrument for several years then. His teacher complained that he couldn’t play a particular part in a way that the teacher would appreciate. And he is a very skilled student technically. He took my guitar, problem solved. He played with that guitar in the exam. It means that sometimes an instrument can hold the development of a player, for sure. But this doesn’t mean that one needs an expensive guitar to be a good player, that’s something else.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

I met with John Williams 2-3 years ago in Eindhoven. He played his Smallman, and later on he showed me his guitar, how colourful that guitar was. But I disagree. John and Greg are very close friends, and I respect John very much. But the strange thing is that, I've had a similar experience with a Dutch female guitarist, once she said big stories about how much she cared for timbral colours and dynamics, but they weren’t there in her playing. Being a high quality musician, how can they say so? John Williams is a legendary musician, how come he doesn't hear this? He is John Williams, whatever you consider him to be; he is one of the exceptional great performers of all times.

Yes, he is totally exceptional.

You should learn this kind of playing. You're a professional player, not an amateur. I'd understand an amateur who plays at home in the living room, not for the audience, s/he wants to enjoy what's happening here. But a professional, giving concerts, should be able to enjoy an instrument that projects the sound well but also that is delicate that s/he feels when s/he hits the string like this way (showing a perpendicular right hand action angle in relation to the strings), the sound goes like this, and s/he hits that way (showing a rather parallel right hand action angle in relation to the strings), the sound goes like that, or s/he has a guitar that can't do that no matter how s/he hits the strings. That's a professional development as a concert player, that's intuition, even I know that.

For me the biggest failure is the holes on the sides of the guitar, that's a big mistake. A lot of builders do that, and classical guitar makers didn't invent it; that is coming from the archtop guitar, then classical guitar constructors copied that, it is quite irrational. The rationale behind the sound and its travel is quite simple, sound can't travel in every direction.

Yesterday it was in my mind, when you open a hole on the side of the guitar, then how come it is supposed to travel forward. It has to lose some of its projection capability.

For sure. To give an example, Ahmet Kanneci has that two soundhole guitar which I made years ago. It is a very interesting phenomenon, these soundholes do not have this form just by some incident, there is a reason why they are different and asymmetrical. One friend of mine helped me measure the necessary size of those holes by miking the room at different positions to see how these two holes have a negative and positive influence on each other. So, the shape of that sound hole is very important. And interesting enough, double-soundhole guitars tend to be difficult to record. Human ear can hear the sound in ambience along with echoes and ambience sounds, but when you put the microphones close, then you have to deal with a gap between the sound holes. So, it is really difficult to get the whole image of the guitar's voice in a good recording. But these sound holes have a positive influence to push the sound forward. Soundholes on the sides is like designing a speaker with holes on the sideways, whereas the speaker should be facing towards the audience.

Since you don't open a traditional hole, you open two instead, but you place them where the top doesn't have too much vibrations. So you gain a lot of space. Therefore, you should have more body in the voice.

My first idea was to gain space to create more sound, but it is not that spectacular. The good thing is that I can use 27 frets without any problem on that guitar. On a normal round hole guitar you wouldn't be able to do that. It requires a lot of construction. These guitars are very powerful in general. A lot of players like them. We have a collector here in Holland, he bought a double sound hole guitar from Nadja Kossinskaja, then he ordered one with a round sound hole, he wanted to have one. Now he wants another double sound hole especially made for him. For players, it is a very nice sensation to have two sound holes. It feels very powerful.

Thank you very much.

Kağan Korad
16.03.2016

Can you please describe what "playability" means to you? What do you expect from such a guitar?

Probably, it's safe to call them "player friendly", which consists of easy action, not only related to the quality of frets on what we press or the action height, but also the thickness and the shape or maybe I should say the contour of the neck -that can be oval or slightly rectangular, not symmetrical often. There are standards but this doesn't mean that standards point to the best option available. Usually performers have different preferences and needs, such as their hand span, left hand thumb position. Due to anthropometric variability, one particular instrument may fit a performer, and another particular instrument can make things easier, as well, for another performer. The same principle also applies to tension.

Do you think that it is possible to boost musical expression with a high quality guitar?

Maybe, because I have the need for volume, I mean, I benefit from 'high volume' as a part of musical expressions such as dynamics. Therefore, a very easy and 'player friendly' guitar would chatter on stage, or even breaks.

As far as I know, it happened once?

Yes, I also broke a guitar on stage (laughs). So, to select a guitar, I'd wish to have a playable and comfortable guitar, too, like others. But I have to bear in mind that there are other important factors such as volume, dynamics and colour. A milder guitarist, who plays mellower than me, may feel more comfortable with a 'player friendly' guitar, so may prefer a more *playable* guitar. That's why, the question "*How would you define a playable guitar*?" should be answered with special regard to a performer's technique and attitude. Nevertheless, correct intonation, depressible action height, clear separation and balance are crucial for playability. In addition, apart from those mentioned above, depending on a musician's taste and personal expectations, playability may mean more, like I mentioned earlier. As a concert performer, I think the volume is important, not for filling the whole venue but for supplying me with a sonic space where I'd be able to perform dynamics from triple piano to triple forte. Eventually, if the ceiling is 2 metres high, the space I can jump is very limited, whereas I can jump as much as I want provided that the ceiling has 4 metres of height. The volume gives me that ability, as well as having multi-fortes, a playable instrument, for me, should also have multi-pianos. Some instruments can't perform piano; even with a soft touch they produce forte sounds.

Is it possible to categorise them, i.e. double-top guitars?

By their nature, double-top guitars generally sound sort of aggressive, but I have seen some double-top guitars that respond to soft and strong attacks well. However, some traditional guitars might have that disadvantage of inability to produce piano tones, as well as many double-tops. Eventually, the nuance and colour palette should be wide, and the guitar should be able to respond to my needs.

What are the difficulties of mid-level guitars that can create problems for a performer? How do you compare these student guitars to high-end concert guitars?

Intonation and a decent action height are crucial. Tonal balance of high and low registers is another basic need, so that listeners can hear both low and high parties. Bass tones should not overpower the higher partials, or vice versa. Obviously, one should not have great expectations from study guitars, as they don't usually possess a deep tone and expressive beauty. I think what is important is that there is a transition from beginner guitars to concert instruments. That intermediate level is very important (usually at a price range of 700 $ and 2500 $). Sometimes, whether they are concert guitars or study guitars gets a little bit compounded. I mean, you might be paying much more than you should, because sometimes these guitars have a handsome 'make up' and it becomes hard to differentiate. That is a dangerous range.

Student guitars might pose issues related with the action height, and it's fairly simple to get rid of it by filing or replacing the saddle bone. So, the height can be adjusted, or we can get it adjusted for us by a luthier. Very high action is not easy or comfortable. And sometimes fret buzz could be fixed by replacing the saddle bone with a 1 or 2 millimetres higher one. However, in my opinion, these issues are not substantial problems, but I think a promising student should change their instrument when they start joining in competitions. High-end instruments are often advantageous, because juries listen to the 'tone' eventually. After a contender playing on a high-end instrument, chances for the next contender to beat the previous player with an average quality guitar is not too many.

How would you define virtuosity? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance? How do you realise this heightened state of performance? How does it reveal itself?

To me, a virtuoso performer is the one who can express at the highest level possible. On the other hand, many people may think that a virtuoso performer is someone who can play at 200 bpm speed or very challenging pieces with incredible technical dexterity. Okay, that is one part of the virtuosity concept; a virtuoso performer is expected to have dexterous hands and fingers. However, I believe that a virtuoso performer should be virtuoso in making music, not only in playing the Classical guitar. In other words, they should be able to realise what is required by a particular music piece. A virtuoso performer should be able to express their musical ideas to the audience. To me, it means more than an obedience to scores. The 20th century witnessed grand maestros who did not play only notes marked in the musical notation, but they put their musical identity in their performance. Executing each note in an engineer manner, that is to say, precise but without musical identity, is not of great value to me. A true virtuoso is expected to be capable of playing any piece of repertory and they should be able to play at very high levels technically and musically. In other words, technically unprecedented but musically unstimulating virtuosity never exists. Furthermore, virtuosity actually depends on who is listening and judging the performer. Listeners should be qualified enough to put the virtuosity stamp. It is quite subjective, and it depends on how much you know. Virtuosity is more of a broader area, like a title, and there are some subtitles below, such as (a) musical expression and (b) technical dexterity; a + b makes up for virtuosity. If any of them is missing, then we cannot talk about virtuosity. High level of performance is actually different, I wouldn't consider it among these two (a and b). Some grand maestros cannot play at the same technical and artistic level in each concert. They may mess up in some concerts. That's why virtuosity is not a stable and standard line. However, that doesn't mean 2 successful concerts out of 5 (laughs). A number of performers have risen to fame for playing flawless and impeccable, but a few of them became legendary for not making a single mistake in numerous concerts, as a characteristic of their performative skills. Therefore, I think that virtuosity and high level of performance are not usually directly proportional. For me, a performer who has full control over the program of music and is able to perform dexterously and express their musical ideas can qualify the virtuoso status. They can accomplish and show this ability often, not necessarily always.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Actually I'll propose an analogy: while driving a good quality car, I may want to feel the acceleration and I need stop as safe as possible when the brakes are pressed. Just like that, a high-end instrument supports us. It enables us to perform and realise our musical aims more easily. Or just the opposite, a low quality guitar can jeopardise our performance. The same applies to the sound quality. If you have a well sounding guitar, it creates an advantage personally and listener wise. For instance, in competitions, very often jury members listen to so many performers from 9 am to 7 pm. At the end, they get exhausted. At that very moment, if one plays on a well sounding instrument with a good tone, that immediately makes a difference. That subtle quality poses a great advantage. Voice of an instrument is so important. Music is equal to voice and sound. Painting cannot exist without vision; likewise, music cannot exist without the voice.

What do you think about contemporary instruments as opposed to traditional guitars? How does this change affect the art of performance?

Some players appreciate them, some criticise; it is all about personal taste. Just like different cuisines. In regard to sound, several things, such as your character, how you play or what you seek for, come into the picture. And, actually, whether the listener can hear or not, isn't the primary concern for me. I've never selected a guitar depending on that. I select an instrument according to my taste, because that instrument will be my voice eventually. Then the listener will listen to that voice. So, that is not a mutual acceptance; it is rather a single sided acceptance. I select, and the public will listen to me; if indeed they like and wish to. Apart from that, it is a reality that contemporary makers place emphasis on the volume, because concert halls are larger nowadays, whereas, Classical guitar concerts used to be held in relatively smaller venues. Nowadays, guitarists frequently perform with orchestras in larger venues. In addition, performers are passionate about playing without amplification in concerts, so they don't want to use microphones. That's why, they seek for powerful guitars. This situation has created a deviation from the norms of traditionally lyrical and charming Classical guitar. Contemporary guitars sound harsh and aggressive. So, different guitarists prefer to follow different paths. Some of them give importance to being audible and choose contemporary guitars with a bigger volume and an aggressive sound, and some guitarists care for musical sensitivity.

Personally, for me, the important thing is nuances and the timbre palette and richness of tonal colours of a guitar. Volume is important, but not in the sense of filling a concert hall. I mean, the instrument should be able to respond to triple pianos as well as it can respond to triple fortes. For me, the volume is important in that sense. But filling a large concert hall is not so important, because I have to use amplification. I use a system which I believe can truly project my guitar's sound.

Many thanks

Soner Egesel
16.03.2016

What does a "playable guitar" mean to you and what does a playable guitar offer you as a concert artist?

To describe playable guitars, for sure we should talk about ease and a low action height, but that unfortunately doesn't interest us, because we need some tension. Especially on concert guitars.

Do you think that it is possible to boost the superiority in performance with a high quality guitar?

For many years we complained about difficult guitars, such as high action, but eventually, at the age of 28 or 30 we all acquired a sort of guitar which we had criticised and complained before. Because that is an obligation. You, as a guitarist, have to press, even though the action is high, just like a cello player has to press, as well. Flamenco guitars are usually easier, due to some reason. My guitar is quite easy, but if you measure you might think that it wouldn't be so easy. That means Theo Scharpach (his cedar-spruce double top guitar's builder) has some tricks to make it more playable; something that he knows as a craftsperson. Seemingly, concert guitars are getting more and more playable these days. They are not exactly like their 'ancestor'.

Which sides make them easier?

The neck contour is very important. Oval or rounded. What our thumb feels is very important. If a maker can solve this issue, then it means they had solved many other issues. Another issue is the intonation, tones and all registers should be harmonious. Climatic conditions can be critical, but the performer has to be aware and should be careful. For concerts, psychology is very important. I should fall in love. It is like a sweetheart. If you love, you wouldn't care whether it is easy, high, low etc. I do wish I'd be able to have an easy and "lovely" guitar (laughs).

What are the difficulties of student guitars that can create difficulties for a performer?

The problem here is that very good students usually achieve a very rapid growth, and they need better guitars. This happens gradually. As they improve their technical skills, they acquire better guitars and probably they buy and sell guitars every 6 months up to maybe 7 or 8 times. We have all lived through and witnessed that. One guitar can be said to have become insufficient when it is not capable of reflecting musical ideas of a learner. I mean, whenever musical ideas, dynamics and ornaments that a learner tries to realise and master nights after nights, start to sound null and become inaudible, it means, that particular guitar is not enough anymore, that student has gone beyond the ability of that guitar. They should change their guitar, but it is not easy for families due to economic reasons. Therefore, I believe that families should buy a average-high quality guitar at the very beginning and teach their children how to take good care of that instrument. Later on, unfortunately they have to pay large sums of money for concert guitars. Otherwise, it is not possible to get the results we are seeking for. Sometimes I ask my students to play restroke, so the guitar should produce a super nice sound, but it doesn't. I pick that guitar to try, and it doesn't. Then, I come to understand that it is not capable any more, not at that level. It reminds me of luthiers; they should be supported. They are parts of a living organism and without them, Classical guitar traditions doesn't blossom. We, as performers, owe them a great deal in that sense.

How do you compare these student guitars to high-end concert guitars?

Mid-quality guitars can be tiring for two reasons. First, since they pose difficulties, we physically feel them to be tiring. Secondly, they can be tiring since they cannot give what a student, who has learnt how to hear, wants to get from that instrument. Apart from tiredness, it can cause psychological issues. If and when a student prepare their nails and practice all the things they learnt from their teacher, but at the end is not able to obtain a good tone from the guitar, that may be devastating.

How would you define virtuosity and compare (a) virtuosity (b) technical mastery (c) and high level of performance? How do you realise this heightened state of performance? How does it reveal itself?

My ideas have changed a lot for the last 7-8 years. Guitar show business in the world has changed a lot, as well. Those who play very fast scales without any single mistake, flawlessly, they are in great demand, unfortunately. Well, having said 'unfortunately', I don't mean to reject them. They are great; but the thing is why do we do it, or what do we do? I can play really fast scales, but I didn't play them in any serious concert. They never helped me. In other words, if our aim is to make music, one average music piece is 4 or 5 minutes, consisting of 3 pages of musical scores, you have to devote your life so that it becomes "yours", and you as a performer contribute to that, and do what the composer tells you to do, and stay away from exaggerated things. This is my obsession. If we play only fast scales all the time, it gets very boring. I mean, unfortunately, the generation that used to hug their guitars has become extinct. But, it seems it is coming back again. A virtuoso player is someone who can spellbind you. Not only musically educated people, they should be able to convey their magic to anyone. They should be able to teach something, even in a couple minutes. A virtuoso performer should be able to show them how much s/he cares their job. That's a true virtuoso. Otherwise, on the Internet one can find eleven million players who can play at an extreme speed flawlessly. Technical mastery can be applied to everything, from carpentry to painting. How to barre and how to decide on fingering is about a player's technique. Guitar is a difficult instrument. Buzzes and clicks are okay, do they harm a high level of performance? The total of the concert will define it. If you're down psychologically and make friction noises etc., then at the end, it is bad. However, if you play with full emotions and make clicks etc, they are not a problem. Especially, once you return home and try to remember what you've done, and pick the guitar and try to improve, I'd call it true virtuosity.

Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar?

Absolutely. Because it helps you to realise what you wish to do. It makes your work easier; it gives you what you want easily. For sure, a good guitar is necessary for aspiring learners or guitarists.

There is some argument that contemporary guitars (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

This is a bit complicated, because, after playing a Dammann you can't get over yourself (from the pleasure) for about fifteen minutes (laughs). The same after Scharpach, or Hauser, or Fleta. My guitar has got one of the nicest imaginable voices I can think of, but it is worth multi-thousand Euros. A guitar that I can't/don't get a grip is worth a lot more due to owing to or being made by someone famous, for instance. I am absolutely certain that it is not any better than mine. But, the attachment of a performer to that guitar, say Hauser, means a lot, psychologically. When I walk on stage with a Hauser in my hand, I feel like "*should I save myself or the guitar if I trip over and fall*" (laughs). Playing on a Hauser guitar feels great for our heart, a Hauser made in the 1950s, for example. It is unbelievable. For recording, I'd do on my guitar. But Hauser means something else, it means love and psychological attachments.

Sound volume isn't important for me, because, even if they manage to produce triple of what my guitar can give, even in that case, one would need to use amplification for concerts, or s/he will play in smaller venues. That's why, I'd prefer a lower volume but expressive beauty of her voice. I've an obsession. While technology improves, we are losing some things. For instance, José Ramírez. I couldn't stop playing that guitar. It belonged to Ahmet Kanneci and I don't remember how many times I went his home and played that guitar for hours and hours.

Many thanks

Onur Türkmen
14.04.2016

What do you think about the situation of the Classical guitar with respect to other orchestral instruments? Too many luthiers are still busy with redesigning this instrument.

There is an important point, in fact; the volume proved to be crucially important for the Western music, especially in the beginning of the 18th century. First concerts were given in England in the 17th century, and spread to the continental Europe in the 18th century. Prior to that, there wasn't any concerts but chamber music, especially at the court or in churches. Since there wasn't any concerts in Turkey, as we understand today, until the 20th century, traditional Turkish instruments, say Kemençe, didn't develop and have remained as they are for centuries. In Europe, some famous instruments became extinct due to their insufficient volume and projection, one of them being the guitar. I mean, the ancestors of the Classical guitar, such as lute. When the 'concert' phenomenon, as one would understand today, came to existence in the 17th century, the famous instrument of that century, that is lute, disappeared or had to be modified, probably because they were lacking a big volume enough to fill a concert venue. The cello and violin were modified; viola de gamba, clavichord and lute disappeared. Guitar is in line with that, as well. As Darwin suggests, the ones that can keep up with the changing environment were able to survive. Clarinet, for instance, is a fairly new instrument and it was very technologically advanced with respect to the period it was invented. I think, the guitar, including the double-top guitars, can't be played in large concert halls without amplification. Therefore, I think, the microphone feature is more important than the structure or quality of the Classical guitar. I believe that composers should focus on that. It's happened to me, I was very unhappy about a concert performance, but later I listened to the concert recording, and in fact it was very good. The question is "*can we overcome the volume problem of the Classical guitar without microphones?*" Microphone is vitally important for the "new music" composers; since we make a "sound centred music", the quality of sound (dynamics, timbre etc.) is in the centre for us. I mean, either the concert hall or the instrument has to change. I think, a virtuoso performer should have a solid concept of dynamics, I mean, they should be able to give 3-fortes, if that's written that way by the composer. Or sfortsando, or crescendo… How much crescendo (relatively to the sound capacity of the classical guitar). Since we like composing at high and low levels, low levels tend to become inaudible. Composers do not put too much thinking in how their music will be heard, because the main effort goes to artistic creativity, stylistic approach and so on, but they should do, in my opinion. If I write music for the guitar again, it will be for an amplified guitar, for sure. I am very sorry for not scoring a microphone system in musical notation. I mean, how to place the microphones and how to use them; I believe that should be the path to follow.

Do you take into account the player's guitar you are composing for?

Not really. In fact, there is another thing. I wonder why Classical guitarists play the nylon strung guitar only, but not steel strung, electric or 12-string guitar. I think 12-string guitar is an awesome instrument, it has many benefits and opportunities. I'd write if there were players around me. Flutists play bass flute and alto flute, or clarinet players play bass clarinet and E flat clarinet. Likewise, guitar players should be interested in other guitars, they should widen their palette. I think they are quite conservative. In our day, composers' mind is very wide and very open to experiments. Baritone guitar, for instance, it is an amazing instrument, pop musicians do play it, I wonder why not classical performers? They may even swap their classical guitar with a non-traditional one.

These days many performers acquire a romantic guitar as their second instrument.

That's the wrong direction (laughs). I wish they did acquire a steel strung guitar with a bigger sound, because the new music repertory written for electric or steel strung guitar is quite diverse. There are many composers working on it, I don't mean jazz or pop music, I mean new concert music. But, as far as I can see, they (classical guitarists) feel ashamed.

When you hear your pieces played, do you get affected by the guitar's sound qualities itself (i.e. tone, response, sustain of the instrument)?

Well, not actually, for me, that is the ability of a performer, I don't care whether they have a high-end guitar or not. I ignore the guitar, personally. Because, I don't only compose for the Classical guitar. Otherwise, we have to worry about having to play on a low quality violin, piano and so on. Different guitarists play my pieces, and there are substantial differences between them in terms of touch, approach and their artistic expressivity. Some of them approach the guitar as a fragile and delicate instrument. They play "hygienically" with "extreme aristocracy" and I am not very comfortable with that approach. Yes, their performance is clean and technically advanced, but that's not what I am up to. Their 3-forte is my mezzo forte. What I want is not clean and hygienic performances, I'd want them to put themselves into the music with all they have; sweating, like an actor, their body becoming a part of the scene, part of the world. I don't expect elegant and clean performances. I want to see a sweating actor, giving out all what they have. My music has time and dramatic variables; I've seen well-known and so-called "virtuosic" performers ignoring these variables. Therefore, they weren't really virtuoso performers for me, and that makes me sad.

How would you describe musical virtuosity? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How do you realise this heightened state of performance? How does it reveal itself?

Actually it is defined as "new virtuosity" in Berio's Sequenzas, how they approach the rhythmic structures, how they conceive the rhythmical concepts, the relationship with timbre, these are more important aspects in the new music. Playing clean scales is important but not the main concern. How one can get into the "*world of timbres*", how they forget what they had known and start over again and re-learn with a fresh mind and fresh eyes. Actually how "flexible" they are, how much effort they put in order to get into the composer's world. For my music, getting into a world of rite or ceremony and reflect that. For instance, Unutulmuş Çocuk Şarkıları (Forgotten Children Songs); a musician should not try to play it clean. For me, it is a spiritual moment and I want to hear the explosion in the piece. It is very theatrical, the performer should be able to comprehend and give that feeling out like a strong actor. That's virtuosity for me. But, that shouldn't mean to forget technical aspects. In fact, actually, this requires a great control over the instrument. Establishing strong and masterful relationships with (a) time and (b) timbre and reflecting them expressively is the most important part of virtuosity, so that a virtuoso performer can "forget" the technical aspects and they can focus on the "theatre". In other words, understanding the composer's ideas well, adding his/her own ideas and presenting them as a unique piece of art. Trying to understand the harmonic Bartok pizzicato and being conscious that "*it could be produced by the X angle of my nails, or should I use the Y angle for a better sound*", I believe that this should be the spirit.

How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

Technical mastery reminds me of agility, but to me, it is only one parameter.

Comprehending the rhythm is another parameter. In the new music, rhythm may become a complex and complicated issue. Virtuosic skill is required to sort this out. Some technically skilled performers may play fast, but if they can't understand or reject to play those complex rhythmic structures in the way they should (which is notated by the composer), I'd dispute that they really are virtuoso performers. Thus, technical mastery may lead to virtuosity if it is combined with expressive and musical details. They should be able to comprehend a piece by reading the scores, without actually touching their instrument. They should be able to realise both technical and spiritual aspects for high level of performance. They should be able to convey dramatic and structural characteristics. I mean, this music piece should become their own music, that's real high level of performance for me. They are able to reach a similar level each time. For instance, Hezârfen Ensemble played one of my pieces four or five times. After some rehearsals they asked for my ideas, and I said "*I am not going to say anything anymore, because it became your music. It's not my music anymore*", they've put so much so that it became their music. Today, a Beethoven performer can make this composer's music their own brand and create a notion that associates them with Beethoven. They play so characteristically that it is a reminiscent of that very performer; it becomes *their* music. That’s high level of performance for me.

Do you think that your music could be played with less difficulty using a more playable guitar?

Violin players, pianists and so on, they don't worry about these things, but guitar players always want to change for the better.

The Classic guitar didn't have a Stradivarius. And it has its own problems such as body contact. Classical guitars contact a performer's body more than many instruments. And also the friction sound of bass strings is a down side.

Well, yes. A contemporary composer may wish to use it (the friction sound) as an input or sound effect. But, my answer to this question is, yes. I notate some harmonics, and some guitars give it out louder. That’s very important for my music.

As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument?

I play the guitar, and I can guess more or less. But it's the same for many instruments, except very standard ones, such as the violin or cello. I believe that, as a composer, I should get acquainted with that instrument if I'm writing for it. I write for the Ney, and there is one over there (pointing his Ney instrument), even though I can't play, I try to understand what is possible and what is not possible. But that can be tricky, that can misguide me. Ideally, one should buy a beginner guitar and try to understand, in my account. The guitar is a difficult one to imagine chord positions. But it supplies with many advantages such as different harmonics and different effects.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite- tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

I don't agree. The violin has been through a reformation and became a different instrument, it is very different from the old gut-stringed violin, but we cannot say "*the contemporary violin is unable to produce 3-piano tone*". That's a big critic and argument, because music takes shifts accordingly. One might argue that the contemporary violin has a plastic-like sound, and the baroque violin had a richer tone. That's very subjective. I believe that we have to understand the purpose. Why have they been changing? Could they not be standardised? Kemençe owns its own argument, 3-stringed Kemençe players do not accept the 4-stringed Kemençe and they think it is another instrument. What is the reason to change? Why would one add an extra string to Kemençe? Why did the Violin bow change? What is the reason they have changed the wood frame of the Piano with a metal frame? This can't be stopped. It became a standard. Since there isn't a strict standard in the Classical guitar world as to how to make concert guitars, and they make double-top guitars or lattice guitars or fan-braced guitars, therefore, there might be confusions.

Many thanks.

Füsun Köksal
06.06.2016

Do you normally take into account the guitar that will be used to play your music, in terms of quality or whether it is a traditional guitar or not, when composing for the Classical guitar?

I believe I shouldn’t be doing so. I hope my music is played by different artists with different approaches, hopefully many. So, I prefer to write in a way that can sound pretty well even on a low quality instrument. Having said that, I, for sure, should take into consideration if I write specifically for performer who a special guitar, i.e. 11-string guitar.

How would you describe musical virtuosity? Which qualities are they in musical performance that make a musician worthy of a virtuoso status? How do you realise this heightened state, or in other words, how does it reveal itself? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?

I think that a virtuoso is a performer who can play technically very challenging passages with ease, like “*playing a game*”, and who can remain their musicality at the same time. Playing difficult passages with ease but, also, without losing their musicality makes a performer qualify for that. If I need to compare virtuosity and technical mastery to high level of performance, the last one (high level of performance) could be identified as a performer’s knowledge in stylistic characteristics of music as well as the context of musical mechanics.

Do you think that your music could be played with less difficulty using a more playable guitar?

Here we should make a special note of what *playability* consists of. If it is a matter of acquiring loud volume from an instrument, or having an adequate and easy action height, yes, my music can be performed with less difficulty. However, I believe that there might be more parameters than I can guess regarding the playability of a guitar. Another important aspect is the composer’s writing style and composing techniques. While performing the “new music”, for instance those examples I've given like Uroš Rojko, Magnus Lindberg, Tristan Murail, performers would need volume capacity and sustain, in specific.

As a composer, how do you understand-recognise limits of the Classical guitar? How do you take these 'limits' into account when composing music for this instrument?

I took up the Classical guitar, because my father used to play. I know from my experience that one cannot play the same exact chords, as they play on the piano, using original positions marked in the musical notation. In addition, the time required to move from one chord to another can take more time than it should, because the performer needs to change their left hand position. Since the guitar is more suitable for homophony than polyphony, due to its structure, polyphonic music should be written with great care. These are the technical difficulties of the guitar in my account.

Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Contemporary guitars (double-tops, lattice guitars or composite- tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

We know that the Classical guitar used to be performed in smaller venues and gatherings. So, I think that performers select their instruments according to the concert hall they will perform. This, for sure, is an aspect that affects the final sound.

Many thanks

APPENDIX E

Table E. Luthier Interview Guide

Interview Guide: **LUTHIER**

1 Concept of playability	2 Making playable instruments	3 Playable vs. Non-Playable Instruments	4 Playability - Virtuosity intersection
What does playability mean to you? What are the product qualities of a classical guitar that promises improved playability?	What is it that makes the act of performance less difficult on an easy-to-play guitar? Do you think that the playability is an asset that deserves all the effort made through the guitar manufacture?	The difficulties of student guitars (medium level quality) that can create difficulties for the performer.	Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar? Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Modern guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

APPENDIX F

Table F. Performer Interview Guide

Interview Guide: **PERFORMER**

1 Concept of playability	2 Playable vs. Non-Playable Instruments	3 Musical Mastery and Technical Aspects	4 Playability - Virtuosity intersection
What does "a playable guitar" mean to you? What aspects make it more playable and what do you expect from that guitar? What does a playable guitar offer you as a concertising artist?	What are the difficulties of student guitars (medium level quality) that can create difficulties for the performer? How do you compare medium quality student guitars to high-end concert guitars?	How would you describe the virtuosity on guitar? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How do you realise this heightened state of performance? How does it reveal itself? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?	Do you think that it is possible to boost the superiority in musical performance and expression with a high quality guitar? Well-known traditional instruments (especially Hauser, Fleta and Friederich) are especially famous for their timbral and expressive qualities. Modern guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

APPENDIX G

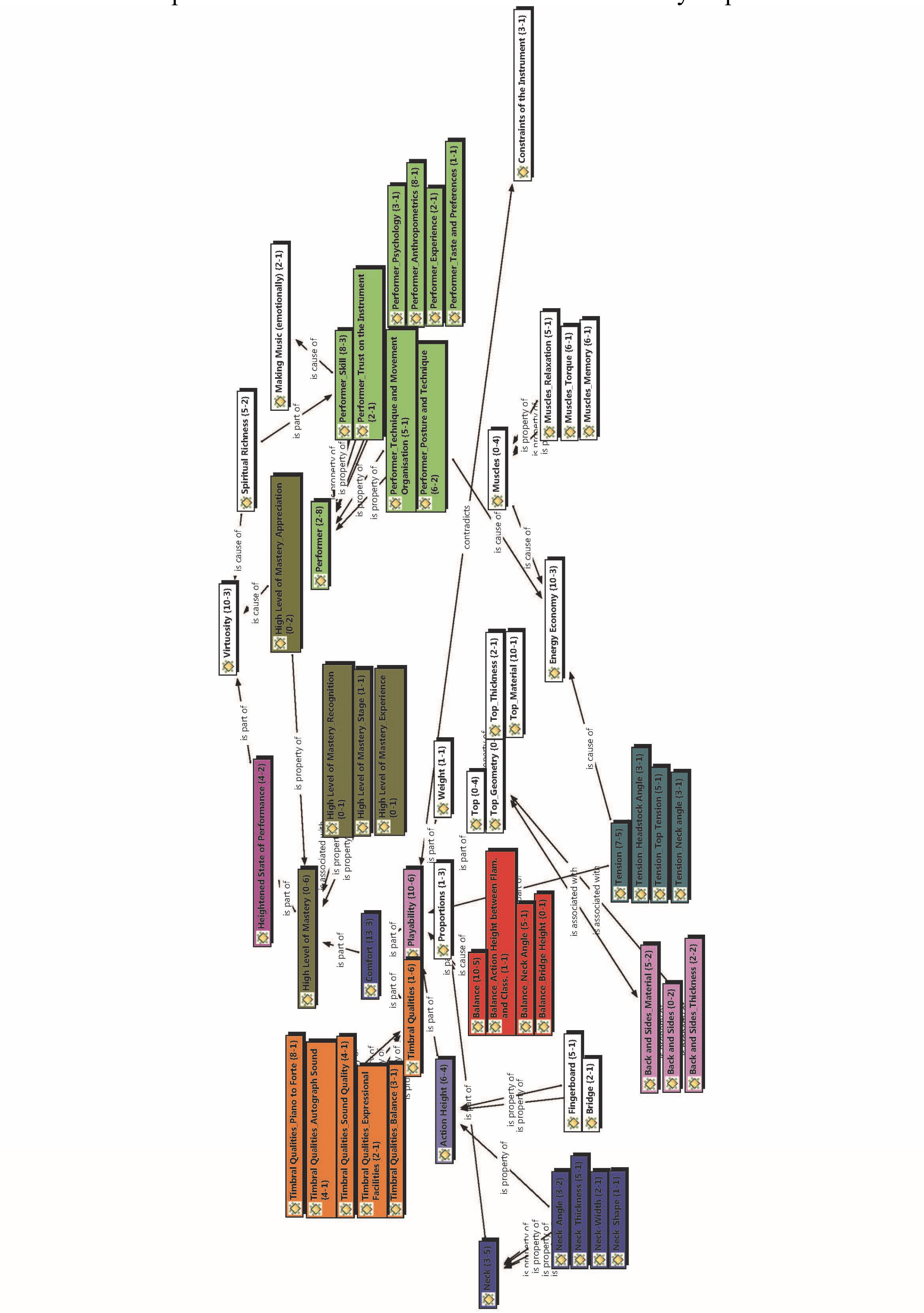
Table G. Composer Interview Guide

Interview Guide: **COMPOSER**

1 Concept of playability	2 Playable vs. Non-Playable Instruments	3 Musical Mastery and Technical Aspects	4 Playability - Virtuosity intersection
Do you take into account whom you are composing for and what guitar s/he owns and plays when writing for guitar?	When you hear your pieces played, do you get affected by the guitar's sound qualities itself (i.e. tone, response, sustain of the instrument)?	How would you describe musical virtuosity? What are the qualities in a musician's performance that make them qualify to be considered for virtuoso status? How do you realise this heightened state of performance? How does it reveal itself? How would you compare (a) virtuosity (b) technical mastery (c) and high level of performance?	Do you think that your music could be played with less difficulty using a more playable guitar? As a composer, how do you understand-recognise the limits of the classical guitar? How do you take its limits into account when composing music for this instrument? **For guitarist-composers:** Well-known traditional instruments (especially Hauser, Fleta and Friederich) are famous especially for their timbral and expressive qualities. Modern guitars (double-tops, lattice guitars or composite-tops etc.) known as loud and powerful. There is some argument that these contemporary instruments (double-tops, lattice guitars or composite-tops etc.) do not have the singing and charming quality of traditional guitars. How does it affect the art of performance?

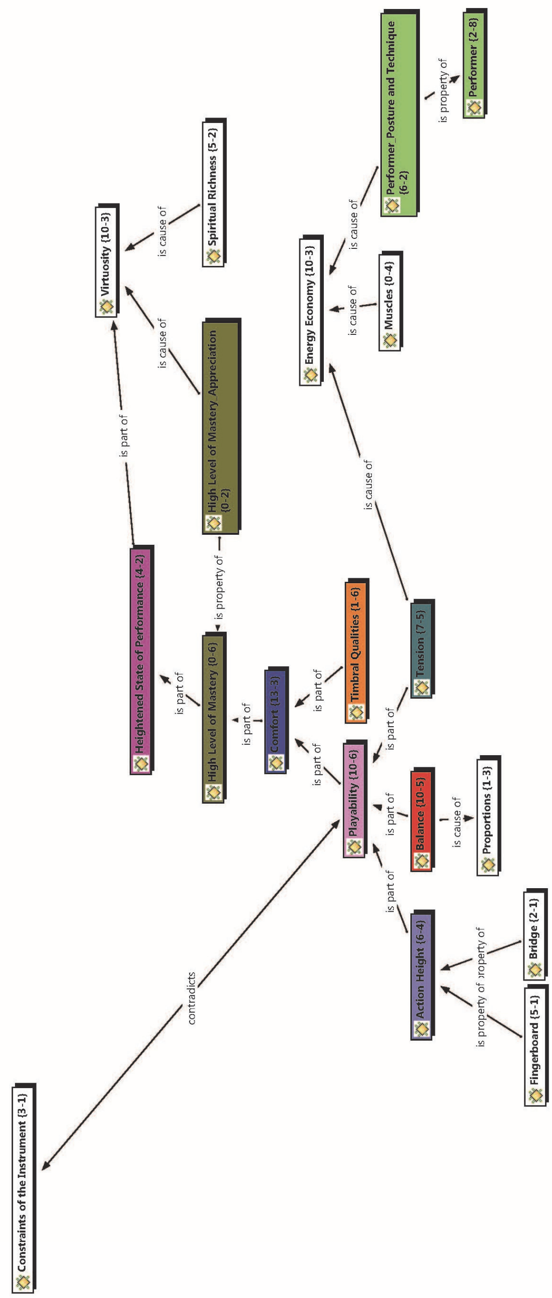
APPENDIX H

Table H.1. Complete Atlas.ti codes from the initial content analysis phase



APPENDIX H Cont.

Table H.2. Simplified Atlas.ti codes from the initial content analysis phase



APPENDIX H Cont.

Distributed codes and code families of playability across participants groups from the initial content analysis phase

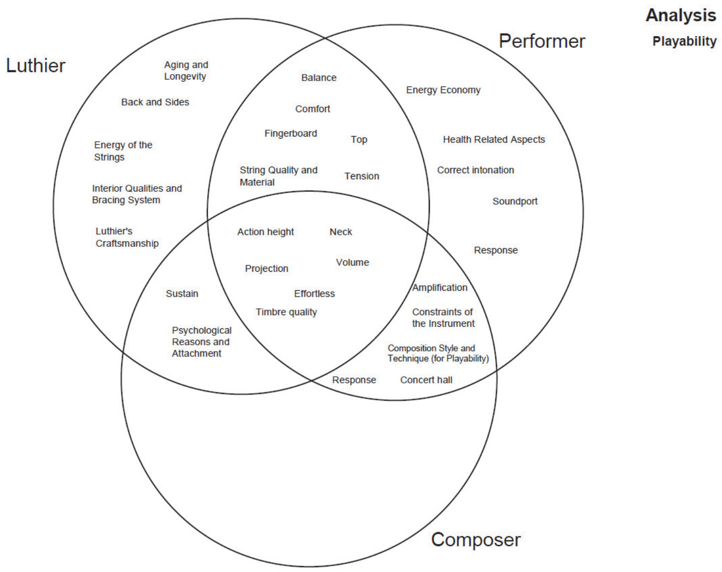


Figure 148 Venn diagrams of distributed codes and code families for the code "Playability"

Distributed codes and code families of virtuosity across participants groups from the initial content analysis phase

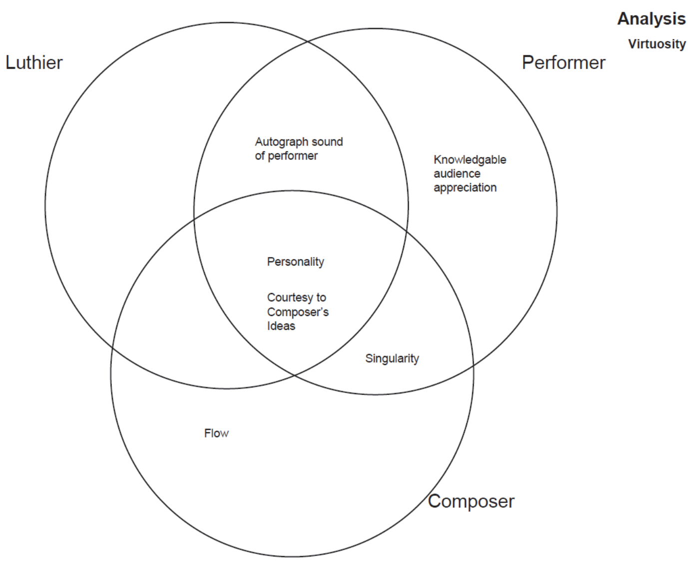
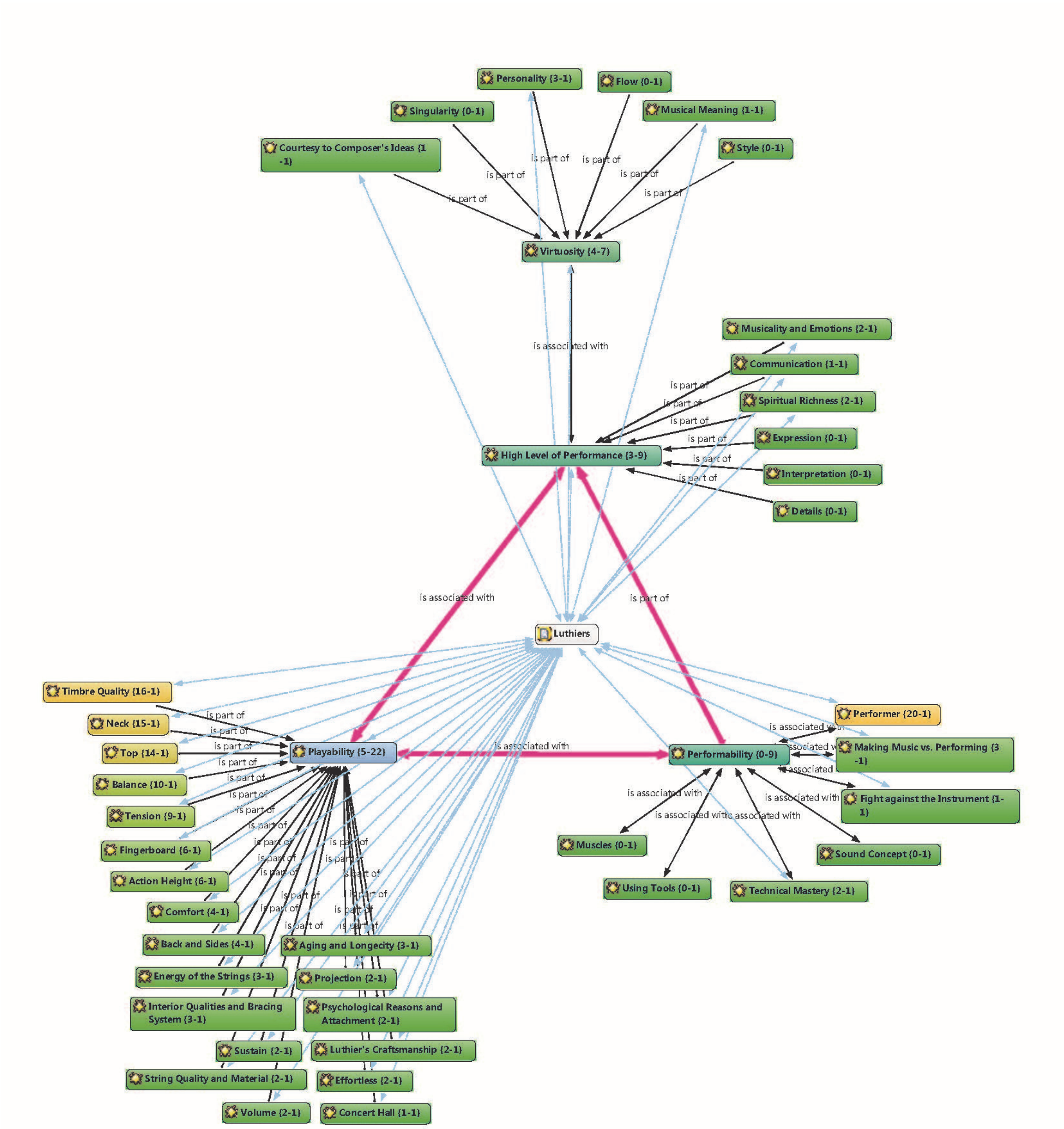


Figure 149 Venn diagrams of distributed codes and code families for the code "Virtuosity"

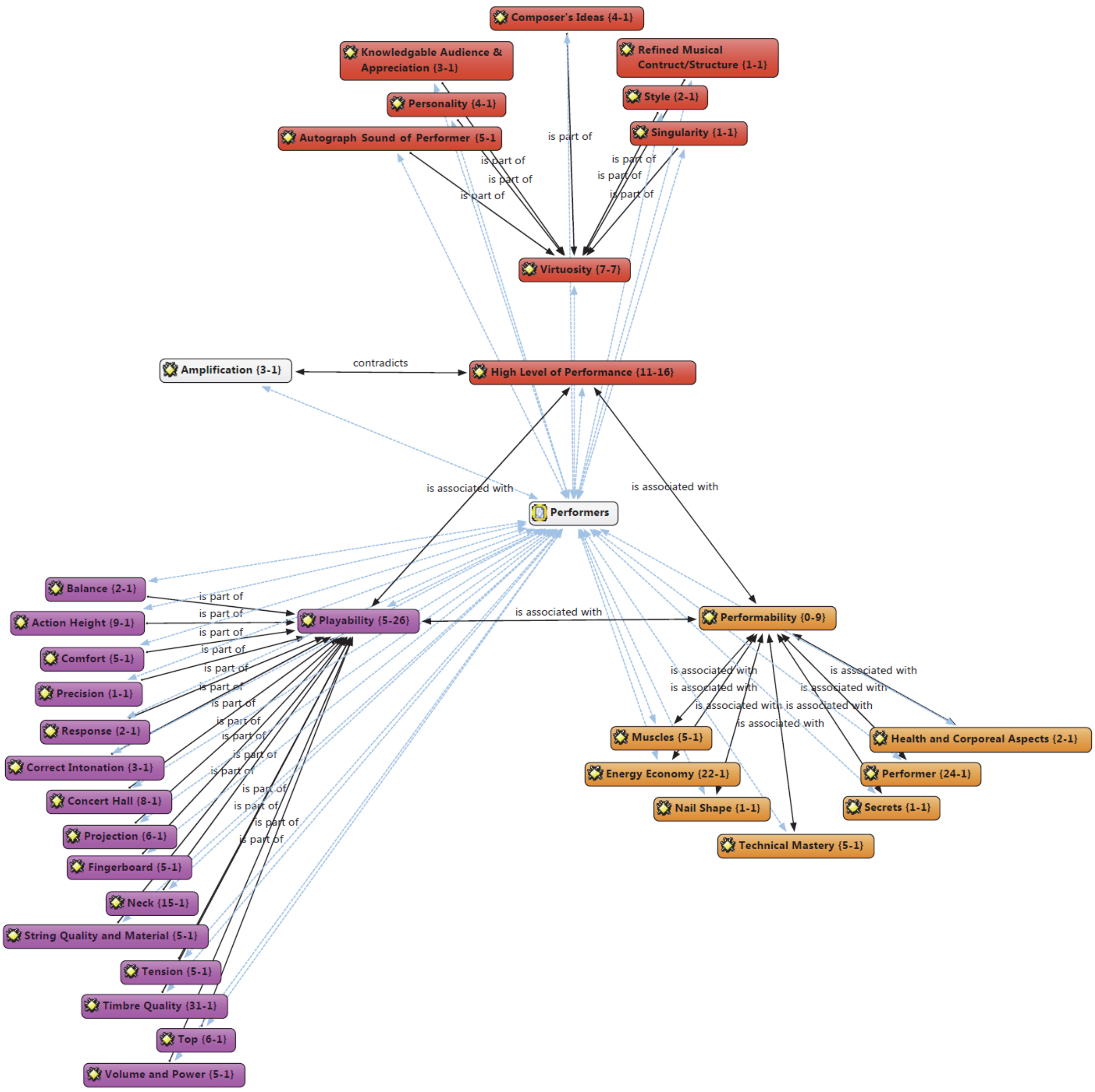
APPENDIX H Cont.

Table H.3. Playability, performability, high level of performance, virtuosity and related coding of luthiers



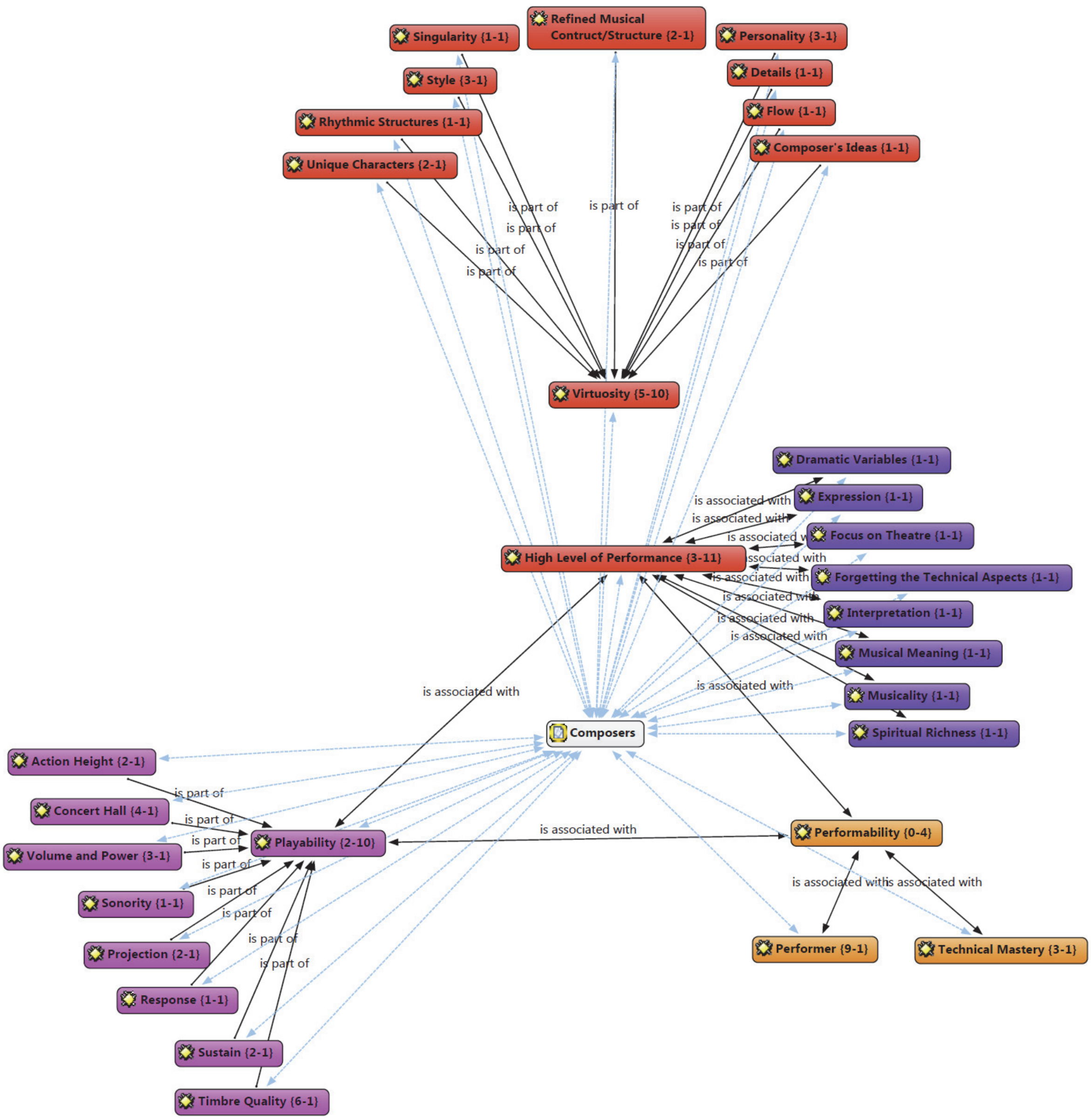
APPENDIX H Cont.

Table H.4. Playability, performability, high level of performance, virtuosity and related coding of performers



APPENDIX H Cont.

Table H.6. Playability, performability, high level of performance, virtuosity and related coding of composers



APPENDIX H Cont.

Table H.7. Initial intensity analysis of codes across participant groups

Playability	Luthiers	Performers	Composers
Action height	6	9	2
Balance	6	2	
Concert hall	1	8	4
Comfort	4	5	
Neck	12	15	
Fingerboard	6	5	
Tension	9	5	
Projection	2	6	2
Top	10	6	
Timbre quality	17	31	6
Volume and power	1	5	3
Response		2	1
Precision		1	
Correct intonation		3	
String quality & mat.		5	
Sustain			2
Sonority			1

APPENDIX I
GLOSSARY OF TERMS

articulation: how long a tone sounds and which tone is silenced (p. 37)

back and sides: the back part and sides of a guitar's sounbox (pp. 89, 90, 106)

bridge: the bottom end of the scale length where strings are anchored (pp. 91, 119, 120, 122, 153, 155, 166, 167, 239, 240)

double-top (also triple-top or composite-top): a special type of soundboard construction that is made with two thin soundboard plates connected to each other using various methods such as carbon composites and Nomex honeycomb (pp. 105, 112, 163, 182)

double-stop: two voices played simultaneously on bowed instruments (p. 29)

fan-strut: interior parts used to soundboard the support in traditional guitars (pp. 94, 95, 102, 105)

harmonic: a special sound effect usually performed without pressing the strings onto the fretboard (p. 212)

harmonic bar: similar to the fan struts in function but is used to support the back of a guitar (pp. 97, 187, 188)

lattice bracing: a bracing type which employs carbon or balse criss-cross lattice braces to support and strengthen a thin soundboard (pp. 105, 106, 110, 112)

nut: the upper end of the scale length where strings are anchored to the machine heads (pp. 66, 122, 125, 126, 131, 192)

projection: the quality of an instrument to push the sound forward (pp. 68, 87, 95, 99, 106, 107, 114, 160, 170, 218)

CURRICULUM VITAE

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2012. Music and Machines. Berlin, Germany: Lambert Academic Publishing / ISBN: 978-3-8473-2824-7

2010. Keyboard Music: from Art Performance to Designed Experience - CIANTEC 2010. *Art, New Technologies and Communication Proceedings* / ISBN: 978-856-281-401-3 / Pp. 227-234

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2009. Design for Humanity in the Century of Famine and Warfare. MX Design Conference 2009 *Social Impact of Design Proceedings* Volume 3, Pp. 28-31

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