

**AN APPROACH FOR ELICITING FUNCTIONAL  
REQUIREMENTS OF THE SOFTWARE INTENSIVE  
SYSTEMS BASED ON BUSINESS PROCESS MODELING**

**A THESIS SUBMITTED TO  
THE GRADUATE SCHOOL OF INFORMATICS  
OF  
THE MIDDLE EAST TECHNICAL UNIVERSITY**

**BY**

**OKAN YILDIZ**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR**

**THE DEGREE OF MASTER OF SCIENCE**

**IN**

**THE DEPARTMENT OF INFORMATION SYSTEMS**

**AUGUST 2002**

Approval of the Graduate School of Informatics

Prof. Dr. Neşe Yalabık  
Director

---

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Semih Bilgen  
Head of Department

---

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. Onur Demirörs  
Co-Supervisor

---

A. Nusret Güçlü  
Supervisor

---

Examining Committee Members

Prof. Dr. Semih Bilgen

.....

Assoc. Prof. Dr. A. Kadir Varoğlu

.....

Assoc. Prof. Dr. Onur Demirörs

.....

Dr. Altan Koçyiğit

.....

A. Nusret Güçlü

.....

**ABSTRACT**  
AN APPROACH FOR ELICITING FUNCTIONAL  
REQUIREMENTS OF THE SOFTWARE INTENSIVE SYSTEMS  
BASED ON BUSINESS PROCESS MODELING

Yıldız, Okan

M.S., Department of Information Systems

Supervisor: Nusret GÜÇLÜ

Co-Supervisor: Assoc.Prof.Dr. Onur Demirörs

August 2002, 111 pages

In this thesis, eliciting system functional requirements based on business requirements during software intensive systems acquisition or development process is investigated and an approach is proposed for this purpose. Concepts and current problems within the framework of business requirements are investigated with a general literature review of requirements engineering and technology acquisition. Determination of requirements of IT system to be acquired according to the business objectives and base lining business processes is dealt with business process modeling. ARIS providing integrated and complete information system architecture along with modeling techniques and modeling tool is also investigated. Proposed approach recommends EEPC as process modeling technique and ARIS software as supporting toolset, and explains how to conduct application of automatic requirements eliciting from business process models, by extending a reporting script provided by ARIS software. Proposed approach was partially applied to the real project and the obtained results were presented in this thesis.

Keywords: Requirements Engineering, Business-IT Alignment, Business Process Modeling, and Requirements Elicitation.

## ÖZ

### YAZILIM AĞIRLIKLI SİSTEMLERİN FONKSİYONEL GEREKSİNİMLERİNİN İŞ SÜREÇ MODELLEMİYİ ESAS ALARAK ELDE EDİLMESİ İÇİN BİR YAKLAŞIM

Yıldız, Okan

Yüksek Lisans, Bilgi Sistemleri Bölümü

Tez Yöneticisi: Nusret GÜÇLÜ

Ortak Tez Yöneticisi: Doç. Dr. Onur Demirörs

Ağustos 2002, 111 sayfa

Bu çalışmada, yazılım ağırlıklı sistem alım veya geliştirme sürecinde, sistem fonksiyonel gereksinimlerinin is gereksinimleri esas alınarak elde edilmesi incelenmiştir ve bunun için bir yaklaşım önerilmiştir. Gereksinim mühendisliği ve iş gereksinimleri çerçevesinde teknoloji tedariki ile ilgili literatüre genel bir bakışla kavramlar ve mevcut problemler incelenmiştir. Tedarik edilecek bilgi teknoloji sistem gereksinimlerinin iş amaçlarına uygun ve iş süreçlerini esas alarak belirlenmesi is süreç modelleme ile birlikte ele alınmıştır. Ayrıca sağladığı entegre ve tam bilgi sistem mimarisi, modelleme teknikleri ve modelleme aracıyla ARIS incelenmiştir. Önerilen yaklaşım iş süreç modelleme tekniği olarak EEPK ve bunu destekleyen araç olarak ARIS yazılımını önermekte; ARIS yazılımının sağladığı bir raporlama program parçacığını genişletilerek iş süreç modellerinden otomatik gereksinim çıkartma uygulamasının nasıl yapılacağını açıklamaktadır. Önerilen yaklaşım bir projede kısmen uygulanmış ve elde edilen sonuçlar tez içinde sunulmuştur.

Anahtar Kelimeler: Gereksinim Mühendisliği, İş-Teknoloji Uyuşması, İş Süreç Modelleme, Gereksinim Çıkartma.

## **ACKNOWLEDGEMENTS**

I express sincere appreciation to Nusret Güçlü for his guidance, assistance and insight throughout the research. Thanks go to Assoc. Prof Dr. Onur Demirörs for his guidance and suggestions during the lectures and thesis and also to Mr. Burak Emri for his support. And to my parents, I offer gratitude for their faith in me.

**To My Wife, Özlem**

## TABLE OF CONTENTS

|   |            |
|---|------------|
| <b>ÖZ.....</b>  | <b>iv</b>  |
| <b>ACKNOWLEDGEMENTS.....</b>  | <b>v</b>   |
| <b>TABLE OF CONTENTS.....</b>   | <b>vii</b> |
| <b>LIST OF TABLES .....</b>   | <b>xi</b>  |
| <b>LIST OF FIGURES .....</b>  | <b>xii</b> |
| <b>LIST OF ACRONYMS .....</b>   | <b>xiv</b> |
| <b>LIST OF ABBREVIATIONS .....</b>  | <b>xvi</b> |
| <b>1 INTRODUCTION.....</b>  | <b>1</b>   |
| 1.1 STATEMENT OF PROBLEM .....  | 2          |
| 1.2 APPROACH .....  | 4          |
| 1.3 ROADMAP.....  | 5          |
| <b>2 BACKGROUND .....</b>   | <b>6</b>   |
| 2.1 OVERVIEW OF REQUIREMENTS ENGINEERING .....                              | 6          |
| 2.1.1 Requirements Elicitation.....   | 7          |
| 2.1.2 Challenges of Requirements Engineering and Its Elicitation Phase .... | 8          |
| 2.1.3 Joint Application Development (JAD) for Requirements Elicitation ..   | 9          |
| 2.1.4 Automation Support In Requirements Elicitation.....                   | 10         |
| 2.2 REQUIREMENTS ENGINEERING METHODS .....                                  | 11         |
| 2.2.1 Structured Analysis and Design Methods .....                          | 13         |

|          |   |           |
|----------|---|-----------|
| 2.2.1.1  | Data Flow Diagrams .....  | 13        |
| 2.2.2    | Object Oriented Models .....  | 15        |
| 2.2.3    | Formal Methods .....  | 16        |
| 2.3      | BUSINESS AND IT ALIGNMENT.....                                      | 17        |
| 2.3.1    | Strategic Planning .....  | 19        |
| 2.3.2    | Business Process Analysis .....                                     | 22        |
| 2.3.2.1  | Process-Oriented Structuring Versus Functional Structuring.....     | 23        |
| 2.3.2.2  | Understanding Existing Business Processes .....                     | 24        |
| 2.3.3    | Designing The Target Business Processes.....                        | 24        |
| 2.3.4    | Business Process Modeling.....                                      | 25        |
| 2.3.4.1  | Integration Definition For Function Modeling (IDEF0).....           | 29        |
| 2.3.5    | Information System Architectures .....                              | 32        |
| 2.3.5.1  | IFIP Architecture - Information System Methodology .....            | 32        |
| 2.3.5.2  | CIMOSA .....  | 33        |
| 2.3.5.3  | Zachman Framework .....   | 36        |
| 2.3.5.4  | ARIS.....   | 37        |
| <b>3</b> | <b>ARIS.....</b>  | <b>39</b> |
| 3.1      | ARIS BUSINESS PROCESS MODELING VIEWS .....                          | 39        |
| 3.1.1    | Definition of Views.....  | 41        |
| 3.2      | ARIS MODELING METHODS.....  | 42        |
| 3.2.1    | Event-Driven Process Chains (EPCs):.....                            | 42        |
| 3.2.2    | Function Allocation Diagram.....                                    | 45        |
| 3.2.3    | EEPC-Extended Event Driven Process Chain .....                      | 46        |
| 3.2.3    | Advantages of EEPC Modeling Technique .....                         | 49        |
| 3.2.4    | Detailed Description of Business Process Models.....                | 50        |
| 3.2.5    | Relationship Types Between Objects of Business Process Models... 50 |           |
| 3.3      | ARIS TOOLSET .....  | 53        |
| 3.3.1    | ARIS Toolset Reporting & Analysis .....                             | 54        |
| 3.3.2    | ModelHierarchy.rsm .....  | 55        |

|          |   |           |
|----------|---|-----------|
| <b>4</b> | <b>APPROACH .....</b>   | <b>56</b> |
| 4.1      | STRATEGIC PLANNING .....  | 56        |
| 4.2      | AS-IS STUDY .....   | 57        |
| 4.2.1    | Gathering all resources related with business processes.....  | 57        |
| 4.2.2    | Organize interviews and JAD sessions .....  | 57        |
| 4.2.3    | Study of value added process chain .....  | 58        |
| 4.2.4    | Modeling of existing BP during JAD sessions and interviews.....   | 58        |
| 4.2.5    | Approval of business process models .....   | 59        |
| 4.3      | TO-BE STUDY.....  | 59        |
| 4.3.1    | Determination of bottlenecks, new business and information flows<br>and IS-supported processing functions ..... | 59        |
| 4.3.2    | Developing target design of business processes .....  | 60        |
| 4.3.3    | Approval of target business process models .....  | 63        |
| 4.4      | AUTOMATED FUNCTIONAL REQUIREMENTS ELICITATION.....  | 63        |
| <b>5</b> | <b>AN APPLICATION.....</b>  | <b>66</b> |
| 5.1      | INTRODUCTION .....  | 66        |
| 5.2      | DEFINITIONS USED .....  | 67        |
| 5.3      | THE ROLES USED IN MODELS .....  | 67        |
| 5.4      | THE DEFINITIONS OF INPUTS AND OUTPUTS OF THE PROCESS.....   | 69        |
| 5.5      | PROCESS TO BE INVESTIGATED.....   | 70        |
| 5.5.1    | Steps of the General Process.....   | 70        |
| 5.5.2    | Evaluation of Step1 .....   | 72        |
| 5.5.3    | Evaluation of Step 2.....   | 76        |
| 5.5.4    | Evaluation of Step 3 .....  | 81        |
| 5.6      | REPORTING SCRIPT.....   | 83        |
| 5.6.1    | Extended Reporting script- <i>Newhierarchy.rsm</i> .....  | 83        |
| 5.6.2    | Comparison and Evaluation of Outputs .....  | 85        |
| <b>6</b> | <b>CONCLUSION.....</b>  | <b>89</b> |

|     |  |            |
|-----|--|------------|
| 6.1 | FUTURE WORK.....   | 91         |
|     | <b>REFERENCES.....</b>   | <b>92</b>  |
|     | <b>APPENDIX A: OUTPUT OF <i>NEWHIERARCHY.RSM</i> SCRIPT .....</b>        | <b>96</b>  |
|     | <b>APPENDIX B: EXTENDED PART OF <i>MODELHIERARCHY.RSM</i> SCRIPT ...</b> | <b>99</b>  |
|     | <b>APPENDIX C: USER DIALOGS.....</b>                                     | <b>110</b> |

## LIST OF TABLES

|  |           |
|--|-----------|
| <b>TABLE 1. IDEF0 STRENGTHS AND WEAKNESSES.....</b>                            | <b>31</b> |
| <b>TABLE 2. CIMOSA MODELING VIEW DIMENSION.....</b>                            | <b>34</b> |
| <b>TABLE 3. CIMOSA MODELING LEVEL DIMENSION.....</b>                           | <b>35</b> |
| <b>TABLE 4. CIMOSA GENERICITY LEVEL DIMENSION.....</b>                         | <b>35</b> |
| <b>TABLE 5. ARIS ADVANTAGES.....</b>   | <b>38</b> |
| <b>TABLE 6. ARIS FLOWS IN BUSINESS PROCESS.....</b>                            | <b>40</b> |
| <b>TABLE 7. ARIS VIEWS.....</b>  | <b>41</b> |
| <b>TABLE 8. OBJECT TYPES OF TYPICAL EPC.....</b>                               | <b>43</b> |
| <b>TABLE 9. OBJECT TYPES OF FAD.....</b>                                       | <b>45</b> |
| <b>TABLE 10. ADDITIONAL OBJECT TYPES.....</b>                                  | <b>46</b> |
| <b>TABLE 10. ADDITIONAL OBJECT TYPES (CONT...)</b>                             | <b>47</b> |
| <b>TABLE 11. VIEWS OF MODEL IN FIGURE 13.....</b>                              | <b>49</b> |
| <b>TABLE 12. DATA-FUNCTION RELATIONSHIPS.....</b>                              | <b>51</b> |
| <b>TABLE 13. FUNCTION-DATA RELATIONSHIP.....</b>                               | <b>51</b> |
| <b>TABLE 14. FUNCTION-OUTPUT RELATIONSHIP.....</b>                             | <b>52</b> |
| <b>TABLE 15. OUTPUT-FUNCTION RELATIONSHIP.....</b>                             | <b>52</b> |
| <b>TABLE 16. FUNCTION-FUNCTION RELATIONSHIP.....</b>                           | <b>52</b> |
| <b>TABLE 17. ORGANIZATION-FUNCTION RELATIONSHIPS.....</b>                      | <b>53</b> |
| <b>TABLE 18. ESSENTIAL OBJECT TYPES AND RELATIONSHIPS.....</b>                 | <b>61</b> |
| <b>TABLE 19. REPORT TEMPLATE INCLUDING ALL ASPECT OF ANY PROCESS<br/>.....</b> | <b>64</b> |
| <b>TABLE.20. DEFINITIONS TO BE USED.....</b>                                   | <b>67</b> |
| <b>TABLE 21. ROLES TO BE USED IN THE MODELS.....</b>                           | <b>68</b> |
| <b>TABLE.22. INPUT/OUTPUT TO BE USED IN THE MODELS.....</b>                    | <b>69</b> |

## LIST OF FIGURES

|   |    |
|---|----|
| FIGURE 1. LEVEL 1 DFD FOR STUDENT REGISTRATION.....           | 15 |
| FIGURE 2. RELATIONSHIP BETWEEN BUSINESS AND IT .....          | 18 |
| FIGURE 3. METAMODEL OF BUSINESS ENGINEERING.....              | 19 |
| FIGURE 4. STRATEGIC PLANNING MODEL .....                      | 20 |
| FIGURE 5. EXTENDED STRATEGIC PLANNING MODEL .....             | 21 |
| FIGURE 6. PHASED APPROACH .....                               | 28 |
| FIGURE 7. IDEF 0 .....  | 30 |
| FIGURE.8. CIMOSA ARCHITECTURE.....                            | 34 |
| FIGURE 9. ZACHMAN FRAMEWORK .....                             | 36 |
| FIGURE 10. ARIS ARCHITECTURE.....                             | 37 |
| FIGURE 11. EXAMPLE FOR EPC .....                              | 44 |
| FIGURE 12. EXAMPLE FOR FAD .....                              | 45 |
| FIGURE 13. EXAMPLE FOR EEPC .....                             | 48 |
| FIGURE 14. ASSIGNMENT OF OBJECT.....                          | 50 |
| FIGURE 15. MODELING TOOLS .....                               | 54 |
| FIGURE 16. PROPOSED METHOD FOR FUNCTIONAL REQ. ELICITATION... | 63 |
| FIGURE 17. ORGANIZATIONAL CHART OF TLFC PROJECT OFFICE .....  | 67 |
| FIGURE 18. ORGANIZATIONAL CHART OF METU PROJECT OFFICE.....   | 68 |
| FIGURE 19. FUNCTIONAL REQUIREMENTS ELICITATION PROCESS .....  | 71 |
| FIGURE 20. FUNCTION TREE OF AS-IS STUDY .....                 | 73 |
| FIGURE 21. EEPC OF AS-IS STUDY.....                           | 74 |
| FIGURE 22. MODELING OF EXISTING BUSINESS PROCESSES.....       | 75 |
| FIGURE 23. FUNCTION TREE OF TO-BE STUDY .....                 | 77 |
| FIGURE 24. EEPC OF TO-BE STUDY .....                          | 78 |
| FIGURE 25. EXAMPLE FOR INCOMPLETE BPM .....                   | 79 |

**FIGURE 26. COMPLETED TARGET BUSINESS PROCESS MODEL ..... 81**  
**FIGURE 27. STEP 3 APPLIED ..... 83**

## LIST OF ACRONYMS

|               |   |  |
|---------------|---|--|
| <b>ARIS</b>   | : | Architecture of Integrated Information System              |
| <b>BPM</b>    | : | Business Process Model                                     |
| <b>CAPE</b>   | : | Computer Aided Process Engineering                         |
| <b>CASE</b>   | : | Computer Aided Software Engineering                        |
| <b>CCR</b>    | : | Clear Command Request                                      |
| <b>CIM</b>    | : | Computer Integrated Manufacturing                          |
| <b>CIMOSA</b> | : | Computer Integrated Manufacturing Open System Architecture |
| <b>CIN</b>    | : | Clear Information Need                                     |
| <b>CSP</b>    | : | Communicating Sequential Processes                         |
| <b>DFD</b>    | : | Data Flow Diagram  |
| <b>EPC</b>    | : | Event Driven Process Chain                                 |
| <b>EERP</b>   | : | Extended Event Driven Process Chain                        |
| <b>ER</b>     | : | Entity Relationship  |
| <b>EERM</b>   | : | Extended Entity Relationship Model                         |
| <b>FAD</b>    | : | Function Allocation Diagram                                |
| <b>HW</b>     | : | Hardware   |
| <b>IDEF</b>   | : | Integration Definition                                     |
| <b>IDA</b>    | : | Interactive Design Approach                                |
| <b>IEEE</b>   | : | Institute of Electrical and Electronics Engineers          |
| <b>IEM</b>    | : | Information Engineering Methodology                        |
| <b>IFIP</b>   | : | International Federation For Information Processing        |
| <b>IS</b>     | : | Information Systems  |
| <b>ISA</b>    | : | Information System Architecture                            |
| <b>IT</b>     | : | Information Technology                                     |

|              |   |   |
|--------------|---|---|
| <b>JAD</b>   | : | Joint Application Development                 |
| <b>JSD</b>   | : | Jackson System Development                    |
| <b>METU</b>  | : | Middle East Technical University              |
| <b>NIAM</b>  | : | Nijssen's Information Analysis Method         |
| <b>SADT</b>  | : | Structured Analysis and Design Technique      |
| <b>SSADM</b> | : | Structured Systems Analysis and Design Method |
| <b>SW</b>    | : | Software                                      |
| <b>TLFC</b>  | : | Turkish Land Forces Command                   |

## LIST OF ABBREVIATIONS

|               |   |              |
|---------------|---|--------------|
| <b>Org.</b>   | : | Organization |
| <b>Req.</b>   | : | Requirements |
| <b>Seq.</b>   | : | Sequence     |
| <b>Log.</b>   | : | Logical      |
| <b>Activ.</b> | : | Activity     |
| <b>Sys.</b>   | : | System       |

## CHAPTER 1

### 1 INTRODUCTION

Today, process innovation practices cause organizations to have a need for the applicable methods to achieve alignment of business and information technology. Supporting business processes with software intensive systems is the most commonly used way of process innovation practices. “A description of the IT-based systems needed to support a new process is an important aspect of the process design. The degree of accuracy and completeness of such systems requirements will have a direct impact on the duration of the implementation effort and the appropriateness of the systems ultimately delivered” [Davenport, 1993]. Requirements determination of current business processes and transforming those requirements into requirements of target business processes, which are supported by software intensive system are the most important milestones in business-IT alignment. The required interface between business and IT perspectives must be based on a clear and continuous translation of the business requirements into technical specification.<sup>1</sup>

As the characteristics and the requirements of the proposed system that we want to develop or acquire can be derived from these activities, requirements engineering gains more importance in business-IT alignment process.

Importance of business orientation in software intensive system development process has also gradually increased. This tendency will have an impact on methods applied and tools used.

---

<sup>1</sup><http://www.cutter.com/itreports/achieving.html>

## 1.1 STATEMENT OF PROBLEM

Requirements development is one of the key process areas of the software intensive system acquisition process. Because of the diversity of the software intensive system development projects there is no common standard approach for requirements elicitation process [Wieggers, 1999]. It is performed during initial planning phase and begins with the translation of operational requirements into solicitation documentation. When the requirements are defined clearly and completely, the acquirer can obtain realistic assessments of the size, scope and the effort required for producing the software and this helps acquirer to make a realistic budget and schedule estimates. Unpredictability of the acquisition can be addressed in this way. However, generally acquirers are not much successful in determining functional requirements of the proposed system although those requirements specification will be the foundation of the contract they prepare. System acquired may not meet the business needs, or system cannot be finished on time or on estimated cost due to the most important problem, requirements. Requirements are inconsistent and/or incomplete.

Whether there is competent staff in the organization for requirements analysis or perhaps requirements determination activity shall be given to the contractor, or functional requirements of the proposed system will be determined together with the developer, reasons of incorrect, incomplete or incomprehensive determination of system requirements are always the same. There are always misunderstandings between the customer, those developing system requirements and the developer. Current requirements engineering methods generally have deficiency in finding out the business needs, because focus is mostly on technology rather than on business. Business requirements are not only what business people say. There might be other things beneath the surface that need to be discovered. Acquirers are not completely aware of what is needed and don't have a full understanding of the problem domain. Current business processes must be analyzed within the partnership of IT people and business people.

Analysis and design methods are generally developer oriented, for example, there are some difficulties for business people, in understanding the notations used in the modeling techniques that are used for formulating requirements. End user, executive or domain expert who express the business requirements can't understand the developer's language used in the modeling activity. They are not familiar with modeling techniques. Besides modeling techniques, formal methods based on mathematically formal syntax and semantics are also difficult to understand. At that time, communication problem arises between developer and business people when transforming business requirements into proposed system requirements, so system, which is to be developed or to be acquired, may not meet the business needs.

Each modeling technique serves for the different views of the system architecture, namely, data, function, organization, and process. Business processes impact all views of the organization, but current process modeling techniques have some deficiencies in describing all of them.

Processes are more measurable than functions as they directly relate to organizational goals. Process oriented approach rather than function oriented approach helps the organizations to see the big picture of the system and to link the system requirements to business requirements and to link business requirements to the business strategy. Current practices do not take the business strategies and goals into account when determining the requirements of target business processes.

Besides techniques, almost none of the existing CASE tools have the ability of process engineering or business process modeling tool in terms of modeling the business requirements in business terms. Most of the CASE tools deal with design and implementation of the system. A few tools for requirements engineering exist and most of them are related with requirements management. None of them can assist or carry out streamlined requirements generation activity.

Preparing system requirements specification document, which is clear and understandable for both acquirer and software developer, and modifiable easily, is very difficult.

New approaches are required to overcome above-mentioned in order to make all software intensive system development projects be successful through business-IT alignment. We proposed an approach that can address this challenge partially.

## 1.2 APPROACH

Some of the problems stated above can be addressed by an approach, by which functional requirements of software intensive system are elicited through either business, or customer or process oriented analysis considering ARIS views and using Extended Event Driven Process Chain (EEPC)-modeling technique. Architecture of Integrated Information System (ARIS) is an integrated architecture for describing information systems and an integrated process engineering approach, which is developed by IDS Prof. Scheer<sup>2</sup> In order to describe business processes and information systems, it provides framework, which has five views, namely process, function, output, data and organization [Scheer, 1999]. EEPC modeling technique is a business process modeling technique that can cover all these views, which the business people are familiar.

We propose a requirements elicitation process, which has three steps based on strategies and goals determined by the customer: AS-IS Study, TO-BE Study and Functional Requirements Elicitation. Business process modeling supports all phases of the approach. Generally speaking, essence of this approach is that specification of functional requirements of target software intensive system can be obtained automatically from business process models created during system analysis. This system analysis approach actually serves for the achievement of business-IT alignment.

Business oriented aspect of this method is achieved through AS-IS and TO-BE Study. Before technical aspect of the solution is considered, current business, its problems, needs or requirements are dealt with and then those are transformed into target design by using EEPC modeling technique that allows mutual understanding for all the stakeholders.

---

<sup>2</sup> <http://www.ids-scheer.com>

EEPC modeling technique is a customer-oriented technique, and customer can easily understand the notations used in the models. This technique takes a “process” as a foundation for an analysis and can represent all views of system architecture.

Automated elicitation of functional requirements is achieved by using reporting mechanism of a CAPE Tool, ARIS Toolset<sup>3</sup>. This will help both acquirer and developer to formulate system requirements easily based on the standard format that can be easily understood by all the stakeholders.

### **1.3 ROADMAP**

This study is divided into six chapters, which are introduction, background, ARIS, method, case study and conclusion.

In Chapter 2, research related with this study and background of the research is described.

In Chapter 3, ARIS approach that provides integrated, complete architecture and business process modeling techniques is described

In Chapter 4, three-step life cycle method proposed for eliciting functional requirements of software intensive system is described.

In Chapter 5, evaluation of proposed method partially applied in actual project is explained and reporting script and its output we developed are given with their purposes.

In Chapter 6, we assess the results of the study and also describe the future work in addition to this study.

---

<sup>3</sup> <http://www.ids-scheer.com>

## CHAPTER 2

### 2 BACKGROUND

#### 2.1 OVERVIEW OF REQUIREMENTS ENGINEERING

Success of the software intensive project heavily depends on the activities performed during requirements development phase of the project. “Between 40 and 60 percent of all defects found in a software project can be traced back to errors made during the requirements stage” [Leffingwell, 1997]. What is a requirement?

The IEEE define a requirement as one of the following [Dorfman, 1997]:

- A condition or capacity needed by a user to solve a problem or achieve an objective;
- A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification or other formally imposed documents;
- A documented representation of a condition or capability as in first definition or second.

Pohl defines Requirements Engineering as: “The systematic process of developing requirements through an iterative co-operative process of analyzing the problem, documenting the resulting observations in a variety of representation formats, and checking the accuracy of the understanding gained” [Macaulay, 1996]. It focuses on “what” needs to be designed rather than “how” it can be designed. Requirements elicitation, analyzing, specification, modeling, verification and management are the foundation of requirements engineering [Wieggers, 1999].

### 2.1.1 Requirements Elicitation

Requirements elicitation is a collaborative decision-making activity involving users, developers, and customers [Christel, 1992]. This phase of the requirements engineering is very important and more emphasis must be put on this phase. It is the most difficult, most critical, most error-prone and most communication-intensive aspect of software development [Wieggers, 1999]. Requirements must be gathered before requirements can be analyzed, modeled or specified [Pressman, 2001]. Most of the projects fail due to the inadequate requirements determination. First of all, we must capture what and why we actually need. Requirements elicitation is an evolutionary activity, that is, not all requirements are captured during the first iteration. There are some traditional methods of collecting system requirements:

- Individually interviewing people informed about the operation, preferably the domain expert, and issues of the current system and needs for systems in future organizational activities.
- Surveying people via questionnaires to discover issues and requirements.
- Interviewing groups of people with diverse needs to find synergies and contrasts among system requirements.
- Observing workers at selected times to see how data are handled and what information people need to do their jobs
- Studying business documents to discover reported issues, policies, rules, and directions as well as concrete examples of the use of the data and information in the organization.

There are also some modern methods for collecting system requirements:

- Bringing together users, sponsors, analysts and others to discuss and review system requirements in a joint application design (JAD) session.
- Using group support systems to facilitate the sharing of ideas and voicing opinions about system requirements.
- Using computer aided process-engineering (CAPE) tools to analyze current systems to discover requirements to meet changing business conditions.

- Iteratively developing system prototypes that refine the understanding of system requirements in concrete by showing working versions of system features [Jeffrey, 1999].

### 2.1.2 Challenges of Requirements Engineering and Its Elicitation Phase

A Savant Institute study found that “56% of errors in installed systems were due to poor communication between user and analyst in defining requirements and that these types of errors were the most expensive to correct using up to 82% of available staff time” [Goodrich, 1990]. Requirements engineering and especially its requirements elicitation phase have some challenges encountered in all projects; all of the errors found, related with requirements are caused by these challenges:

- Because it has a multi-disciplinary nature, to meet the needs of the stakeholders who might come from different disciplines is a very big challenge.<sup>4</sup>
- Documentation of the requirements is another challenge, as people always prefer more informal ways of communication, and software is a formal description [Dorfman, 1990].
- Making changes to the requirements after they have been agreed is very difficult. Modifying the target document is difficult.
- There are always misunderstandings between customer, those developing system requirements and developer [Kotonya, 1998].
- People may have different understanding of the problem domain.
- Requirements are inconsistent and/or incomplete [Kotonya, 1998].
- Customers/users are not completely sure of what is needed, have a poor understanding of the capabilities and limitations of computing don't have a full understanding of the problem domain and have trouble communicating needs to the system or software engineer [Christel, 1992].

---

<sup>4</sup> <http://www.cs.toronto.edu/%7Eesme/papers/2000/ICSE2000.pdf>

- Changeability of the requirements. Requirements change over time due to the dynamic nature of the organizations.
- There are a lot of elicitation techniques and their output might overlap or conflict.
- Traditional elicitation approach of asking what they want the system to do is not a powerful approach [Wieggers, 1999].
- Lack of early system model that can be used as a discussion vehicle.
- Lack of tools compared with programming.

Elicitation is not only a simple transcription of what customers say they need. User proposed solutions could mask the users' actual needs. Requirements analyst must probe beneath the surface of the requirements that the customers presents in order to understand the true needs. There must be an effective communication between them, because elicitation can succeed only through an effective customer developer-partnership [Wieggers, 1999]. Today JAD is used for this kind of partnership and can overcome some challenges of requirements engineering.

### **2.1.3 Joint Application Development (JAD) for Requirements Elicitation**

This methodology was developed by IBM and first came to use in the early 1980s. It is a technique that allows the development, management, and customer groups to work together to build a product. JAD sessions are used in the Product Life Cycle to collect and manage product requirements. The focus is on business objectives. It is very effective method for collecting requirements from end users, customers. Requirements can be defined and specified in a consistent and structured way.

JAD refers to joint process of collecting requirements and resolving issues as early as possible through a series of meetings. There are some benefits of this method:

- “It saves time. By properly using transition managers, and the appropriate users, the typical cultural risk is mitigated while cutting implementation time by 50%” [Engler, 1996].
- It eliminates process delays and misunderstandings

- It reduces function creep, most of which results from poor initial requirements [Anthes, 1994].
- It avoids bloated functionality, gold plating, and helps designer's delay their typical "solution fixation" until they understand the requirements better [Whitmore, 1995].
- It lays the foundation for a framework of mutual education, separate brainstorming, binding negotiation, and progress tracking [Whitmore, 1995].
- It shortens the requirements elicitation stage by getting the key players together to solve the disagreement on requirements.

Today JAD is used in strategic business planning, process analysis and target business process design. It has become the most important part of the IS development process focusing on analysis of the system. During JAD sessions, models can be used to increase the mutual understanding. Modeling creates a common language that can be understood and used by the stakeholders of the projects. Thus, it facilitates JAD sessions. Today, requirements determination activities are not only used for understanding what is needed and desired in future systems but also used for understanding current problems and opportunities, as current way of doing things has a large impact on the new system. Business process modeling helps to understand and find out the problems of the current system and the solutions to these problems. Business process modeling and understanding existing processes are explained in 2.3.4, and 2.3.2.2.

#### **2.1.4 Automation Support In Requirements Elicitation**

In the 1970s, requirements analysis was usually considered primarily a question of eliciting requirements from users through interviews, brainstorming, and JAD sessions. In the 1980s, it was seen as a documentation problem, with great emphasis on visual modeling techniques such as structured analysis and object-oriented analysis. In the 1990s, the emphasis shifted to managing requirement, with automated tools. In the first decade of the millennium, requirements analysis is now

seen as a carefully balanced combination of elicitation, documentation, and management<sup>5</sup>.

Today most of the automation support is focused on design and implementation phase of the system development life cycle. There is lack of tools for requirements engineering activities especially in requirements elicitation and most of the current tools are only focused on requirements management activity.

Automation in requirements elicitation may provide some benefits for the stakeholders of the software-intensive system development projects:

- It shortens the requirements elicitation stage, saves time for other phases of the project.
- Changes of requirements can be easily reflected.
- Trace ability of the requirements is easier.
- Verification of requirements is easier.
- It provides standard and consistent requirements expressions. Thus, understandability of the requirements by the developer and the customer increases.
- It speeds up documentation of the requirements.
- Transition to succeeding step in the life cycle of the IS development is easier.

Whatever the tools are used, success of the IS development projects heavily depends on the discovering true requirements of the proposed system and achievement of this activity depends on the requirements engineering methods.

## **2.2 REQUIREMENTS ENGINEERING METHODS**

Process of requirements engineering are usually guided by a requirements method. Requirements methods are systematic ways of producing system models. System models are important bridges between the analysis and design methods

---

<sup>5</sup> <http://www.yourdon.com/seminars/RM.HTML>

[Kotonya, 1998]. There are a lot of classifications of requirements engineering methods, made by various working groups and researchers. All of them take this subject from different aspects and make a different categorization. “There are no ideal requirements engineering method” [Kotonya, 1998]. In this section, all of the methods are not examined detailed, but some of the modeling techniques they use will be considered. A number of methods use a variety of modeling techniques to formulate system requirements. Modeling can guide requirements elicitation.<sup>6</sup>

“A model is an abstraction or simplification of some part of the present or proposed information system” [Avison, 1995]. There is no universal agreement about which aspects of the existing and/or the new information system should be modeled and the notations that should be used to model them [Steele, 1999].

The development of an information system is a complex activity. The variety of things to deal with is very large. Abstracting from complexity is a very good technique for dealing with this complexity. In order to express all the subtleties of complex systems, it is necessary to use multiple views, with each view representing a subset of the aspects of interest [Booch, 1994]. The graphical aspect of system means it can be used both as a static piece of documentation and as a communication tool.

Modeling frameworks define the models to be used and their roles within the system development methodology [Booch, 1994]. There are many approaches for modeling frameworks. Each framework is different, but the contexts that they provide are the same. All of them have:

- Modeling technique,
- Modeling elements, and
- Modeling context.

Modeling element is defined as an abstraction drawn from the system being modeled. e.g. organizational unit, function or information carrier [Steele, 1999]. Modeling context is a modeling universe of discourse, or area of modeling focus [Halpin, 1995] e.g. requirements, design, and implementation. Modeling technique

---

<sup>6</sup> <http://www.cs.toronto.edu/~sme/CSC2106S/05-Modeling1.pdf>

is a modeling procedure and a corresponding notation to carry out a certain type of modeling activity [Brinkkemper, 1990].

Today structured analysis and design methods use some modeling techniques to overcome the some of the challenges of the requirements engineering.

### **2.2.1 Structured Analysis and Design Methods**

All of the structured methods were developed as results of attempts to meet the following requirements in one-way or another [Yeates, 1994].

- More clarity of stated requirements by using graphical representation.
- Less scope for ambiguity and misunderstanding.
- A greater focus on identifying and then satisfying business needs.
- More trace ability, to enable a business requirement to be followed through from initial analysis, into the business-level specification and finally into the technical design.
- Much more user involvement at all stages of the development.

Information engineering, Yourdon approach, Jackson System Development, Structured Systems Analysis and Design Method (SSADM) are some of the typical structured methods. These methods view information systems principally in two ways, firstly as data, the information that the system records, and secondly as processing, what the system does with this data. Much emphasis in these methods has been placed in modeling process aspects and data aspects of the information system. In structured analysis and design methods, structured modeling techniques are mostly used. These are the techniques for which the syntax is well defined, but the semantics is less well defined. For example: entity relationship (ER) diagrams and data flow diagrams (DFD). ER diagrams are used for data modeling and DFD is used for process modeling. Because our focus is on functional aspect of the systems, DFDs are considered.

#### **2.2.1.1 Data Flow Diagrams**

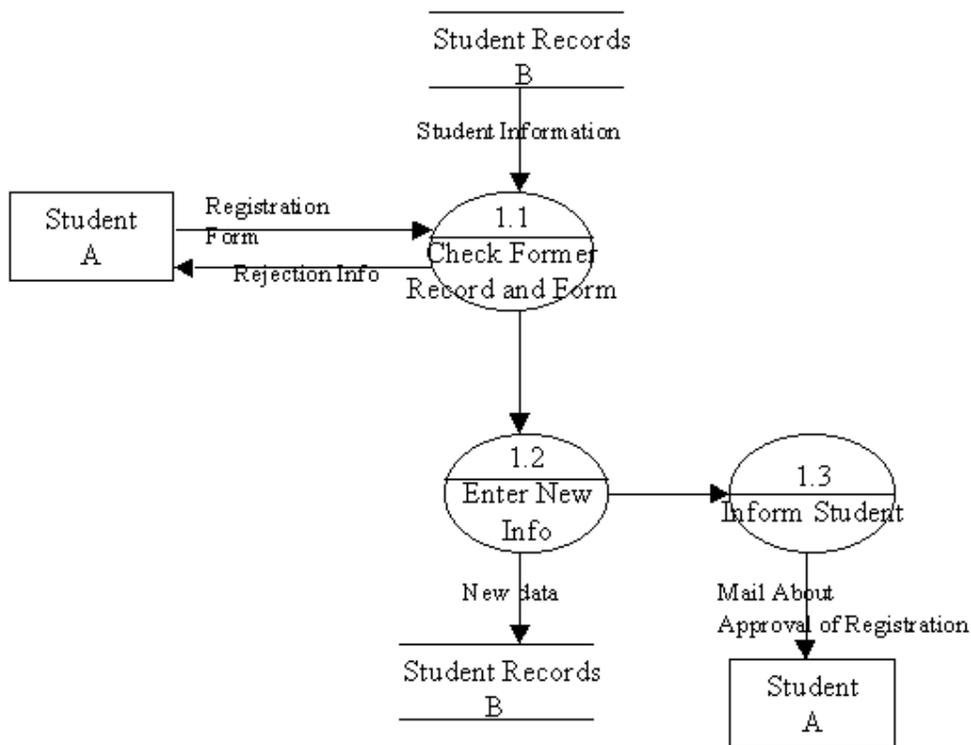
Data flow diagrams are the most commonly used way of documenting the processing of current and required system in structured analysis and design methods.

As their name suggests, they are a pictorial way of showing the flow of data into, around and out of a system [Yeates, 1994].

DFD is composed of four elements:

- The data flow: Data flow is represented by an arrow and depicts the fact that some data is flowing or moving from one process to another.
- The processes: The processes or tasks performed transforms the data flow by either changing the structure of the data or by generating new information from the data.
- The data store: It represents data that is not moving.
- External entity: It represents sources of data to the system or destinations of data from the system.

Representations of DFD' s elements vary in structured methods. Most common notations used are given in Figure 1, where A is the external entity, and B is the data store. Data flow is represented by arrows, and 1.1, 1.2, 1.3 are the processes.



**Figure 1. Level 1 DFD for Student Registration**

One of the most important features of the DFD is the ability to construct a variety of levels of DFD according to the level of abstraction required. This “leveling” process gives the DFD its top-down characteristic [Avison, 1995]. Sequence and process logic have no place or meaning in a DFD. These diagrams have no process view, however this view helps either developer or business user to understand the system mutually and well and easily find out the weaknesses, deficiencies and improvement points. EEPCC business process modeling technique that is described in section 3.2.3 can be used to address this problem.

Object-oriented methods use many modeling techniques, namely object oriented models to formulate system requirements.

### 2.2.2 Object Oriented Models

Object oriented analysis is an approach for developing information system and has an increasing importance among information system development

methodologies [Scheer, 1999]. The creation of object-oriented models is based on their system theory goal of capturing, explaining and describing complex systems by using consistent standards. One advantage of object-oriented modeling is the close link of the models with implementation. This makes prototyping very easy.

Because object oriented modeling adheres closely to the concept of system development, it does not specifically focus on business issues and does not support illustrating processes in a very detailed manner [Scheer, 1999]. Even with methods such as use case or interaction diagrams, it is difficult to depict process branching, organizational aspects and output flows. State transition diagrams as well as actions and object flow diagrams are process illustrations. “There is a lack of framework for classifying illustration elements in object-oriented modeling” [Scheer, 1999]. Therefore, it is more difficult to recognize any overlapping or any contradictions within diagram types. In addition to this, these kinds of models are developer or engineer or analyst oriented. Business users have a trouble in understanding these models. In the same way, technical people can understand these models but they don't have business perspective.

Besides these techniques, formal methods are trying to formulate requirements based on mathematically formal syntax and semantics.

### **2.2.3 Formal Methods**

"Formal methods provide a means for achieving a high degree of confidence that a system will conform to its specification. The number of formal methods in use today can be divided into two categories" [Kotonya, 1998]:

- Model-based notations: Z and VDM
- Process algebras-based notations: Communicating Sequential Processes (CSP) and Lotos

Formal methods have some advantages. They remove ambiguity; and it is possible with them to verify the correctness, incompleteness and inconsistency checking of the specification. Formal methods are not widely used among software developers. Because they have some disadvantages:

- Difficulty in understanding the notations;

- Difficulty in formalizing the certain aspects of requirements.
- Difficult to represent the behavioural aspect of the problem.
- Do not address the problem of how the requirements are constructed.
- Lack of adequate tool support.

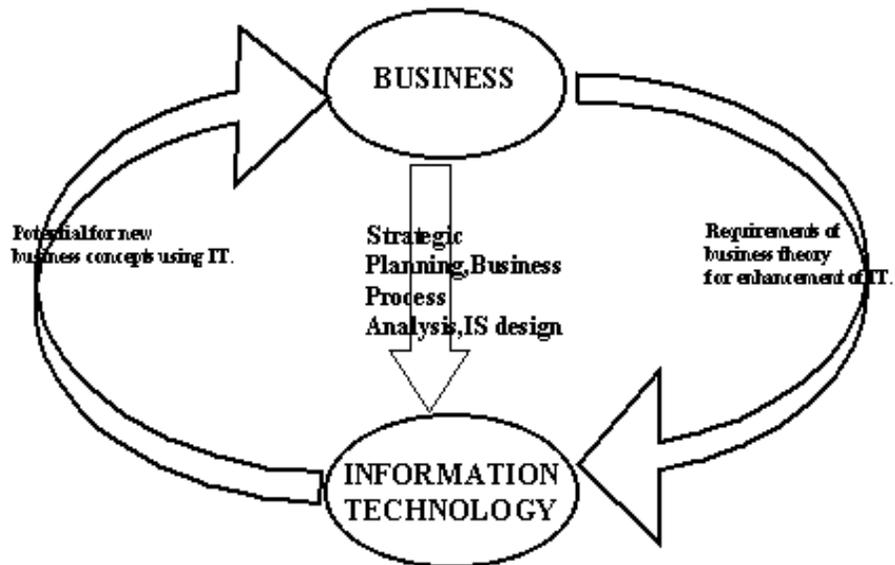
Whatever techniques are used, business requirements must drive analysis and design activities. In other words, focus must be on business requirements rather than on the technology. There must be a way for building a bridge between the all aspects of business and technology. Actually, requirements engineering as an emerging discipline that helps us align business with technology.

### **2.3 BUSINESS AND IT ALIGNMENT**

Today usage of IT for the purpose of innovation of business processes is rapidly adopted approach by many organizations. Acquisition of IT without sound business strategies has shifted organizations towards a fragmented, less integrated state. Thus, acquisition caused the organizations to have redundant, no cohesive business structures and fragmented data and system architectures [William, 2001]. This is due to the fact that organizations ignore business-IT alignment concept during any business process innovation. Business-IT alignment is achieved when business requirements, strategy, infrastructure, and processes are synchronized with each other and with IT infrastructure, data, systems, and processes.<sup>7</sup> Although there is a bi-directional relationship between two, as shown in Figure 2, turning business-IT alignment concept into practice is not an easy task.

---

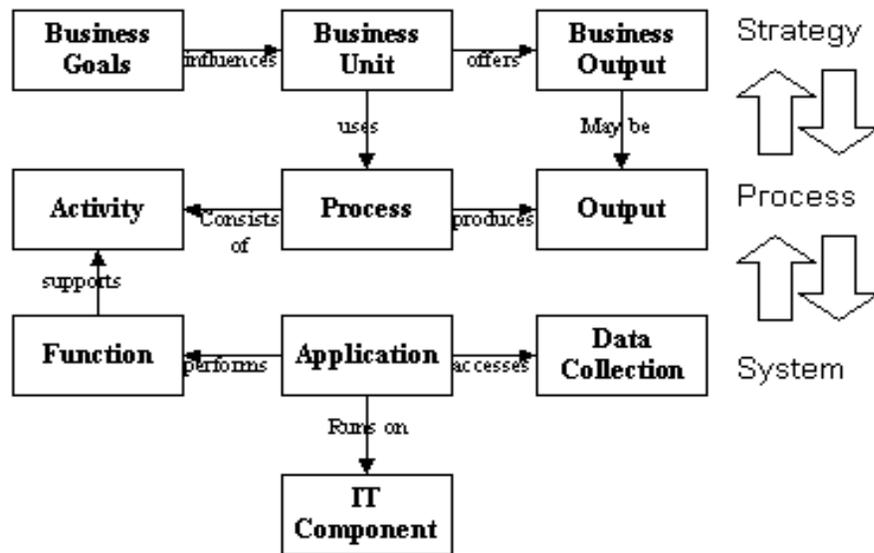
<sup>7</sup> <http://www.cutter.com/itreports/achieving.html>



**Figure 2. Relationship between Business and IT [Scheer, 1999]**

Coordination between three domains; strategic planning, process analysis and target process design information systems; can help organization in business-IT alignment. How can business goal be achieved with IT? What are our business requirements and how can we derive target system requirements from business requirements? Strategic planning methodologies, business process analysis and IS supported business processes design methodologies can be together central to meeting these challenges. They really do act as bridges between business and information technologies.

Business engineering structures the alignment and divides the alignment process into the development of strategy, process and systems, breaks down these levels into small manageable steps and unites them through the outcomes, shown in Figure 3.



**Figure 3. Metamodel of business engineering [Blessing, 1999]**

It is realized that because strategic planning, business process analysis, and information systems are critical subjects in achieving the business and IT alignment; we must follow a unified methodology which can integrate the strategic planning, business processes analysis and design of target business processes that will be supported by IS.

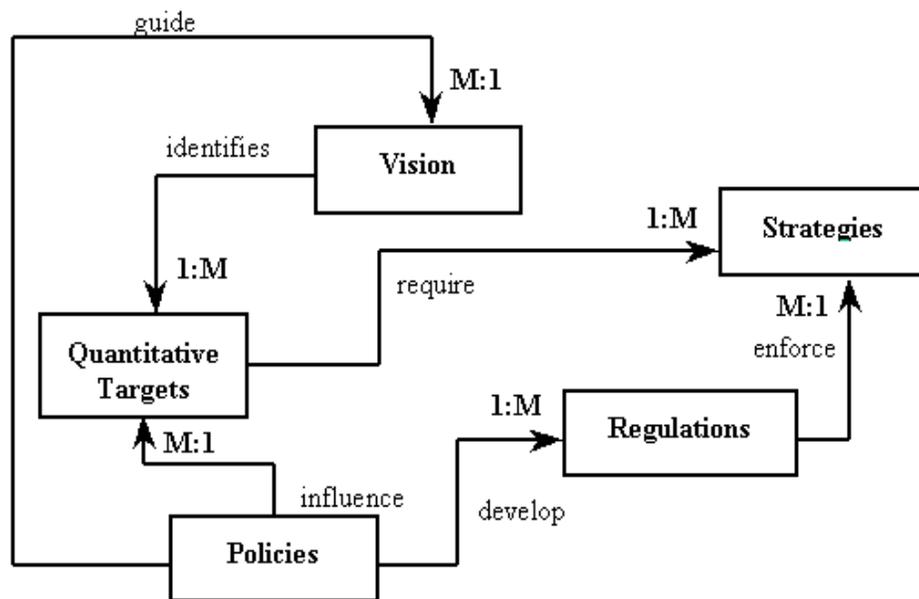
### 2.3.1 Strategic Planning

Organizations must have their own strategic plan, which defines their vision, goals and strategies. The vision is a clear indication of where the organization is to be headed and its identification is the first step of the any strategic plan. The goals represent the long-term goals, which describe where the organization would like to be in the future and the strategies are developed based on the goals. Strategies are the directions that guide an organization for achieving the business objectives. Strategic planning serves a variety of purposes in organization, including to:

- Clearly define the purpose of the organization and to establish realistic goals and objectives consistent with that mission

- Communicate those goals and objectives to the organization's constituents.
- Develop a sense of ownership of the plan.
- Ensure the most effective use is made of the organization's resources by focusing the resources on the key priorities.
- Provide a base from which progress can be measured and establish a mechanism for informed change when needed.
- Bring together of everyone's best and most reasoned efforts have important value in building a consensus about where an organization is going.
- Provide clearer focus of organization, producing more efficiency and effectiveness
- Produce great satisfaction among planners around a common vision.<sup>8</sup>

There is no one right strategic planning model for all organizations or circumstances. Following Figure 4 is the abstraction for the strategic planning developed by George Mason University:

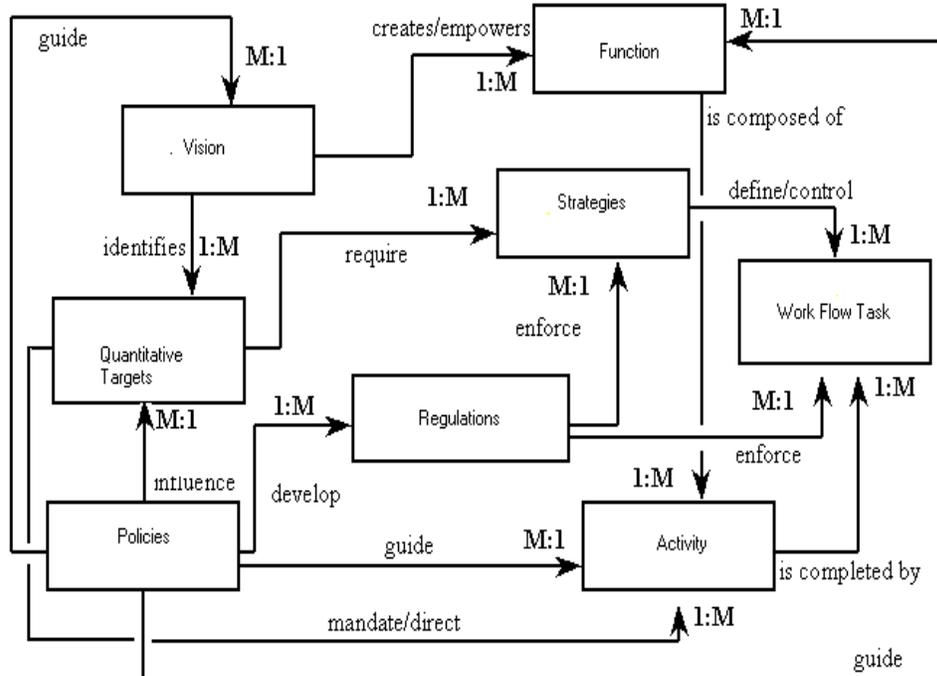


**Figure 4. Strategic Planning Model<sup>9</sup>**

<sup>8</sup> [http://www.mapnp.org/library/plan\\_dec/str\\_plan/str\\_plan.htm#anchor453886](http://www.mapnp.org/library/plan_dec/str_plan/str_plan.htm#anchor453886)

<sup>9</sup> <http://ion.ii.metu.edu.tr/ion/courses/ion542/lectures>

This strategic planning model can further be extended to cover vision, goals, strategies and processes, as shown in Figure 5.



**Figure 5. Extended Strategic Planning Model<sup>10</sup>**

“There needs to be a wholistic approach to start modeling the organization based on the strategies, which should be based on qualitative and measurable goals, which have to be achieved to realize the organizational vision; that is for proper Vertical Integration, the model, and hence the process, has to be aligned with the strategies, which have to be aligned with the vision” [Güçlü, 2001]<sup>11</sup>. Alignment of IT objects with the business processes and alignment of business processes with the organization’s strategies are very important for the success of business process innovation. “Business process consists of a group of logically related tasks that use the resources of the organization to provide defined results in support of the organization’s objectives” [Harrington, 1991]. Business processes are the focal

<sup>10</sup> <http://ion.ii.metu.edu.tr/ion/courses/ion542/lectures>

<sup>11</sup> <http://ion.ii.metu.edu.tr/ion/courses/ion542/lectures>

point in business-IT alignment. “Strategies are translated into action through business processes” [Marshall, 2000].

There is yet no software tool support starting from vision, and continue with business process analysis and information systems design and implementation. In other words, there is no software tool that can streamline abstract vision to the concrete business processes by which it is achieved. Tools and techniques for achieving process analysis objectives are distinct in use from those for working towards systems development objectives.

### **2.3.2 Business Process Analysis**

“A process is a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined and outputs: a structure for action” [Davenport, 1993]. A business process defines how an organization achieves its purpose including vision and goals. The term “business process” has many definitions because a process impacts all aspects of an organization [Marshall, 2000]. There is no product and/or service without a process. Likewise, there is no process without a product or service. Although business processes have been ignored in the past, much more effort is given to improving business processes today. This effort helps the organization in a number of ways, by:

- Allowing the organization to focus on the customer,
- Providing a means to effect major changes to very complex activities in a rapid manner,
- Helping the organization effectively manage its interrelationships,
- Providing a systematic view of organization activities,
- Helping the organization understand how inputs become outputs,
- Preventing errors from occurring,
- Providing a view of how errors occur and a method for correcting them,
- Providing an understanding of how good the organization can be, and defining how to get it there,

- Providing a method to prepare the organization to meet its future challenges [Harrington, 1991].

### 2.3.2.1 Process-Oriented Structuring Versus Functional Structuring

Business processes form a link between corporate goals and the necessary measures to meet this goal, such as by using IT aids. Thus, “business process oriented development of software systems, by which complete business processes are optimized, aids in meeting the strategic objectives of an enterprise” [Kirchmer, 1999]. Functionally structured organization is the most common form of organizations today. Functionally organized groups are often parochial-with little more than a narrow perspective on organizational goals or purpose. In part, because of this limitation they lack built-in objectives that directly relate to organizational goals and could otherwise serve as mechanism for coordination of their activities. [Sadoe, 2001]. This kind of organization has an extra need for coordination and control.

Process-oriented structuring is most appropriate when there are significant interdependencies across the entire workflow. Process, as defined by Davenport as “structure for action”, reduces the requirement of hierarchical control. Sequencing of activities is a strong feature of a process. This often acts as a built-in mechanism for coordinating work. Furthermore, with a clearly identified inputs and outputs, processes are also easier to improve and highly measurable in terms that directly relate to organizational goals.

Only processes have a direct effect on the customers (internal or external) of the organization. The customers of a specific business are the reason for the existence of that business, and thus the processes of the business must have a direct effect on the customer, else the organization is not achieving its goals and is in business for the wrong reasons<sup>12</sup>.

Analysis and design of business processes are the major tasks of business engineering [Scheer, 1994], [Hammer, 1993]. Any innovation activity such as

---

<sup>12</sup> <http://saturn.cs.unp.ac.za/~normanb/part2.pdf>

automating the processes requires careful analysis and planning. IT should be used to strengthen the right business processes. For this reason, one important strategic decision that an organization can make is not deciding how to use computers to improve business processes, but instead to first understand what business processes need improvement [Keen, 1997].

### **2.3.2.2 Understanding Existing Business Processes**

It is important to understand the current business processes of the organization before designing the new one. There are some reasons for documenting the existing business processes:

- Understanding existing processes facilitates communication among participants in the innovation initiative.
- Models or documents enable participants to develop a common understanding of the existing state.
- In complex organizations there is no way to migrate to a new process without understanding the current one.
- Current processes are useful for understanding the magnitude of anticipated change and tasks required to move from the current to a new process.
- Recognizing problems in an existing process can help to ensure that they are not repeated in the new process [Davenport, 1993].

Graphical documentation and process modeling is a good technique to understand the existing business processes. Existing business processes models are used to establish a baseline for subsequent business process innovation actions and programs.

### **2.3.3 Designing The Target Business Processes**

Before starting implementation of the system, requirements for the business process innovation must be translated into proposed system requirements.

There are some issues that need to be considered:

- A description of the IT-based systems needed to support a new process is an important aspect of the process design.
- Describing target system with the business terminology contributes to obtain accurate and complete system requirements.
- Existing business processes are the foundation of this kind of study for finding out the weak points.
- When designing the new system, it is worthwhile to try to describe the new processes based on the business objectives.
- Target business processes design must be streamlined to respond the business requirements [Cummins, 2002]. Event-driven business design helps us in this way.

The “to-be” model serves as the foundation for implementing the new business processes and defines the requirements for new information technology systems. Many methods can be used to create the “to-be” picture, that is, target design of the business processes. Regardless of the method chosen, all methods share common elements, which can be utilized for business process innovation. These elements include the notion of customer focus and the outcomes of the process. Another point is that describing all aspects of business process and analyzing current processes assist in finding the weak points that need to be improved.

Business process modeling is an effective method for these purposes. New business processes of the proposed system must be modeled allowing both customer and developer to jointly see and decide whether proposed solution is a solution for the defined business problems. This approach can further be extended to include simulation before implementing the solution.

#### **2.3.4 Business Process Modeling**

Today, due to an ever-closer alignment of information technology to business processes, the significance of business process modeling has grown. Process is one of the basic concepts of modeling. This results in business process modeling being increasingly regarded as an extension of business administration [Scheer, 1999].

Reorganizing business process requires some form of methodology for modeling existing processes in order to determine which are redundant, which are good or bad, which require modification. A business is a complex system, consisting of a hierarchical organization of departments and their functions. The traditional method for documenting a business is to draw an organization chart, which divides the business into a number of departments or sections, represented vertically. This method is limited to how the business is built and organized. Very few methods or standards exist in this area. Besides flowcharting can't capture the whole business process views. It conveys process logic in an ambiguous manner whereas process modeling conveys process logic with unambiguous syntax. Most of the methods focus on only describing a business rather than on structuring and running a business. Business process models are increasingly becoming a focal point and blueprint for configuring information systems. There are multiple reasons for creating business process models, such as

- It can help to uncover problems,<sup>13</sup>
- Storing corporate knowledge,
- Creating link between business strategy and business processes,
- Utilizing process documentation for any certifications,
- Calculating the cost of business processes,
- “Leveraging process information to implement and customize standard software solutions or workflow systems” [Scheer, 1999],
- Increasing the understanding of the business and facilitate communication about the business providing common language,
- “Optimizing business processes in accordance with business strategy” [Scheer, 2000],
- Being a baseline for continuous improvement. Enterprises must constantly reconsider and optimize the way they do business and

---

<sup>13</sup> <http://www.cs.toronto.edu/~sme/CSC2106S/05-Modeling1.pdf>

change their information systems and applications to support evolving business processes [**Scheer, 2000**],

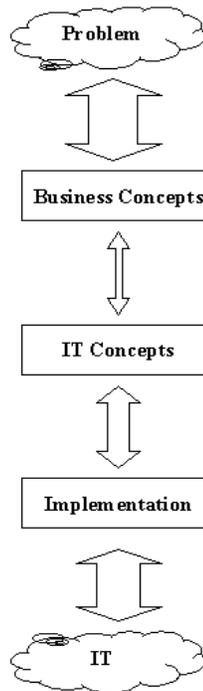
- Quality management is the ideal tool to guide the company in all areas and tasks and to increase efficiency. International quality norms and models such as DIN EN ISO 9001:2000 and EFQM have recognized this and treat the management of business processes as a basic prerequisite for the success of a company. The primary requirement of these worldwide standards is an effective and consistent modeling of business processes.<sup>14</sup>

Because they are used for describing, structuring business processes and for configuring information system, business process models can be used as a starting point in extracting business requirements in the information system planning and development process. Today, computer scientists tend to start modeling with the IT terminology, which in general is never understood by the customer. However, the customer using business terminology expresses business problems and implementation issues are not their concern. Business processes must be designed by business people rather than by technologists, so the process notation should be business oriented rather than technological needs. Business-level specifications must enable business people to understand and control their business systems [**Cummins, 2002**].

It is also necessary to generate IT-level specifications after specifying business-level specification for the purpose of deriving functional requirements of the proposed system. The hardest phase of the business analysis and design is the transition from the business concepts and to the IT concepts, depicted in Figure 6, as once the problem is defined, there are well known and proven methodologies to deliver the solution for the (IT) defined problem.

---

<sup>14</sup> <http://www.ids-scheer.com>



**Figure 6. Phased Approach<sup>15</sup>**

For this reason, there needs to be a modeling technique that enables customers to describe their business processes and to find out and define their problems from the point of their own view and enables computer scientist to describe proposed system with IT terminology that can be understood by the customer and can be easily mapped to the implementation description.

Business process modeling can be used to assist JAD sessions. Because, business process models are common communication languages between the stakeholders for understanding the system processes and used for finding out the weaknesses, strengths and the improvement points of these processes in accordance with the business strategy of the organization.

There are many business process modeling techniques and tools. One of the most commonly used business process modeling techniques used in the defense

---

<sup>15</sup> <http://ion.ii.metu.edu.tr/ion/courses/ion542/lectures>

industry is IDEF0, which is derived from the Structured Analysis and Design Technique (SADT), a well-established graphical language<sup>16</sup>.

#### **2.3.4.1 Integration Definition For Function Modeling (IDEF0)**

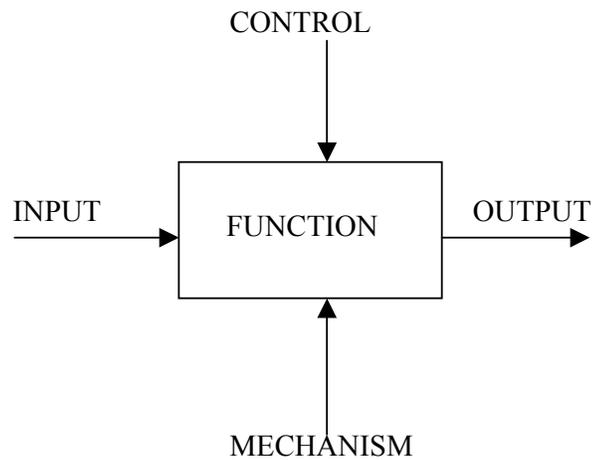
In this section, IDEF0 modeling method is explained. IDEF0 helps to organize the analysis of a system and to promote good communication between the analyst and the customer. It provides a formalized modeling notation for representing the type of functional analysis [Hannam, 1997]. The primary objectives of this standard are:

- To provide a means for completely and consistently modeling the functions (activities, actions, processes, operations) required by a system or enterprise, and the functional relationships and data (information or objects) that support the integration of those functions;
- To provide a modeling technique which is independent of Computer-Aided Software Engineering (CASE) methods or tools, but which can be used in conjunction with those methods or tools;
- To provide a modeling technique that has the following characteristics:
  - Generic (for analysis of systems of varying purpose, scope and complexity)
  - Rigorous and precise (for production of correct, usable models);
  - Concise (to facilitate understanding, communication, consensus and validation);
  - Conceptual (for representation of functional requirements rather than physical or organizational implementations);
  - Flexible (to support several phases of the lifecycle of a project).<sup>17</sup>

---

<sup>16</sup> [www.idef.com](http://www.idef.com)

<sup>17</sup> <http://www.idef.com/Downloads/pdf/idef0.pdf>



**Figure 7. IDEF 0**

The building block of the notation is a box specifying the function or activity and four arrows signifying inputs, outputs, controls and mechanisms, as shown in Figure 7. The arrows can be resources, such as machines or equipment, material, data, information, people, products, thus, almost any aspect of an organization except its activities. IDEF0 tackles the complexity of the functions within the hierarchic structure of diagrams. There is a limitation of detail to no more than six sub functions on each successive function. Thus, there is a control of details communicated at each level. This modeling method has both advantages and disadvantages. These are explained in Table 1. Information on Table 1 is gathered from Hannam's book (1997) and the web site stated at previous page.

**Table 1. IDEF0 Strengths and Weaknesses**

| <i><b>STRENGTHS</b></i>   | <i><b>WEAKNESSES</b></i>  |
|---|---|
| Effective in detailing the system activities by their inputs, outputs, controls and mechanism   | It is so concise that IDEF0 models are understandable only if the reader is a domain expert or has participated in the model development. |
| It facilitates the ability to construct AS-IS models that have a top-down representation and interpretation, but which are based on bottom-up analysis process.       | It does not support the specification of a process. There is an abstraction from sequence and decision logic.                             |
| It is a coherent and simple language, providing for rigorous and precise expression, and promoting consistency of usage and interpretation.                           | Tendency of IDEF0 models to be interpreted as representing a sequence of activities.  |
| It can be generated by a variety of computer graphics tools; numerous commercial products specifically support development and analysis of IDEF0 diagrams and models. | It has also abstraction from process logic. It is not suitable for TO_BE modeling, which is based on top-down logical decomposition.      |
|   | Organizational viewpoints are avoided.  |

As seen in Table 1, besides its benefits, IDEF0 has a considerable weakness: representation of big picture.

Models are the language of the system architectures and architectures provide a means for organizing the models into useful categories. We will now investigate and try to compare some of the most common IS architectures.

### **2.3.5 Information System Architectures**

Information system is an engineered arrangement of people, procedures, computers, communications facilities, software code, and data designed to support a business process.<sup>18</sup> The definition of information system emphasizes the linkage between process and technology in organizations. Because IS do not operate in isolation, all information system architectures must be considered and designed together with organization, its business and business processes in which IS function [Sadoe, 2001]. Information systems objectives are only a portion of the business-IT alignment challenge. These objectives can only be achieved with a complete and clear architecture. From the perspective of IT and IS, the system architecture is a tool which makes sure the technology solutions delivered to the business are relevant and it is also a tool that provides a means for designing the solutions by integrating the technical design with the stated business requirements. From the business manager, the architecture is a tool that helps him to understand the workings and interrelations of all aspects of the business and it also helps him align IT strategies with business strategies<sup>19</sup>. In this section we will briefly investigate IS architectures that are most important in business-IT alignment.

#### **2.3.5.1 IFIP Architecture - Information System Methodology**

This architecture developed by International Federation for Information Processing Task Group is summarized in the guideline “information systems methodology”. The design of methodology does not focus on any particular IS development methods, rather it is based on as many concepts as possible:

- IEM (Information engineering methodology)
- IDA (Interactive design approach)
- JSD (Jackson system development)
- NIAM (Nijssen’s Information Analysis method)

---

<sup>18</sup> <http://ion.ii.metu.edu.tr/ion/courses/ion542/lectures>

<sup>19</sup> [http://www.popkin.com/customers/customer\\_service\\_center/downloads/whitepaper/method.asp](http://www.popkin.com/customers/customer_service_center/downloads/whitepaper/method.asp)

- SADT (Structured analysis and design technique)

IFIP architecture has two dimensions: Perspectives and development steps. It has data oriented, process oriented and behavior oriented perspectives. Entity types and their attributes are reviewed in the data oriented perspective. Business activities are described in process-oriented perspectives and events are analyzed in the behavior-oriented perspective [Scheer, 1999]. This methodology proposes 12-steps life cycle model [Olle, 1991]. There is a lack of implementation phase at development steps dimension and organization and output views at perspective dimension are not also considered. One of the disadvantages of IFIP is its lack of control perspective that can be used to assemble the perspectives at the same platform [Scheer, 1999].

#### 2.3.5.2 CIMOSA

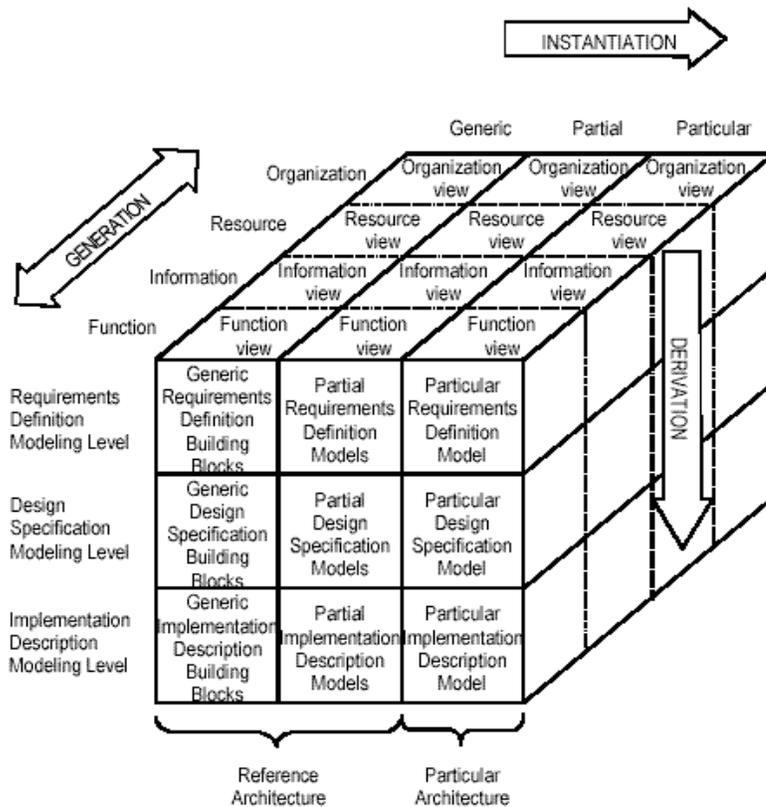
Computer Integrated Manufacturing Open System Architecture (CIMOSA) is developed for CIM systems. It is based on CIMOSA cube and distinguishes three different dimensions, described by the three axes of the cube<sup>20</sup> as shown in Figure 8.

Dimensions are:

- Stepwise generation: Various views of information system are described.
- Stepwise instantiation: Concepts are individualized step by step.
- Stepwise derivation: Three descriptions, modeling levels of the phase concept are described.

---

<sup>20</sup> <http://cimosacnt.pl/Docs/Primer/primer5.htm>



**Figure.8. CIMOSA Architecture**<sup>21</sup>

CIMOSA defines four modeling views of the organizations functions<sup>22</sup>:

**Table 2. CIMOSA Modeling View Dimension**

|                          |  |
|--------------------------|--|
| Function view            | It is the description of activities.   |
| <b>Information View</b>  | It refers to data view, describes the inputs and outputs of functions.                 |
| <b>Resource View</b>     | It describes IT and production resources.  |
| <b>Organization View</b> | It implies the hierarchical organization and defines authorities and responsibilities. |

<sup>21</sup> <http://www.iwi.uni-sb.de/teaching/ARIS/aris-i/aris-e-i/pdfs/ARIS-I-E-81.pdf>

<sup>22</sup> [http://www.pera.net/Arc\\_cimosa.html](http://www.pera.net/Arc_cimosa.html)

The Derivation Process guides the user through the three modeling levels: from the definition of enterprise business requirements (Requirements Definition) through the optimization and specification of the requirements (Design Specification) to implementation (Implementation Description). On each modeling level the enterprise is analyzed from different viewpoints (Modeling Views).

**Table 3. CIMOSA Modeling Level Dimension<sup>23</sup>**

|                                  |  |
|----------------------------------|--|
| Requirements Definition Level    | For gathering business requirements  |
| Design Specification Level       | For specifying optimized and system-oriented representation of the business requirements |
| Implementation Description Level | For describing implemented components.   |

To reduce modeling effort CIMOSA defines three levels of genericity from purely generic to the highly particular, as given in Table 4.

**Table 4. CIMOSA Genericity Level Dimension<sup>24</sup>**

|                  |  |
|------------------|--|
| Generic Level    | Catalog of basic building blocks   |
| Partial Level    | Library of partial models applicable to particular purposes                      |
| Particular Level | Model of a particular organization built from building blocks and partial models |

CIMOSA breaks up the entire context into various views, but it lacks a level for reassembling them. It also does not feature an output view. This methodology is very theoretical, and does not incorporate any tools.

---

<sup>23</sup> <http://www.rgcp.com/cimosa.htm#CimfrW>

<sup>24</sup> <http://www.rgcp.com/cimosa.htm#CimfrW>

### 2.3.5.3 Zachman Framework

This methodology is developed by J. A. Zachman and is based on IBM's information system architecture (ISA). It has a two dimensional structure for describing the information system architecture of an organization, as shown in Figure 9. The first dimension is the roles involved in information system design and second dimension is the views designated by interrogatives. Every field in the matrix is described by a method.

In this framework relationships between views are not entered systematically and the output view is not apparent within the business process. This framework is not capable of being directly implemented into an information system [Scheer, 1999].

|   | <b>What<br/>(Data)</b> | <b>How<br/>(Function)</b>     | <b>Where<br/>(Network)</b>              | <b>Who<br/>(People)</b>             | <b>When<br/>(Time)</b>         | <b>Why<br/>(Rationale)</b>        |
|---|------------------------|-------------------------------|---|-------------------------------------|--------------------------------|-----------------------------------|
| <b>Objective-Scope<br/>(Planner)</b>        | Entity List            | Process List                  | Location List                           | Organization<br>List                | Major Event<br>List            | Objective<br>List                 |
| <b>Business Model<br/>(Owner)</b>           | ER Diagram             | Business<br>Process<br>Model  | Networks<br>(Nodes and<br>Links)        | Organization<br>Chart               | Business<br>Master<br>Schedule | Strategy                          |
| <b>System Model<br/>(Designer)</b>          | Data Model             | Application<br>Architecture   | Distributed<br>System<br>Architecture   | Human<br>Interface<br>Architecture  | Dependency<br>Diagram          | Business<br>Rule<br>Model         |
| <b>Technology<br/>Model (Builder)</b>       | Data<br>Architecture   | System<br>Design              | System<br>Architecture<br>(Hw Sw types) | User Interface,                     | Control<br>Flow<br>Diagram     | Business<br>Rule<br>Design        |
| <b>Components<br/>(sub-<br/>contractor)</b> | Data Design            | Detailed<br>Program<br>Design | Network<br>Architecture                 | Screen,<br>Security<br>Architecture | Timing<br>Definitions          | Rule spec.<br>in program<br>logic |
| <b>Functioning<br/>System (User)</b>        | Converted Data         | Executable<br>Programs        | Communication<br>Facilities             | Trained People                      | Business<br>Events             | Enforced<br>Rules                 |

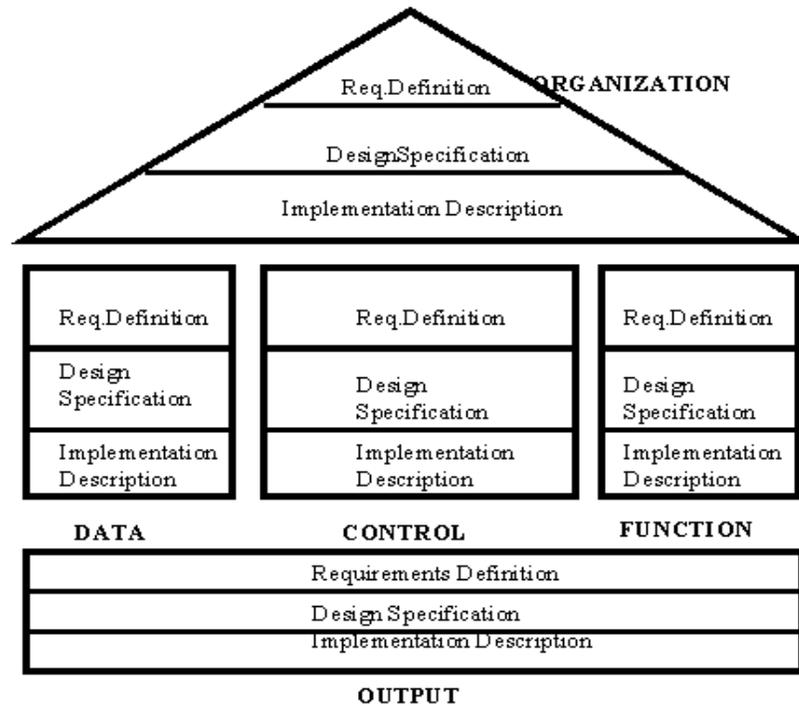
Figure 9. Zachman Framework<sup>25</sup>

<sup>25</sup> <http://www.essentialstrategies.com/publications/methodology/zachman.htm#xzachman>

### 2.3.5.4 ARIS

This concept, “Architecture of Integrated Information Systems”, will be described detail in Chapter 3. It is an architecture for describing information systems and is developed by Prof. Scheer<sup>26</sup>. It provides various modeling methods for describing business processes and is supported by ARIS Toolset<sup>27</sup> software system.

This architecture has two-dimensional structure, depicted by house (of business engineering) as shown in Figure 10 [Scheer, 1992]. First dimension is business process views: Function, data, organization, output and control view. Second dimension is IS life cycle phases: Requirements definition, design specification, implementation descriptions.



**Figure 10. ARIS Architecture**

<sup>26</sup> <http://www.iwi.uni-sb.de>

<sup>27</sup> <http://www.ids-scheer.com>

In the requirements definition (business concept), the information system to be implemented is described and structured in such a way that it can be used as a starting point for a specific implementation. The business content to be described takes up the bulk of this phase. In the design specification, the requirements definition (business concept) is transformed into IT terminology. The last step is technical implementation description.

All views can be modeled individually by various methods of ARIS concept from the point of IS life cycle phases view. In control view, all information system perspectives are assembled and business processes' logical sequence can be represented. This is the major advantage of ARIS and ARIS Toolset program ( a Computer Aided Process Engineering tool) also supports this view by some modeling methods. e.g. EEPC (extended event driven process chain), function allocation diagram. The modeling methods that support control view not only provide understanding of the whole system completely, but also provide modeling business processes considering business strategy. Process oriented and business driven aspects of modeling methods can assist business people in this way. ARIS concept also provides modeling methods that can overcome IDEF0's weaknesses with their integrated top-level business views. ARIS superiorities over other concepts can be seen in Table 5. Table was arranged according to the data obtained from a Scheer's book (1999).

**Table 5. ARIS Advantages**

|                | <b>ARIS ADVANTAGES</b>    |                  |                          |                    |                     |                                 |                     |
|----------------|---------------------------|------------------|--------------------------|--------------------|---------------------|---------------------------------|---------------------|
|                | <b>Architecture Views</b> |                  |                          |                    |                     | <b>Methods</b>                  | <b>Tool</b>         |
|                | <b>FUNCTION VIEW</b>      | <b>DATA VIEW</b> | <b>ORGANIZATION VIEW</b> | <b>OUTPUT VIEW</b> | <b>CONTROL VIEW</b> | <b>VARIOUS MODELING METHODS</b> | <b>TOOL SUPPORT</b> |
| <b>IFIP</b>    | +                         | +                | -                        | -                  | -                   | -                               | -                   |
| <b>CIMOSA</b>  | +                         | +                | +                        | -                  | -                   | +                               | -                   |
| <b>ZACHMAN</b> | +                         | +                | +                        | -                  | -                   | +                               | +                   |
| <b>ARIS</b>    | +                         | +                | +                        | +                  | +                   | +                               | +                   |

## CHAPTER 3

### 3 ARIS

Today, there are many methodologies supporting IS development process. They differ according to their preferred approach and focus. Sometimes in big and complex projects, different development methods are used and their results might overlap. ARIS concept provides integrated framework for individual methods. It shows business administration specialists how to view, analyze, document and implement information systems [Scheer, 1999]. It is used to develop methods for describing or modeling business processes and is also supported by tool, namely Aris Toolset. This tool includes many modeling techniques that are used for creating requirements definition of IS system, making the business processes more understandable, automating reconciliation of the requirements definition of the target concept. Business process modeling techniques that ARIS architecture provides can cover all aspects of business.

#### 3.1 ARIS BUSINESS PROCESS MODELING VIEWS

Identifying functional requirements of the information system perfectly during IS planning and development processes is the leading activity for the success of the IS projects. Understanding structure and dynamic behavior of the system help us to find out the functional requirements of the system. Therefore, we should describe business processes of the system considering responsible entities and their relationships and considering function flows. Business process models are crucial prerequisites for analyzing business process and for finding the best IS architecture for the organizations. There are four types of flows in typical business process to be modeled. Function flow, output flow, information flow and organization flow. None of them is capable of completely describing entire business process. We must combine all these views.

In ARIS business process model, as the function flow is closest to the definition of the business process; it is selected as a foundation and then integrated with other views. The flows developed in the ARIS business process, are depicted in Table 6 [Scheer, 1999].

**Table 6. ARIS Flows in Business Process**

| <i><b>ARIS<br/>FLOWS</b></i> | <i><b>DEFINITIONS</b></i>   |
|------------------------------|---|
| Organization                 | Characterize responsibilities and management of organizational units.   |
| Target                       | Characterize business and conceptual goals to be reached by a process.  |
| Control                      | Control the logical process of functions by means of events and messages. Process functions execute flows by, for example, enhancing input flows by a component, supporting process output. |
| Output                       | Characterize the material output and services.  |
| Resource                     | Characterize the delivery of utilization output of the potential factor “resources”.  |
| Information                  | Controls information access.  |
| Human Output                 | Display the delivery of direct human output   |

Aris concept aims at creating and controlling business processes. It evaluates methods and integrates them by concentrating on their focal points; it is based on this integration concept. Due to the wide variety of classes listed some of them below and their semantic interrelationships, business process models are structured in greater detail in this concept. The resulting structure is known as “Architecture of Integrated Information System” (ARIS).

The classes contained in ARIS meta business process model are:

- Environmental data of the process
- Initial, result event
- Messages
- Functions
- Human output
- Machine resources, computer hardware
- Application software
- Material output, service output
- Organizational units
- Corporate goals [Scheer, 1999]

For the purpose of reducing complexity, classes with similar semantic interrelationships are grouped into ARIS views. This also makes it possible to view coherences within a view, to structure and streamline the business process models and to avoid redundancies.

### 3.1.1 Definition of Views

In Table 7, we describe all views of a business process.

**Table 7. ARIS Views**

| <i><b>VIEWS</b></i>          | <i><b>Definitions</b></i>   |
|------------------------------|---|
| <b>Function Views</b>        | The processes transforming input into output are grouped in a function.   |
| <b>Organization Views</b>    | Responsible entities or devices executing the same work object are grouped in an organization view.   |
| <b>Data Views</b>            | Data processing environment is comprised in Data view.  |
| <b>Output Views</b>          | These views contain all kinds of input and output.  |
| <b>Control/process Views</b> | Relationships among the views (entire business process) are modeled in this view. It shows the dynamic behavioral aspect of the business process flow and structural coherences of the views. |

Describing all views of the system help us to understand the business processes completely, to find out redundancies and weak points of the system processes and to find out the processes that need support from information technology, thus to determine and define the functional requirements of the system. For this reason, effectiveness of modeling methods gain much importance for describing business processes.

### **3.2 ARIS MODELING METHODS**

The ARIS concept provides us with a large number of model types to support the business process analysis. These model types are assigned to the individual descriptive views and descriptive levels in accordance with the Architecture of Integrated Information Systems. Thus, for example, the EERM (Extended Entity Relationship Model) is assigned to the data view's requirements definition level, and the EEPC (Extended Event-driven Process Chain) is assigned to the control view's requirements definition level. Each model types represent different modeling methods. Each model type has its own object and relationship types. Relationship types characterize the possible types of logical link between any two-object types. An object type or connection type can occur in more than one model type. Object types of the model type EPC, for example, are Event, Function, and Rules. Because, the ARIS concept is focused on business concepts, the key focus is on functions and their control flows. All of the views can be represented together in the control/process view. And control view can be represented in some process models such as EEPC.

#### **3.2.1 Event-Driven Process Chains (EPCs):**

This method was developed at the Institute for Information Systems of the university of Saarland, Germany<sup>28</sup>. Business processes must be streamlined to meet the current business requirements [Cummins, 2002]. For this reason design of

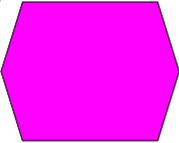
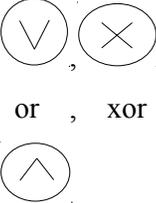
---

<sup>28</sup> [http://www.iwi.uni-sb.de/information/index\\_e.htm](http://www.iwi.uni-sb.de/information/index_e.htm)

business processes must also be streamlined. Event-driven modeling approach provides this consideration.

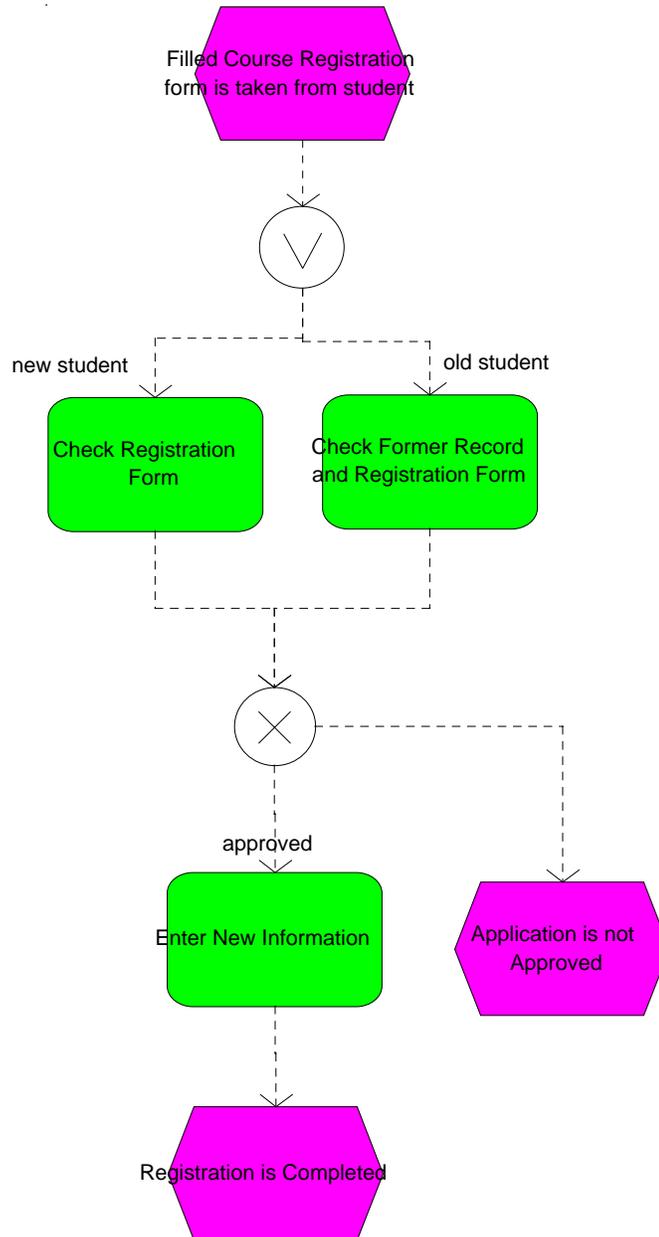
Events are triggering functions and can be the result of functions. By arranging a combination of events and functions in a sequence, so-called event-driven process chains (EPCs) are created. By means of an event-driven process chain the procedure of a business process is described as a logic chain of events. The object types of EPC are events, functions and rules, as described in Table 8 with their notation.

**Table 8. Object Types of Typical EPC**

| <i><b>Object Type</b></i> | <i><b>Symbol</b></i>   | <i><b>Definition</b></i>   |
|---------------------------|--|--|
| <b>Event</b>              |                      | An event is the instance of a state which influences or controls the further flow of one or more business processes. It represents the data view of the process. |
| <b>Function</b>           |                     | A function is the technical task or activity performed on an object in order to support one or several business objectives.                                      |
| <b>Rules</b>              | <br>or , xor<br>and | Rules represent linking operators which allow specifying the logical links that exist between events and functions in process chains.                            |

An example for EPC model can be seen in Figure 11. The start and end nodes of EPCs are always events. Events define which state starts a function and which state defines the end of a function. One event can be the starting point of

several functions. A function can result in several events. Rules are used to illustrate these branching and processing loops. They are actually used for defining the logical links between the objects they connect.



**Figure 11. Example for EPC**

In addition to these objects types, some objects that represent other views of a business process such as organizational units can be put into EPC model.

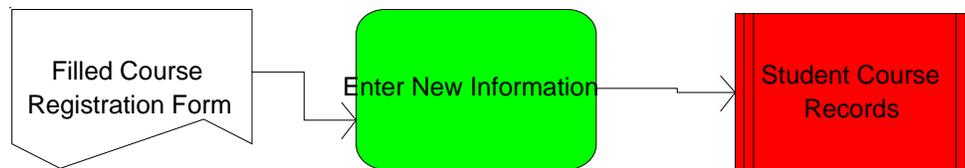
### 3.2.2 Function Allocation Diagram

The transformation of input into output data, namely data flow can be represented in function allocation diagram. It consists of functions of the function view and information objects of the data view. The information objects can be input/output data, data clusters, entity types, relationship types or attributes of the data view. In addition to function type, there is other object types used in typical FAD, described in Table 9 with their notation.

**Table 9. Object Types of FAD**

| Object Type | Symbol  | Definition   |
|-------------|---|--|
| Cluster     |  | It represents the logical view on a collection of entity and relationship types of a data model that is required for the description of a complex object. It can be both input and output data.  |
| Document    |  | We can consider it as a physical input and output to the systems. Data on it is entered to the computerized system manually and data on it can be produced on physical document.<br>We can also consider it as output view of a process. |

We can see an example for a function allocation diagram in Figure 12.

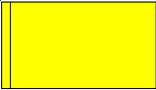
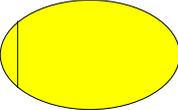


**Figure 12. Example for FAD**

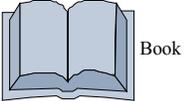
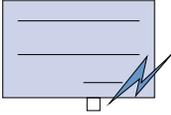
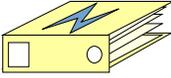
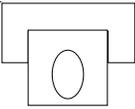
### 3.2.3 EEPC-Extended Event Driven Process Chain

EEPC, as the name implies, is an extension of EPC modeling technique. Using FAD diagram in an EPC model to describe the information flow, we can complete the data view of the process. In addition to this, essential object types, as shown in Table 10 with their notations, that can influence the control flow and represent the output and organization views can also be used in an EPC to achieve clear and complete representation of business processes. These are the components of EEPC modeling technique.

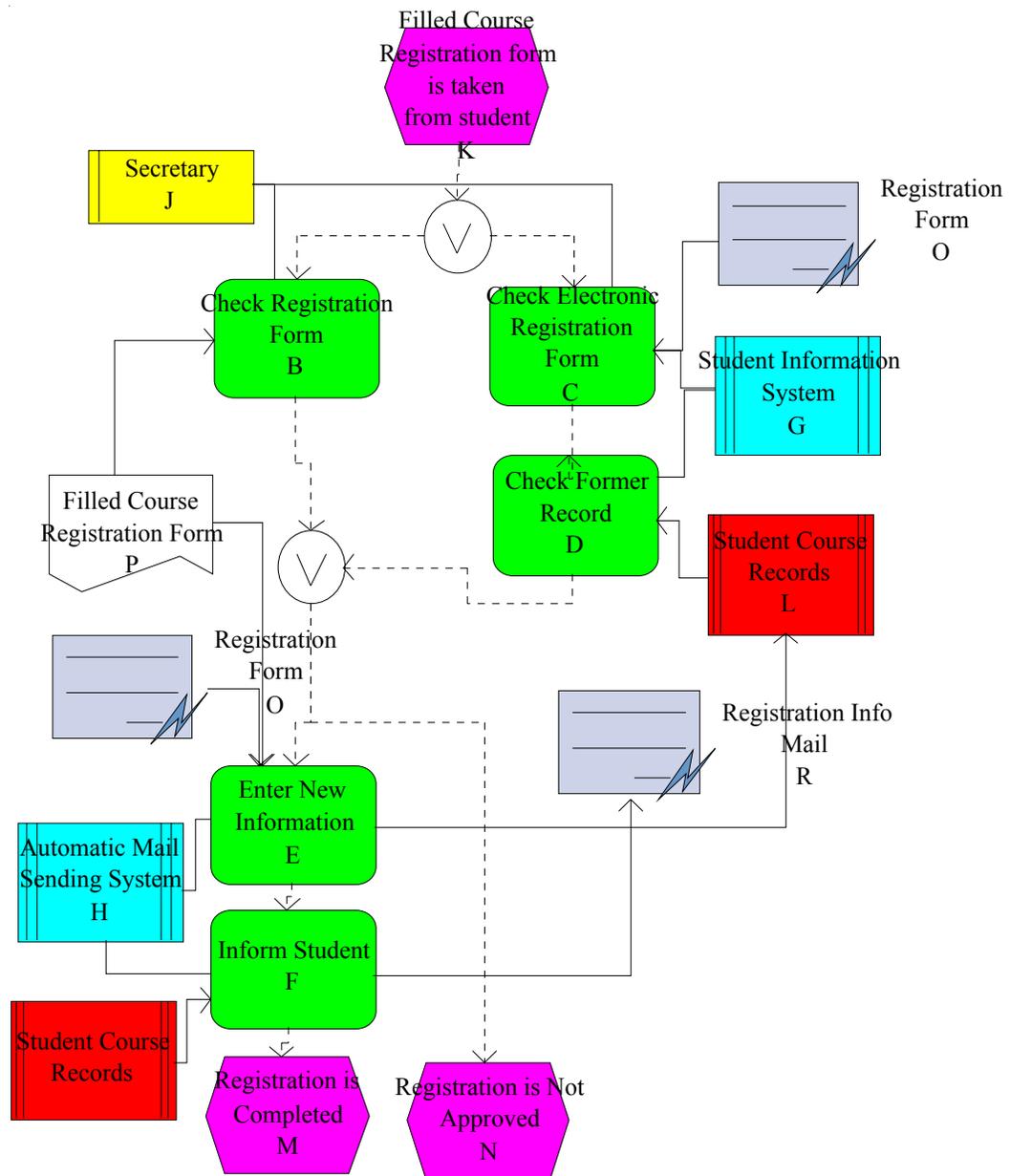
**Table 10. Additional Object Types**

| <b>Object Type</b>             | <b>Symbol</b>   | <b>Definition</b>  |
|--------------------------------|---|--|
| <b>Position</b>                |   | The smallest organizational unit in a company is a position. It is assigned to persons and belongs to organization view.   |
| <b>Application System Type</b> |  | It represents the typification of individual application systems, which have exactly the same technological basis. e.g. Aris toolset ver.2.5. It belongs to function view. |
| <b>External Person</b>         |  | It belongs to organization view and represents the person who involves the process from the outside of the organization.   |
| <b>Organizational Unit</b>     |  | It represents the unit that is responsible for execution of the individual function and consists of persons or positions.  |

**Table 10. Additional Object Types (cont...)**

|                                   |   |  |
|-----------------------------------|---|--|
| <p><b>Book</b></p>                |    | <p>It represents the book that can be used as resource at the time of execution of the function and belongs to output view.</p>  |
| <p><b>Electronic Document</b></p> |    | <p>We can consider it as input and output to the system. It can be taken from the outside in a computerized environment and data on it is used automatically in the system and saved after a predetermined time or data on it is produced for sending to the other system in a computerized environment. It represents the output view of a process.</p> |
| <p><b>Folder</b></p>              |   | <p>We can consider it as a input and output to the systems. Data in it is entered to the computerized system manually and data in it can be produced on physical folder.</p>   |
| <p><b>Electronic Folder</b></p>   |  | <p>We can consider it as input and output to the system. It can be taken from the outside in a computerized environment and data in it is used automatically in the system and saved after a predetermined time or data in it is produced for sending to the other system in a computerized environment. It represents the output view of a process.</p> |
| <p><b>Telephone</b></p>           |  | <p>It represents the output view of a process. Data taken by using it is entered to the computerized system manually.</p>  |

We can describe entire business processes considering organization, data, function, and output or control view by using these types of object together in an EEPC model, as shown in Figure 13.



**Figure 13. Example for EEPC**

We can see how data input on physical document is transformed to the output in data cluster by means of “enter new information” function. We can also see

process sequence controlled by events using logical links. Additional object types, such as, “position” as organizational units is used as responsible entity for the execution of the functions. ARIS toolset mentioned in section 3.3, supports EEPC model.

All entire business process views are represented in this model, described in Table 11. Words written in the object notations are used for this purpose.

**Table 11. Views of Model in Figure 13**

| <i><b>VIEWS</b></i>      |                         |
|--------------------------|-------------------------|
| <b>Function View</b>     | B, C, D, E, F, G, H     |
| <b>Organization View</b> | J                       |
| <b>Data View</b>         | L                       |
| <b>Output View</b>       | O, P, R                 |
| <b>Control</b>           | K, M, N<br>Entire model |

### 3.2.3 Advantages of EEPC Modeling Technique

DFD modeling, object oriented modeling and IDEF0 modeling techniques have been explained briefly in the previous sections (2.3.4.1, 2.2.1.1, 2.2.2.). Their disadvantages and deficiencies are also mentioned. EEPC modeling technique provides some benefits to overcome these disadvantages:

- It provides control view that can represent the relationships among all process views.
- It is possible to see the movement of information within the business process as a whole.
- EEPC model is able to represent the more detailed implementation-level process dynamics by supporting additional modeling elements<sup>29</sup>.

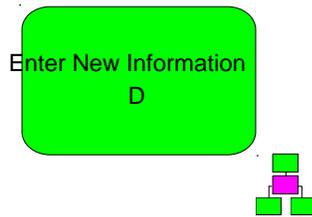
---

<sup>29</sup> <http://saturn.cs.unp.ac.za/~normanb/part2.pdf>

- Transition, described in section 2.3.4, between business concepts and IT concepts can be accomplished successfully by this technique.
- It is easy to understand for the business people who may not be familiar with the modeling techniques
- It is easy to use for those people who has not an IT background without losing any of the necessary detail.
- It provides business process design to be streamlined.

### 3.2.4 Detailed Description of Business Process Models

Modeling function of ARIS toolset mentioned in section 3.3 also provides detailed description facility for the objects. All objects of the business process can be assigned to another model type for the purpose of the detailed description. An example for such decomposition can be seen in Figure 14.



**Figure 14. Assignment of Object**

In this figure, it is expressed that function is assigned to another model. Function of “enter new information” is described detailed in another model. This model might be function tree, EPC or FAD or one of the model types that ARIS modeling methods provide. Assignment is represented by the notation right underside of the object. In the same way, all other objects of the business process model can be assigned to one another model related with it for the purpose of detailed description. For example, data cluster can be assigned to ERM model type; organizational units can be assigned to organizational chart diagram, etc.

### 3.2.5 Relationship Types Between Objects of Business Process Models

There are also relationship types between objects that are not seen in a business process models. These relationship types are tongues of business process

models. They talk together with objects representations to say what the model want to describe. An object might have several relationship types with one another.

Relationship types can be assigned between objects during modeling in ARIS Toolset. There are various relationships between objects that can be assigned to objects in ARIS modeling tool. e.g. organizational unit may be technically responsible for the execution of the function, or execute the function, or contributes to function. We can see possible relationships that are provided by ARIS modeling tool in Tables 12, 13, 14, 15, 16, and 17. As the control view represents all views on own view by focusing on functions, it is preferred that only the relationships of other views with function view are illustrated. These tables represent the relationships from the point of view on the first column.

**Table 12. Data-Function Relationships**

|                                   |                                 |  |
|-----------------------------------|---------------------------------|--|
| <b><i>Data View (Cluster)</i></b> | <b><i>Relationship Type</i></b> | <b><i>Function View (Function)</i></b> |
|                                   | is input for                    |  |
|                                   | is approved during              |  |
|                                   | is checked by                   |  |

**Table 13. Function-Data Relationship**

|  |                                 |                                   |
|--|---------------------------------|-----------------------------------|
| <b><i>Function View (Function)</i></b> | <b><i>Relationship Type</i></b> | <b><i>Data View (Cluster)</i></b> |
|  | has output of                   |                                   |
|  | changes                         |                                   |
|  | archives                        |                                   |
|  | is archived by                  |                                   |
|  | deletes                         |                                   |
|  | distributes                     |                                   |

**Table 14. Function-Output Relationship**

|   |                          |  |
|---|--------------------------|--|
| <b>Function View</b><br><b>(Function)</b> | <b>Relationship Type</b> | <b>Output View</b><br><i>(Document, folder, electronic document and folder,)</i> |
|   | creates output to        |  |
|   | produces                 |  |

**Table 15. Output-Function Relationship**

|   |                          |   |
|---|--------------------------|---|
| <b>OutputView</b><br><i>(Document, folder, electronic document and folder,)</i> | <b>Relationship Type</b> | <b>Function View</b><br><b>(Function)</b> |
|   | provides input for       |   |
|   | is used by               |   |
|   | is consumed by           |   |

**Table 16. Function-Function Relationship**

|   |                          |   |
|---|--------------------------|---|
| <b>Function View</b><br><b>(Application System)</b> | <b>Relationship Type</b> | <b>Function View</b><br><b>(Function)</b> |
|   | can support              |   |

**Table 17. Organization-Function Relationships**

|   |  |   |
|---|--|---|
| <b>Organization View</b><br><i>(Position, org.unit)</i> | <b>Relationship Type</b>               | <b>Function View</b><br><i>(Function)</i> |
|   | is technically responsible for         |   |
|   | executes                               |   |
|   | is it responsible for                  |   |
|   | decides on                             |   |
|   | contributes to                         |   |
|   | must inform about result of            |   |
|   | must be informed about                 |   |
|   | must be informed about on cancellation |   |
|   | has consulting role in                 |   |

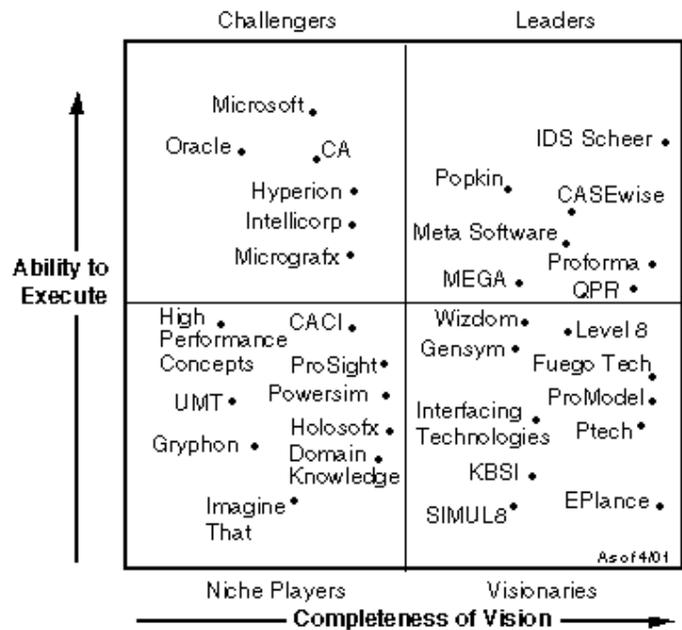
To understand the business process models completely, we must understand all relationships between the objects in a model. A mere graphical representation is not enough to understand them; hence ARIS tool provides a reporting mechanism that can address this challenge.

### 3.3 ARIS TOOLSET

Today business process modeling/analysis tools are increasingly used for multiple reasons. In this thesis, comparison of business process modeling tools is not considered. According to the Gartner Group<sup>30</sup>, as shown in Figure 15, ARIS toolset is listed as the leader, under the vendor’s name, “IDS Scheer”, in business analysis/modeling market. We used ARIS toolset in the phase of preparing a technical contract of one project. This application is explained in Case Study, Chapter 5. ARIS toolset supports all modeling views, methods and notations described in sections 3.1. And 3.2.

---

<sup>30</sup> <http://www.gartner.com/gc/webletter/idsscheer/issue1/article1.html>



**Figure 15. Modeling Tools**

Beside its various functionalities, we used analysis/modeling and reporting capabilities of ARIS toolset.

**3.3.1 ARIS Toolset Reporting & Analysis**

In addition to the graphical presentation of process analysis, ARIS toolset also supports the output of these graphics with report wizard component. Results of the business process models can be seen in these reports. Besides it's various pre-defined report scripts that are used to produce reports, the user can define new scripts with a Script Editor. ARIS Script Editor is a component of ARIS toolset. It provides all the functionality we need to create, edit and check scripts based upon ARIS Basic Language Capability, such as report scripts. A script is a statement that contains Visual Basic commands, as well as the commands from ARIS Basic Language Capability. All objects and methods used in ARIS toolset can be found in [ARIS Toolset Help Files].

Components in ARIS toolset access the scripts to make information available to users from a database in the form of a table or text. Every component accesses a

particular type of script. The two first letters of the file extension identify the types of scripts and third letter identify the context. For example, .RSM file extensions means Report Script and the context is model oriented.

### **3.3.2 ModelHierarchy.rsm**

Results delivered by predefined reports are much diverse. Some report scripts give only function and organizational unit relationships of a process, some give all objects type of the model and their names, whereas some of them give input/output data that are allocated to each function of the process.

One of the pre-defined report scripts is *ModelHierarchy.rsm*. Function is the foundation of analysis. Its results contain data about all views of a business process, thus this report script produces output about the process from the point of control view. Following are the contents of the results produced by this script.

- The report output analyzes the selected models, attributes and available assignments of the function type.
- It gives all relations described in section 3.2.5, of objects of the function type.
- The assigned models are further evaluated like the selected models up to an adjustable structural depth
- Functions of the model selected to see its results can be arranged in alphabetical order, or according to symbol type or its topology.
- The output is issued as text and includes tables for the model and object information.
- Relationship types assigned according to other objects' views during modeling, described in section 3.2.5, are displayed in the report from the point of function object view, e.g. data "is checked by" function becomes function "checks" data.

## **CHAPTER 4**

### **4 APPROACH**

In this chapter, a unified approach that combines and integrates business process modeling with functional requirements elicitation, based on ARIS modeling and reporting methods, is described. This approach defines a requirements elicitation process, which has three steps based on strategies and goals determined by the customer:

Phase 1: AS-IS Study

Phase 2: TO-BE Study

Phase 3: Automated Functional Requirements Elicitation

#### **4.1 STRATEGIC PLANNING**

This phase must be accepted as precondition for our proposed approach. There is no one right strategic planning model for all organizations and circumstances. Every organization must have a strategic plan that describes their vision, goals and directions to that vision that is strategies.

Before organizations start any process innovation activities supported by technology, they must first develop or redevelop a strategic plan., and they must make a connection between this plan and target business design, in the sense that target business process design must be performed according to the strategic plan. It is a manual task to link the strategies, which are based on business goals, which have to be achieved to realize the vision, with target business processes, as currently there is no comprehensive software tool to support these activities.

Target system functionalities that will be later derived as requirements from this kind of study correspond to business processes or process activities that will support our strategies.

Because every organization determines its own strategic plan and focus of this thesis is not on strategic planning, strategic planning methods will not be detailed in this section.

## **4.2 AS-IS STUDY**

After strategic business planning is completed, “as-is” study is performed to understand the current business processes and to provide outputs for to-be study by describing existing business processes. Following are the activities of this phase:

- Gathering all resources related with business processes
- Organizing interview and JAD sessions
- Study of value added process chain
- Modeling of existing business processes during JAD sessions and interview
- Approval of business process models

### **4.2.1 Gathering all resources related with business processes**

Books, manuals, documents in which business processes and domain knowledge exist and strategic business plan in which critical success factors and business goals are clearly described, like master plan are gathered. Those resources will help us in requirements elicitation process for many times, such as in describing business processes and developing target conceptual and detailed design in the direction of the business goals.

### **4.2.2 Organize interviews and JAD sessions**

People who will be interviewed and who will attend JAD sessions are determined. Schedule of these interviews and JAD sessions are also planned. Top executives, domain experts, executives, project management, end user must attend these activities. JAD sessions and interviews plan is produced at the end of this activity.

#### **4.2.3 Study of value added process chain**

This study is the foundation for more detailed business process analysis. Key business processes are determined. Further modeling activities are based on these key business processes. After this phase, we obtain key business process diagrams.

#### **4.2.4 Modeling of existing BP during JAD sessions and interviews**

EEPC method of ARIS concept and ARIS toolset are used for business process modeling. In ARIS toolset, EEPC-modeling option is selected for modeling. Key business processes, all resources and JAD attendees' opinions are used for model developing.

Issues to be considered:

- Each sub process is examined and modeled individually.
- First of all, activities, their logical sequence and initial/result events are determined and modeled.
- Then, for each activity (function), responsible entities and their roles are assigned to the model.
- For each activity (function), information object including input/output data is assigned to the model.
- Input/output and services for each activity (function) are assigned to the model.
- The preview activities can be performed in parallel.
- If the business processes are not automated, that is, if data processing is done manually and data storage is on physical environment, physical document and folder objects can be used to represent the information object of the data view. EEPC method supports these notations.
- Feedback including change request taken at anytime is reflected to the models.
- Models of existing business processes are the output of this phase.

#### **4.2.5 Approval of business process models**

The executives and project management must verify all business process models created. Actually, this activity is performed during all steps of the “as-is” study. Final approval of business process models must be received after modeling is completed. The models can be modified based on corrections and/or changes in business requirements. Approved existing business process models are the output of “as-is” study and input for “to-be” study.

### **4.3 TO-BE STUDY**

After completion of “as-is” study, “to-be” study is started to describe the IS oriented target business processes. This study is very important for elicitation of functional requirements. JAD sessions must be used for this step. Following are the activities of this study:

- Determination of bottlenecks, IS-supported processing functions, new business and information flows.
- Developing target design of business processes
- Approval of target business process models

#### **4.3.1 Determination of bottlenecks, new business and information flows and IS-supported processing functions**

These three activities are performed synchronously as results of each one affect the others.

- Bottlenecks that surfaced during “as-is” study are captured.
- Models of existing business processes are used for this activity.
- IS-supported processing functions are determined for each process considering weaknesses, bottlenecks and deficiency of these processes.
- According to these findings, new business and information flows are determined.

- These determinations are parts of the target design of business processes.
- When performing all these activities, strategic planning is taken into account.

#### **4.3.2 Developing target design of business processes**

Completeness and correctness of functional requirements to be elicited are closely related with this activity. EEPC is used for modeling target business processes. Existing business process models are revisited from the beginning for possible enhancements, and even redesign, considering strategic planning. For each process following issues are considered.

- Control flow, that is logical sequence of process are modeled considering IS-supported processing.
- Organizational units, input/output data, input/output and services are assigned to each function. This can also be represented in Function Allocation Diagram.
- Application systems that will support functions are also assigned to each function.
- To obtain our preferred results at Step 3, that is functional requirements of the target system, notations must be used correctly with their semantics. Some of the usages of the notations are controlled when modeling by built-in mechanisms of ARIS toolset. Incorrect usages are not permitted. Some other semantic controls can be performed using “Analysis” component of ARIS toolset.
- Notations of target business processes are different from the existing business process, especially when information objects are considered.
- When modeling target system, for the purpose of completeness and correctness of business process views, all essential object types of the views, that must be used and their relationships that can/must be assigned focusing on function in an EEPC are described below,

**Table 18. Essential Object Types and Relationships**

| <i><b>VIEWS</b></i>      |        | <i><b>Object Types</b></i>   | <i><b>Relationships</b></i>  |
|--------------------------|--------|--|--|
| <b>Organization View</b> |        | Organizational Unit, Position, Person Type<br>External Person      | is technically responsible for, execute, is IT responsible for, decides on, contributes to, must inform about result of, must be informed about, has consulting role in, accepts |
| <b>Function View</b>     |        | Application System Type  | can support<br>(Assigned automatically)  |
| <b>Data View</b>         | Input  | Cluster  | is approved during ,is input for, is checked by  |
|                          | Output | Cluster  | changes, has output of, archives, is archived by, deletes, distributes   |
| <b>Output View</b>       | Input  | Document, Electronic Document, Folder Electronic Folder, Telephone | provides input for<br>(assigned automatically)   |
|                          | Output | Document, Electronic document, Folder Electronic Folder, Telephone | creates output to<br>(Assigned automatically)  |

As stated in the table above, some relations are assigned automatically when modeling with ARIS toolset. The user assigns remaining relations in the table optionally. For clear and detailed model, we recommend that all relations be assigned correctly.

Some other issues that must be considered during business processes modeling are:

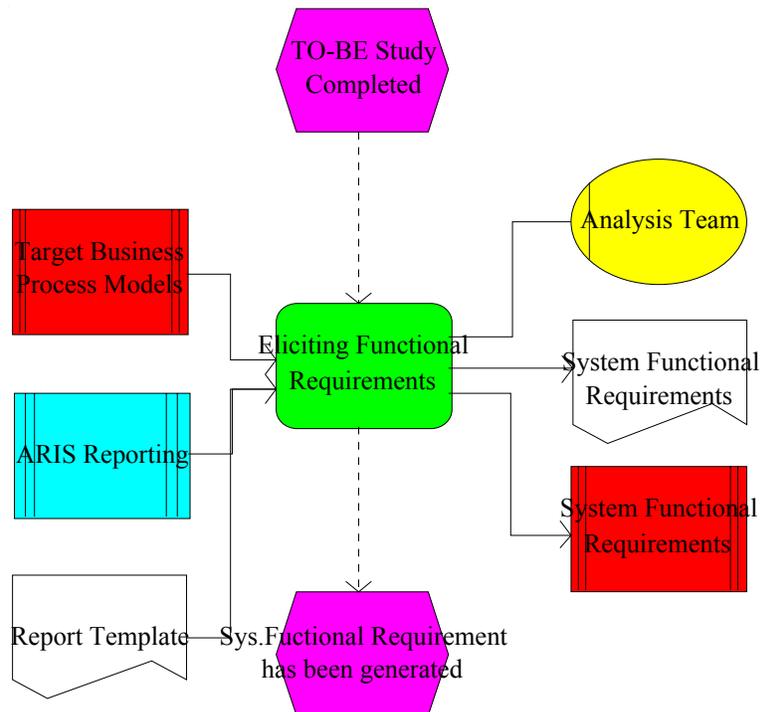
- If a function is IS-supported and performed automatically, thus if data that is retrieved from other IS, is recorded to the system automatically after a determined time.
  - “Application system”
  - “Data cluster” both for data output and “electronic document” for input or output must be assigned to this function.
- If a function is IS-supported and performed manually, thus if data, that is output of another system, is entered by user to the system,
  - “Document, “folder”, or “telephone” for input,
  - “Data cluster” for data output as database
  - “Application system” must be assigned to the function
- If data, that is stored in the system database, is used for obtaining output manually,
  - “Data cluster” for data input as system database
  - “Document”, “folder” for output.
  - “Application system” must be assigned to the function
- If data, that is stored in the system database, is used for sending data to another IS or getting output manually in a digital environment.
  - “Data cluster” for data input as system database
  - “Electronic document” for output
  - “Application system” must be assigned to the function
- If a function is not IS-supported, for both data input and data output
  - “Document” and “folder” must be assigned for both input and data output.
  - Neither “Data cluster” nor “application system” be used.
- Output of this phase is target business process models.

### 4.3.3 Approval of target business process models

Final target business process models must be reviewed and approved by executives and project management. The models can be modified based on corrections and changes in business requirements through change management. Approved target business process models are the output of the “to-be” study and input for the automated functional requirements activity.

## 4.4 AUTOMATED FUNCTIONAL REQUIREMENTS ELICITATION

Target business process models are used for eliciting functional requirements of the proposed system. They represent all business requirements and proposed system requirements. Functional requirements of the proposed system are elicited by using ARIS Toolset reporting mechanism. Model of automated functional requirements elicitation is depicted in Figure 16.



**Figure 16. Proposed Method for Functional Req. Elicitation**

Extended version of *Modelhierarchy.rsm*, report script run by ARIS Reporting Wizard helps us obtain functional requirements automatically from business process models. Extended part of the *Modelhierarchy.rsm*, Aris Reporting script, is given in Appendix C. Although there are many reports that can be generated by ARIS Reporting Mechanism, as the focus is on deriving functional requirements of the proposed system, we designed a report structure, as shown in Table 19, to obtain the functional requirements and we generated it by using our extended script. It is given in Appendix A. Functional requirements specifications generally include five views of a function, namely data, function, organization, output and process view. The first four views are considered as shown in Table 19. Process View, that is logical sequence of the functions are also considered by stating start path, end path of the process and preceding function for each function.

**Table 19. Report Template Including All Aspect of Any Process**

|                                   | <i><b>OBJECTS TYPE</b></i> | <i><b>RELATIONSHIP</b></i> | <i><b>OBJECT NAME</b></i> |
|-----------------------------------|----------------------------|----------------------------|---------------------------|
| .....<br><b>Data View</b>         | DATA INPUT                 |                            |                           |
|                                   | DATA OUTPUT                |                            |                           |
| .....<br><b>Output View</b>       | INPUT                      |                            |                           |
|                                   | OUTPUT                     |                            |                           |
| .....<br><b>Org.View</b>          | ORGANIZATIONAL<br>UNIT     |                            |                           |
| .....<br><b>Function<br/>View</b> | APPLICATION<br>SYSTEM      |                            |                           |

In this Report template;

- This table is repeated for every function of each process. Function name appears at the top of the table.
- Logical sequence of the functions is considered.
- “**Start path**” and “**End path**” of the sequence are stated.

- **Preceding function** for each function is stated with “**by**” expression at the heading of the table. If no preceding function has been stated for a function in the report, it means that this function is at the beginning of the start path. Following function is stated with “leads to” expression.
- “Relationships” column includes the relationships assigned during modeling. They represent the relationships between objects and function whose name appears at the top of the table.
- “Objects names” column includes the definitions written into the symbols during modeling.
- Symbol types are given in the “object name” column with the object names.
- Output of assigned model of each function is also produced according to its detail level.
- A sample output of target business requirements based on the template given in Table 19 is presented in Appendix A.

## CHAPTER 5

### 5 AN APPLICATION

#### 5.1 INTRODUCTION

In this chapter, an application of the approach proposed in Chapter 4 and further study made after this application will be elaborated. This application was performed during the period of technical specifications preparation phase of a IS procurement project for the intelligence department of Turkish Land Forces Command. Method proposed in Chapter 4 is partially applied in this project. We performed all business process analysis activities using ARIS Toolset. In further study, we developed a new reporting script by extending “*Modelhierarchy.rsm*” reporting script of ARIS Toolset to generate functional requirements automatically, although, the developed script was not utilized in the project due to time constraints, the deadline for the delivery of the bidding documents.

Evaluation of the steps of the general process, benefits gained from practice of proposed approach in Chapter 4 will be discussed in this chapter. For the sake of secrecy, original inputs and outputs of the process will not be given. Namely, business process models of intelligence and their reports, all specific resource names used in project including people, tactical books, documents and department names will not be detailed. Instead, we will describe the activities performed using process modeling. Only one process model created during “to-be” study of the project will be used as a typical example for EEPC and this model, given in Figure 25, will also be used for the purpose of automated elicitation of functional requirements. Requirement expressions elicited from this model manually at the time of technical contract preparation will be compared with our requirements document that is created automatically.

## 5.2 DEFINITIONS USED

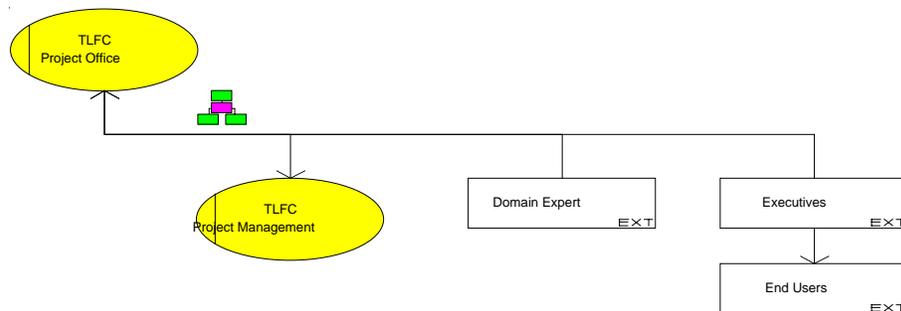
Some important key terms and their meanings that will be used when explaining application on proposed approach are given in Table 20.

**Table.20. Definitions to be used**

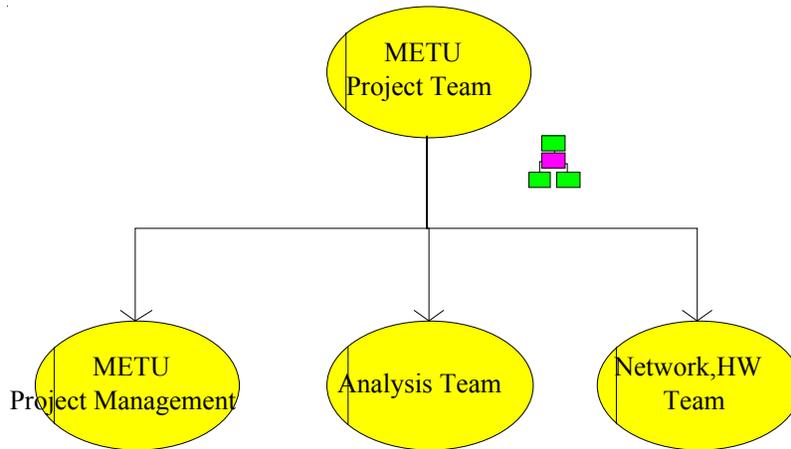
| <i>DEFINITIONS</i> | <i>EXPLANATION</i>   |
|--------------------|--|
| GENERAL PROCESS    | It includes all processes and implies automated requirements elicitation process in which method described in Chapter 4 is applied |
| STEPS              | It means sub processes of the general process.   |
| EEPC               | It describes each process from the point of all views, thus control/process view.  |
| FUNCTION TREE      | It represents the activities of each sub process hierarchically.   |
| STAKEHOLDERS       | All participants of the general process.   |

## 5.3 THE ROLES USED IN MODELS

All notations that can be used in typical business process by using ARIS toolset are described in Chapter 3. Organizational charts, which specify the roles, are given in Figures 17 and 18.



**Figure 17. Organizational Chart of TLFC Project Office**



**Figure 18. Organizational Chart of METU Project Office**

Following are the organizational units and their roles used in the models.

**Table 21. Roles to be used in the Models**

| <b><i>ORGANIZATIONAL UNITS</i></b> | <b><i>ROLES</i></b>  |
|------------------------------------|--|
| TLFC PROJECT OFFICE                | It carries out the IS procurement project and consists of TLFC Project management and externally involved domain experts, executives, end users.     |
| METU PROJECT TEAM                  | It counsels TLFC for preparing the technical contract.   |
| ANALYSIS TEAM                      | It belongs to METU project team and analyzes the business process to find out the system requirements that are the foundation of technical contract. |
| DOMAIN EXPERT                      | It symbolizes all organizational units who have the domain knowledge.  |
| EXECUTIVES                         | It symbolizes all executives of the end users.   |
| END USER                           | It symbolizes all the organizational units who will use the system to be acquired or developed.  |

#### 5.4 THE DEFINITIONS OF INPUTS AND OUTPUTS OF THE PROCESS

In business process models created by EEP method, some input and output objects are used to depict all kinds of inputs and outputs of the process. Their explanations are given in Table 22.

**Table.22. Input/Output to be used in the Models**

| <i><b>INPUT/OUTPUT</b></i>       | <i><b>DEFINITIONS</b></i>  |
|----------------------------------|--|
| RESOURCES                        | It includes books, documents, manuals, master plan and strategic plan used in requirements elicitation process.  |
| KEY BUSINESS PROCESS DIAGRAMS    | It is the output of value added activity process chain study and represents key processes. Key processes were modeled by using ARIS's EPC method.                        |
| EXISTING BUSINESS PROCESS MODELS | It includes all models developed during "as-is" study.   |
| TARGET BUSINESS PROCESS MODELS   | It includes all models produced during "to-be" study   |
| VIEWS DATA                       | This logical model includes all data including function, data, output and organization views of a process, which is being studied on.                                    |
| CHANGE REQUEST                   | It includes all corrections, additions and deletions of the TLFC office for the models.  |
| FUNCTIONAL REQUIREMENTS          | It is both represented as physical document and data cluster as this document is generated with the support of automated tool, as per the format described in Chapter 4. |

## **5.5 PROCESS TO BE INVESTIGATED**

Elicitation of functional requirements that are the main part of the technical contract is the process to be investigated. First of all, general process is modeled by EPC, and then this process is hierarchically decomposed into lower level process steps to show the detailed activities of the process by using both EEPC and Function Tree. In EEPC models all views of a process, namely data, function, output and organization, are represented. In Function Trees, activities of the steps are represented hierarchically.

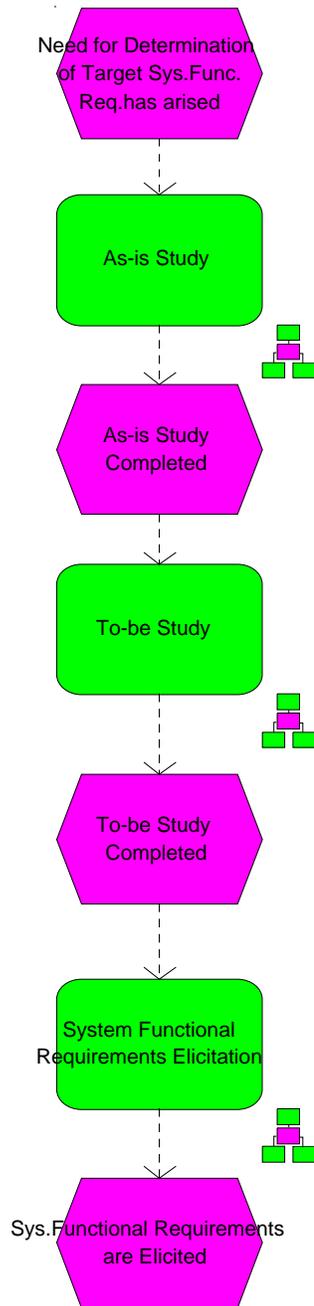
### **5.5.1 Steps of the General Process**

General process with its sub processes is given in Figure 19.

- Step 1: As-is Study
- Step 2: To-be Study
- Step 3: System Functional Requirements Elicitation

Strategic planning phase is not considered in this case study as the responsible unit of the TLFC had already completed this phase and a document, namely “master plan”, which had been approved by the management of the TLFC, was given to the project team as the baseline document.

When applying proposed approach, “master plan” was used as a baseline document for describing business processes. That is, current business processes and target business process were described according to the organization goals.

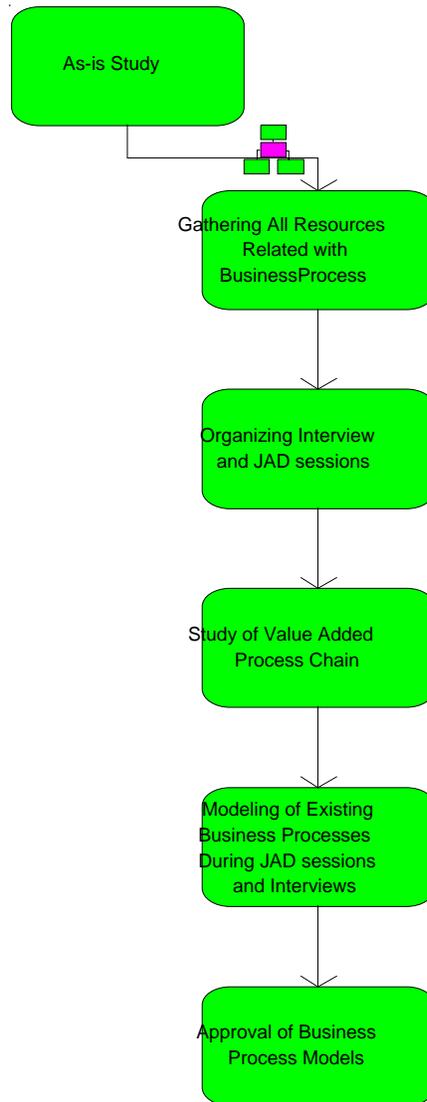


**Figure 19. Functional Requirements Elicitation Process**

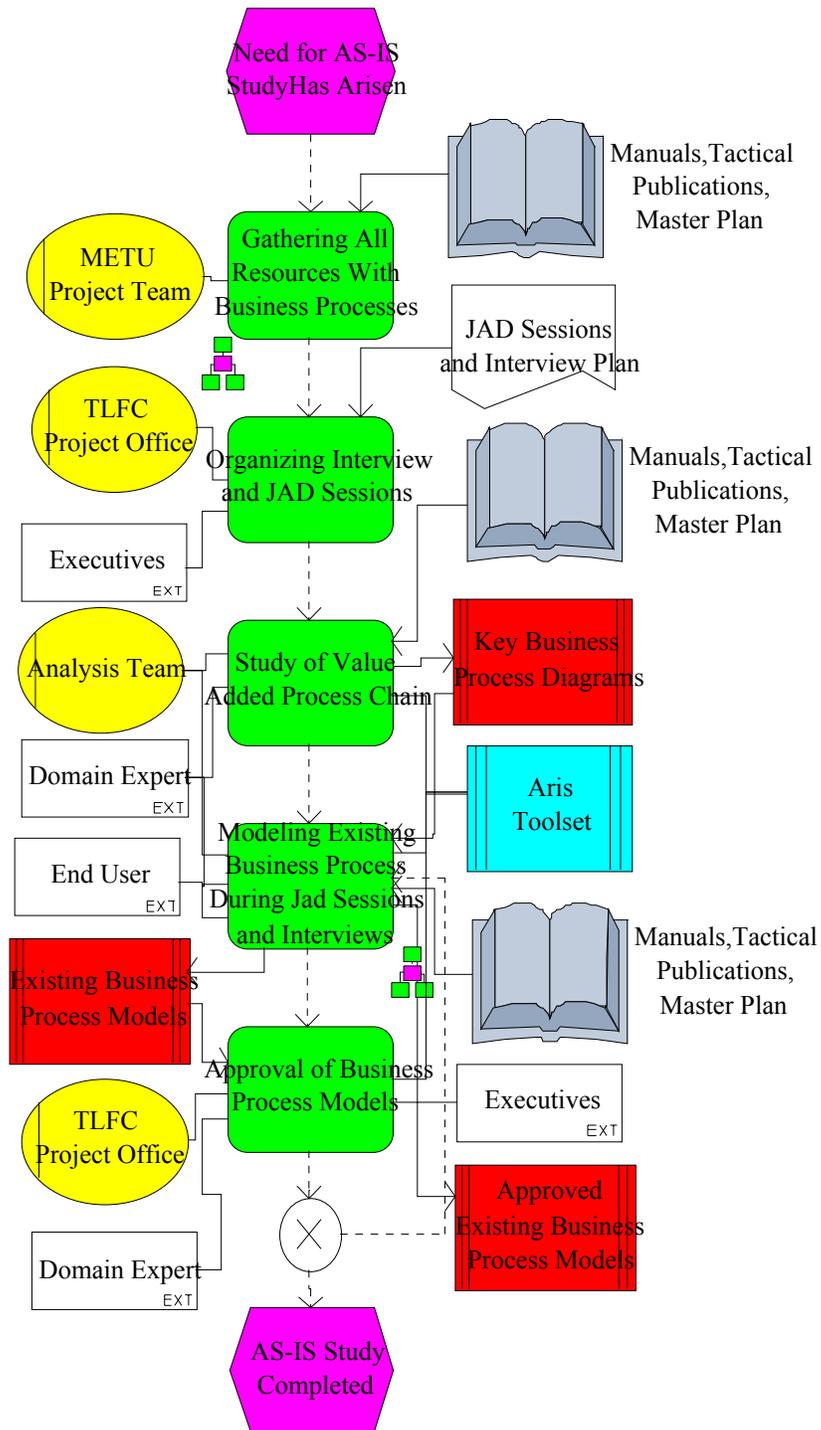
### 5.5.2 Evaluation of Step1

EEPC and function tree of “as-is” study are presented in Figures 20 and 21 respectively. In addition, a detailed description of “Modeling of Existing Business Processes” is shown in Figure 22. Following are the lessons learned from this study.

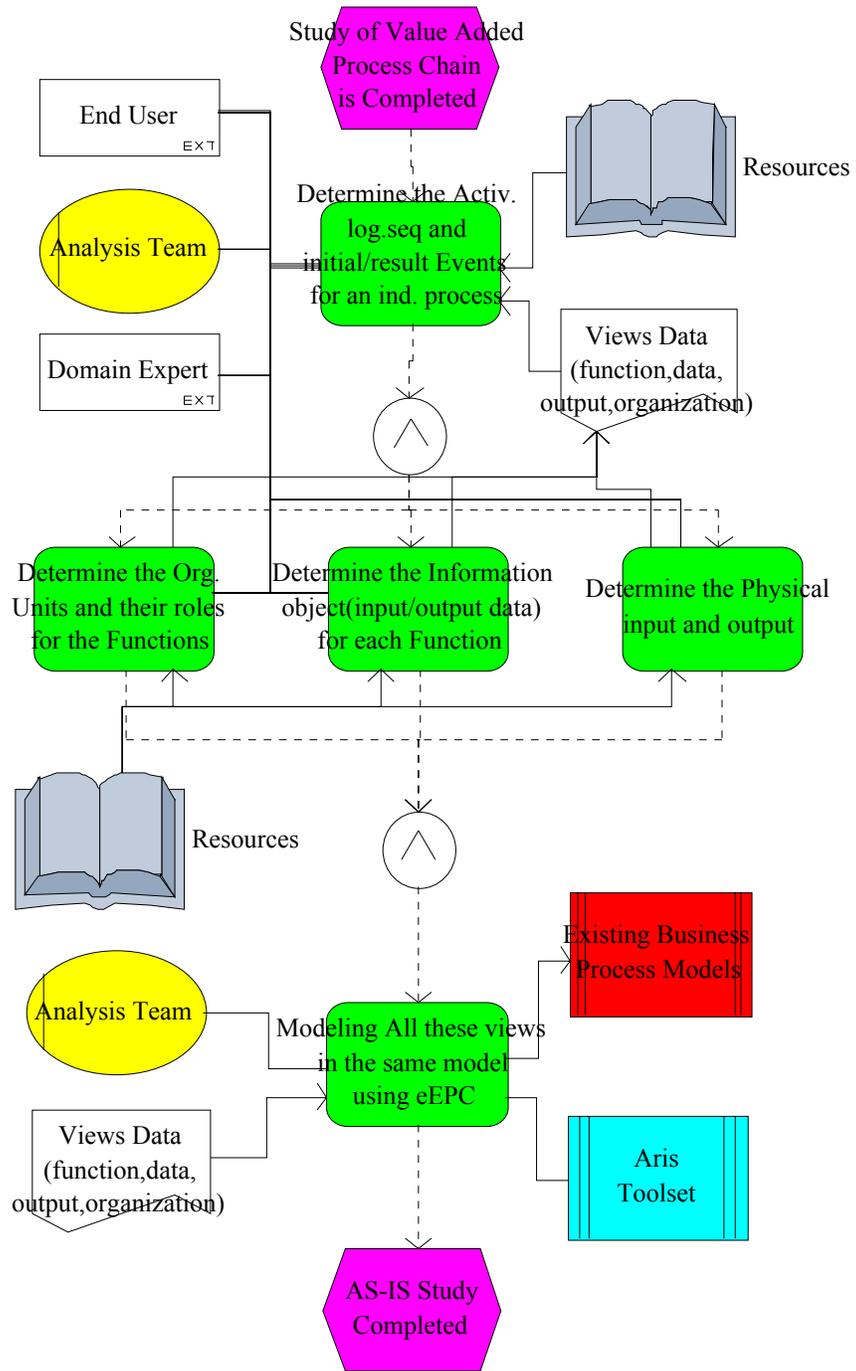
- We had difficulty to commence the analysis with domain experts. Complexity increased when describing and modeling current business processes. Domain experts must have been involved in the business process analysis from the very beginning.
- As there was no domain expert at the beginning, we spent a lot of time in determining key processes. Before initiating the modeling of business processes, key business processes must be determined. Modeling without considering key business processes may lead to increased complexity and it may lead to unnecessary time loss.
- Customer can better understand his own processes by performing “as-is” study, with business process modeling. TLFC understood their processes well and consequently their contributions to definition of the requirements considerably increased.
- It is important for IT people to be involved in the business analysis, because they can learn the business concepts and terminology that will be necessary in transformation of business requirements into IT requirements.
- Business process models are the platforms on which the stakeholders can discuss and draw the conclusions. This enhances mutual understanding.
- Modeling of existing business processes leads to modeling of to-be processes. Thus, customer tends to describe the processes according to the directives and instructions not according to the current state of the processes. This situation contributes to increase in quality of the processes and the transition of “as-is” study to the “to-be” study.



**Figure 20. Function Tree of AS-IS Study**



**Figure 21. EPC of AS-IS Study**

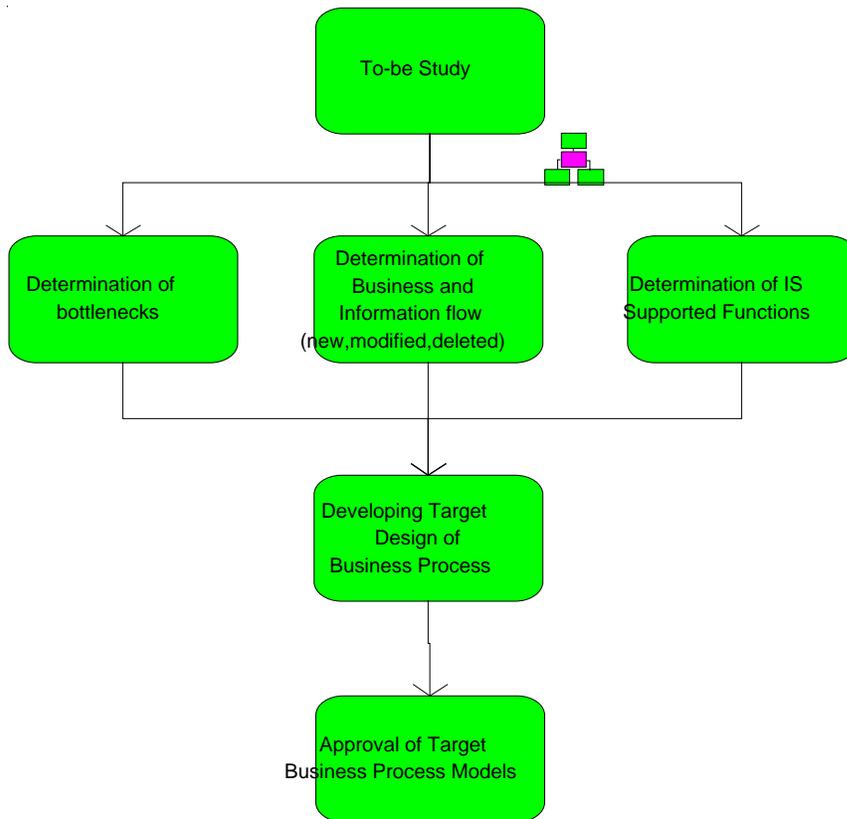


**Figure 22. Modeling of Existing Business Processes**

### **5.5.3 Evaluation of Step 2**

EEPC and function tree of “to-be” study are given in Figures 23 and 24 respectively. Following are the lessons from this study.

- “As-is” study provides considerable input for “to-be” study.
- Existing business process models can help the stakeholders to identify the bottlenecks, deficiencies and the improvement points required in the processes. Current process flows allowed TLFC to compare the existing processes to the processes explained in the tactical publications and instructions.
- “As-is” study and “to-be” study are performed together to some extent, because bottlenecks, deficiencies and problems are already captured in “as-is” study.
- Determination of IS supported functions, new information flows and changes in existing workflows are the results of the “to-be” study.
- Target business process models were not finished completely due to time constraint. An example for an incomplete business process model “Intelligence Orientation”, created at the time of analysis phase, is given in Figure 25.



**Figure 23. Function Tree of TO-BE Study**

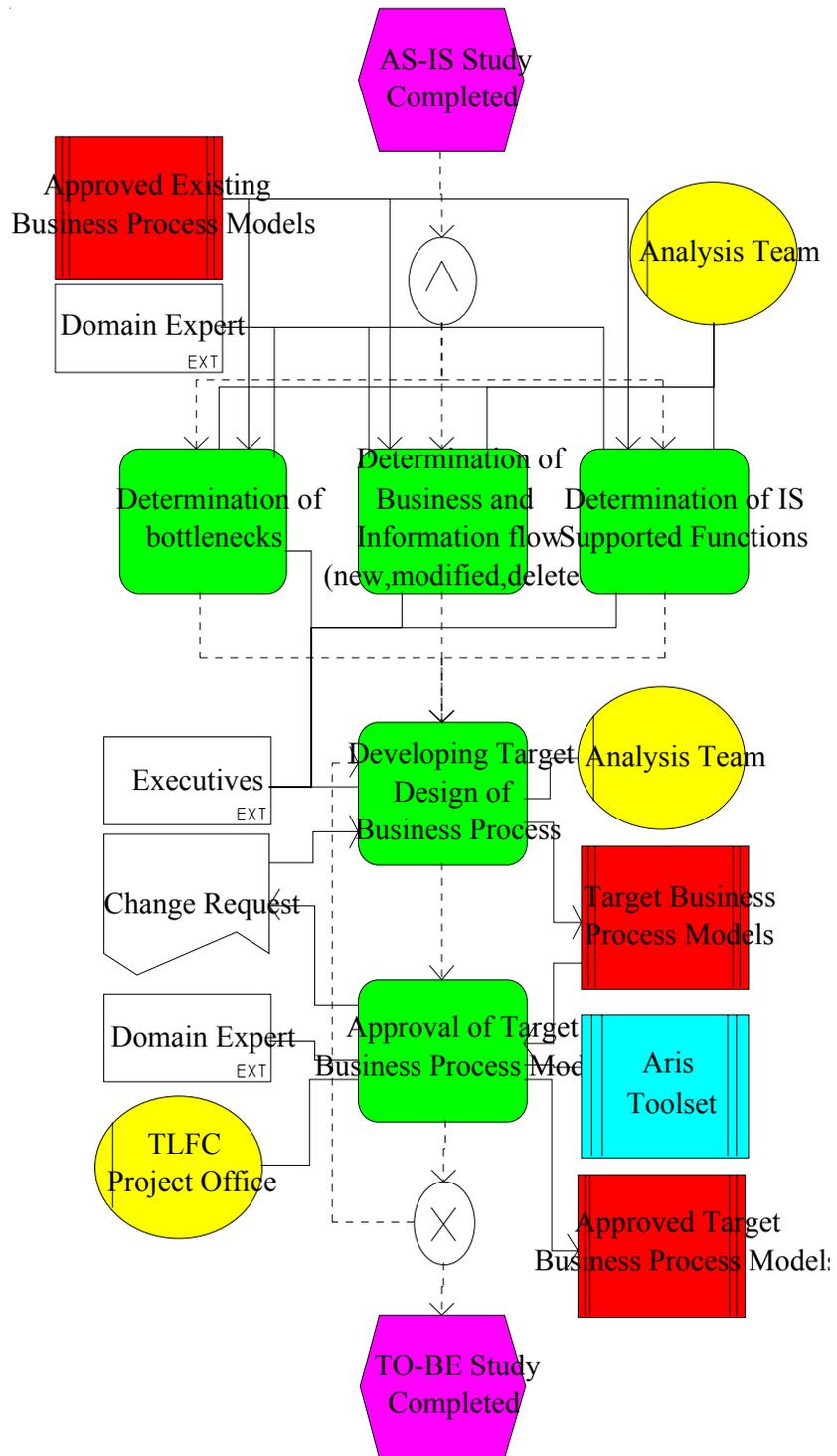
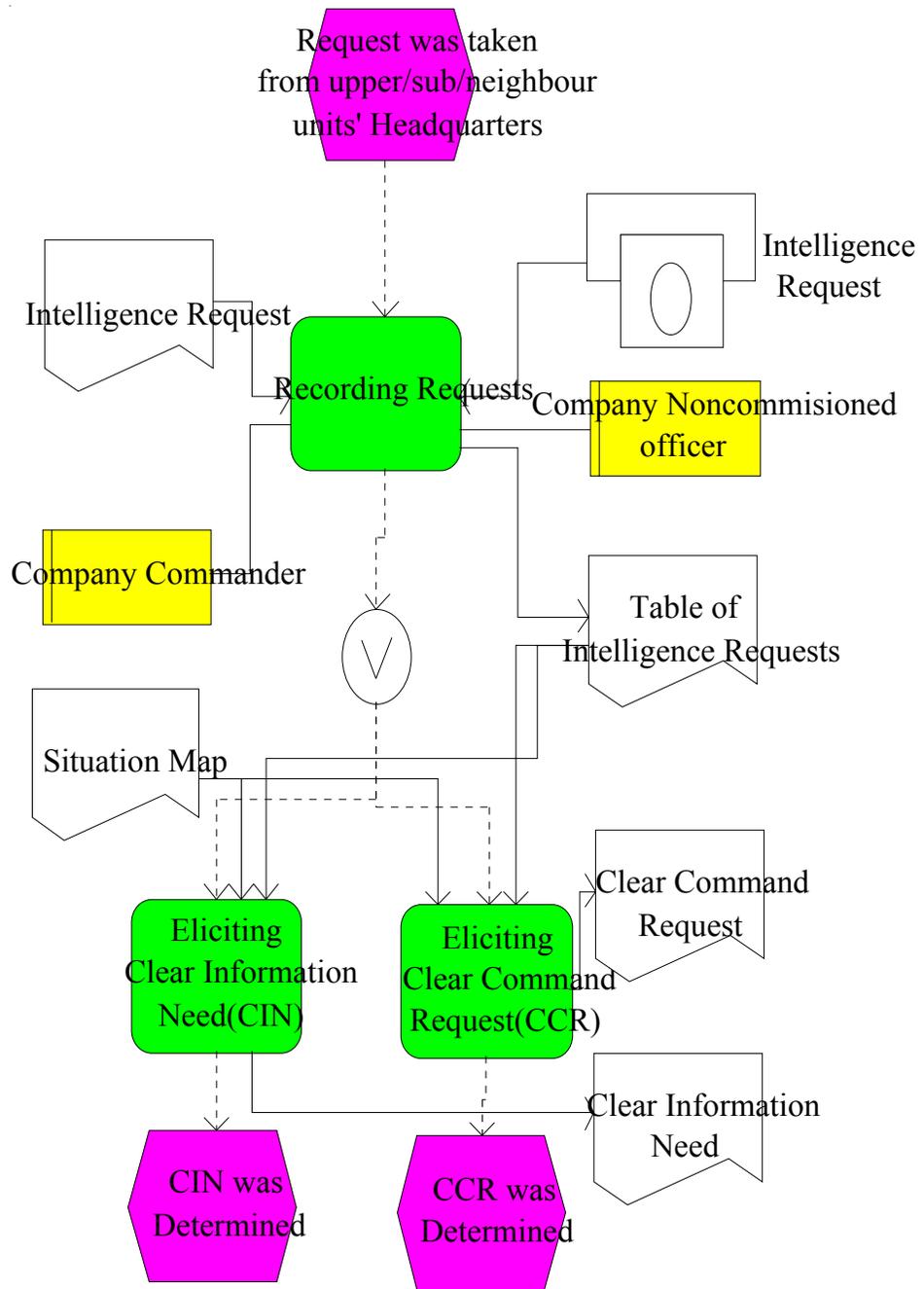
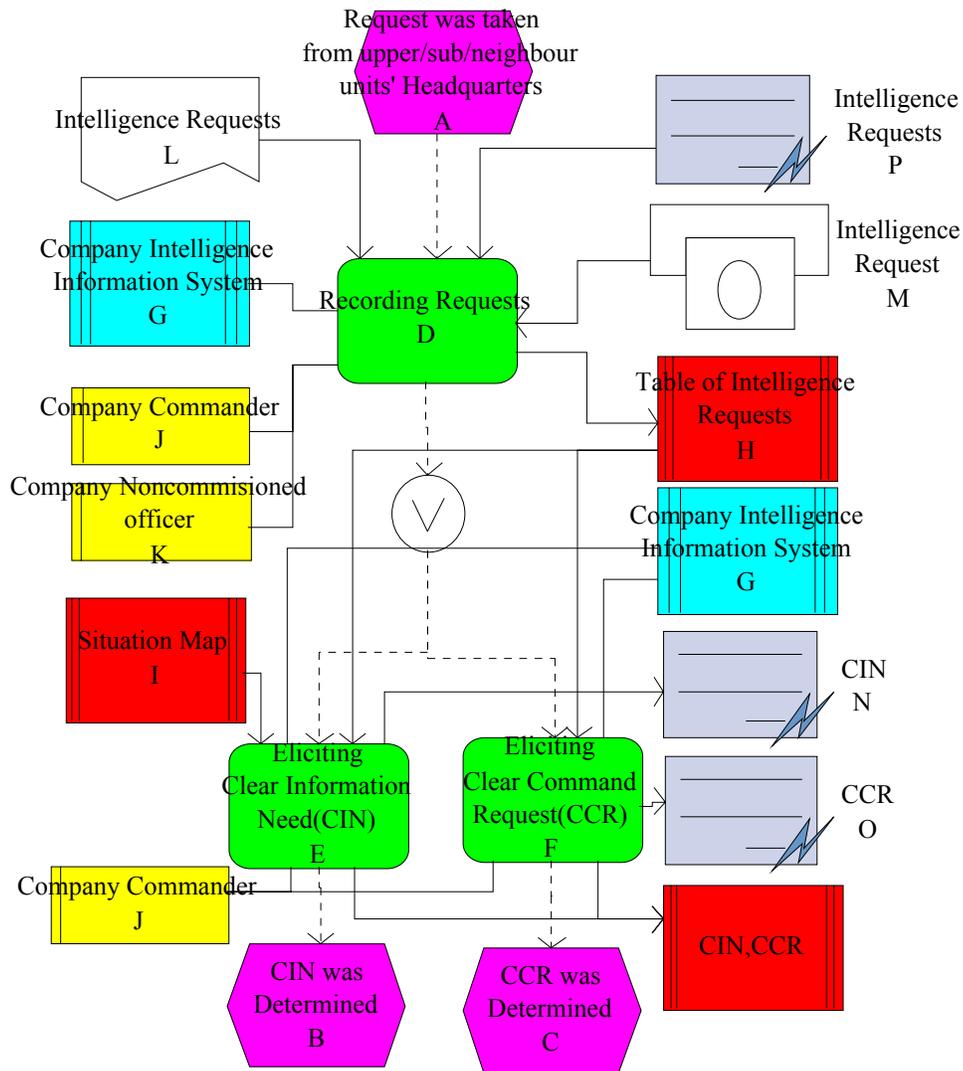


Figure 24. EPC of TO-BE Study



**Figure 25. Example for Incomplete BPM**

- Some object types were not added to the models:
  - Application system type
  - Electronic document, folder
  - Data cluster
- Actually, these object types are not very necessary in order to manually elicit functional requirements of the software-intensive system to be acquired or developed, for those people who have enough software knowledge.
- We take a model created during contract preparation, given in Figure 25 and redeveloped it by adding required object types. New model of the same business process can be seen in Figure 26. Some issues, given in section 4.3.2 were considered when developing target business model for the purpose of completeness and accuracy.



**Figure 26. Completed Target Business Process Model**

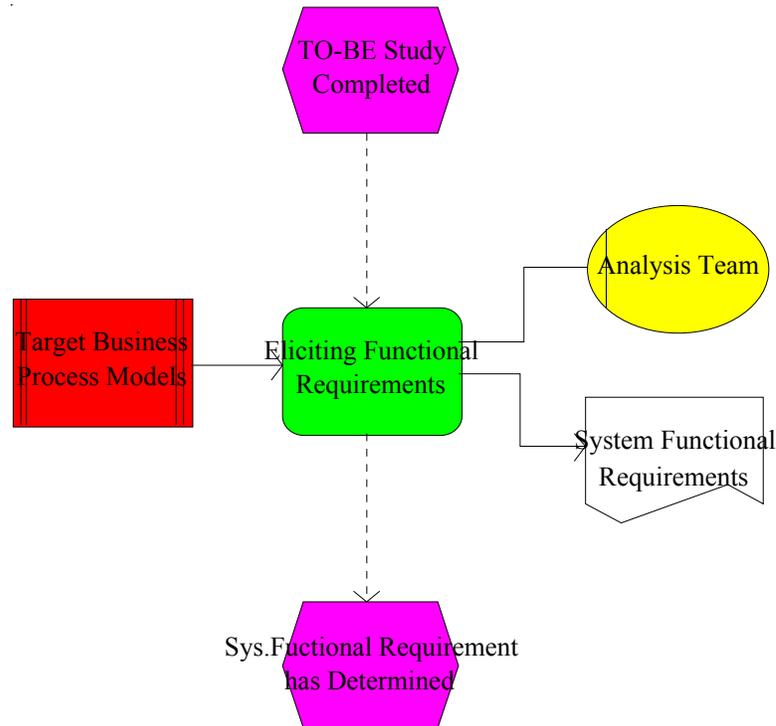
### 5.5.4 Evaluation of Step 3

EEPC of last step of the general process is given in figure 27. Some results and evaluations that are obtained from Step 3 experience are as follows:

- If we can have complete models for target business processes, functional specifications do not have to be developed manually. There

is no need for the complete target business process models absolutely to generate requirements manually.

- We generated functional requirements manually by examining and evaluating the uncompleted “to-be” models. We used the information gathered from users, domain expert and TLFC project management during JAD sessions; and we used our software knowledge.
- Elicitation of functional requirements without tool support takes long time.
- Reflection of business process changes in functional specifications is a cumbersome task with risk of maintaining integrity.
- Requirements specifications generated during contract preparation may lack control view. Thus, there is no indication of beginning and end of the process. In other words, there is no initial and results events.
- Completed target business process models can be used in automated requirements elicitation by utilizing ARIS toolset reporting mechanism.
- We used new target business process model that we developed, given in Figure 26 to demonstrate how to elicit functional requirements automatically.



**Figure 27. Step 3 Applied**

As we see in Figure 27, there is no application software support, that is, requirements had been generated manually by using target business process models.

## 5.6 REPORTING SCRIPT

The case study did not include the automated functional elicitation. Functional requirements of the proposed system were determined manually due to time constraints. We, however, later extended a script of ARIS Toolset and used it to generate functional requirements from business process automatically.

### 5.6.1 Extended Reporting script- *Newhierarchy.rsm*

In ARIS toolset, Visual Basic and ARIS Basic Language Capability commands are used for report and analysis scripts. All classes and methods can be found in ARIS Toolset Help Files. We used *Modelhierarchy.rsm* report script of

ARIS Toolset as a basis. We have redeveloped tree procedures of the script and created a function according to our needs, as given in Appendix B. Following are the extensions applied in the new script.

- To create our own script, unique identifiers [Scheer, 2001] (numbers) are assigned to model, object, relationship, symbol, and attribute types of models. We used relationship numbers.
- *Function isInSet (Index As Integer, TypeNum As Integer) As Boolean* is used to determine the object type whether it is in the index or not . Index gets the numbers between 1-6 as follows:
  1. Data Input
  2. Data Output
  3. Input
  4. Output
  5. Organizational Unit
  6. Application System
- Index is searched according to the parameter, type number “*TypeNum*”. Object types are all process views. Every object type has a relationship types with other object type, described in Table 18, and these relationship types have a type number.
- *Sub OutFunction* and *Sub OutputModelData* has been changed mostly related with report format.
- *Sub OutOfRelationships (oCxnOccs As Object, oCurrentFuncOcc As Object)* is developed according to our needs. “Function” object of the model is called as parameter in this procedure. All of the stated relationships are searched for each object type (1-6) and function whether it exists or not. That is, all possible relationships of six object types with the current function are searched for whether they exist or not and if exist, they are displayed in the table with their names and symbol types.
- When we run the script we are presented with three user-dialogs, given in Appendix C. The first one includes determination of level

depth and graphic output request. The second one is for sorting sequence for evaluating models, we must choose topologically option in order to see the control flow of the process. Third one is model types option; we must choose EEPC option.

### **5.6.2 Comparison and Evaluation of Outputs**

In this section, requirements expressions obtained by using two techniques, manually and automatically will be investigated. We used the model given in Figure 26 to automatically generate output as functional requirements document. This model is target design of “intelligence orientation”. We created it by adding necessary object types to the model given in 25. All of the business process models developed at the time of contract preparation and functional requirements specifications generated from these models can be found in “KEIS Model System Technical Contract” at the intelligence department of TLFC. To give an example, requirements expressions, for the first activity “recording request” of the process (intelligence orientation), generated manually at the time of contract preparation are as follows:

#### **Manually created output:**

“Data on Intelligence Request that is taken from all units by written document or verbally on telephone or wireless radio will be able to be entered to the system. Data entered to the system must be recorded to the database, and data recorded in the database must be able to be updated, reported, queried and deleted”.  
“Data on Intelligence Request that is taken from all units by electronic form must be buffered and saved after a determined time.”

If we generate requirements automatically for the same activity “recording request”, of the same process (intelligence orientation), given in Figure 26, requirements output would be as follows:

**Automatically generated output:**

1. 1. 1 Recording Requests

| <b>OBJECT TYPE</b>  | <b>RELATIONSHIPS</b>                 | <b>OBJECT NAME</b>  |
|---------------------|--------------------------------------|---|
| Data Input          | None                                 | None  |
| Data Output         | has output of                        | Table of Intelligence Requests/Cluster                          |
| Input               | gets input from                      | Intelligence Request /Telephone                                 |
|                     | gets input from                      | Intelligence Requests/Document                                  |
|                     | gets input from                      | Intelligence Requests/Electronic document                       |
| Output              | None                                 | None  |
| Organizational Unit | is under technical responsibility of | Company Commander/Position                                      |
|                     | is executed by                       | Company Noncommissioned officer/Position                        |
| Application System  | can be supported by                  | Company Intelligence Information System/Application system type |

Complete requirements output for the whole process is given in Appendix A.

As we see, there are some similarities and differences between two kinds of expressions:

- Some process views, namely “data”, “function”, “output” views had been considered in the manually created specifications. “Organization” and “Control” views had not been considered.
- All of the process views can be seen in our proposed output. Especially control view that represents process sequence is considered.
- All of the requirements specifications can be seen in our proposed output, but some expressions like: “Data entered to the system must be recorded to the database, and data recorded in the database must be able to be updated, reported, deleted and queried” and “by electronic form must be buffered and saved after a determined time.” can not be expressed directly but can be deduced from the table’s columns.
- In our proposed report template, symbol types of all objects are displayed. If symbol of input object type is “electronic document”, we can consider that “must be buffered and saved after a determined time” expression can be used for this situation.
- If output data is exist as “cluster” in the table, “Cluster will be able to be updated, reported, deleted and queried.” expression can also be used for this situation.
- To make a comparison, we evaluated two types of requirements expressions in quantitative approach. If we consider the process “intelligence orientation”, there are 22 functional requirements specifications developed manually at the time of contract preparation. These can be found in “KEIS Model System Technical Contract”. 14 of them are related with standard expressions (reporting, deleting, updating and querying) stated above. One of them is about notification message. 7 of them are the specific (essential parts of the) functional requirements.
- In our requirements report for the same process, given in Appendix A, essential parts are obviously captured. Thus we covered %100 of the essential parts of the manually generated specifications. If we assume

that other standard specifications can also be deduced from our report generated via new script, it means that approximately %95 of the overall functional requirements can captured.

As a result, requirements specification document that is obtained by using modified script of ARIS CAPE Tool can be used as a baseline system functional requirements document that all the stakeholders agree on, who participate analysis activities.

## CHAPTER 6

### 6 CONCLUSION

Within this study, a unified approach that combines and integrates business process modeling with functional requirements elicitation, based on ARIS modeling and reporting methods is proposed.

With a general literature review, requirements engineering, its challenges and business–IT alignment concept are analyzed. Some requirements engineering methods, like DFD modeling, object oriented modeling and formal methods are briefly explained with its advantages and disadvantages. Business-IT alignment process is discussed with three domains: Strategic planning, business process analysis and design and IS architectures. Business process modeling concept is investigated as a means of business analysis and design. IDEF0 process modeling technique is also reviewed. After general review, ARIS approach is analyzed with its integrated and complete architecture, modeling methods and tool. EEPCC modeling technique is explained with its advantages over other techniques. ARIS toolset that supports “EEPC modeling” and “model reporting” that can be used for automated requirements elicitation is also investigated.

Then, proposed approach for functional requirements elicitation is described. Most of the steps of the proposed approach are applied to the TLFC project. In case study, Chapter 5, proposed approach phase of this project, namely functional requirements elicitation phase is explained. What we learned from this project and what have been done after this project in terms of requirements generation are also described in the case study. As a further study completed after TLFC project, automated elicitation of functional requirements is examined based on ARIS toolset reporting, as a phase of the proposed approach.

Information system is an important concept in which information technology and business processes are integrated with each other. If an organization will acquire a new information system whether there exists an old one or not, it must determine the requirements of the target system within the context of strategic planning, business process analysis and design and complete IS architecture. Our proposed requirements elicitation process helps the analyst to coordinate these three domains in order to align IT with business. We however did not integrate strategic planning with business process analysis and design. Our proposal takes strategic planning as a precondition. Formal integration of strategic planning into requirements elicitation has already been proposed as future work, as we believe that strategic planning must be related to business process analysis and design in any process innovation activities.

When determining requirements, a process-oriented approach rather than a function-oriented approach helps organizations to see the big picture of the system, thus they can organize around outcomes not the tasks. Processes are more measurable than functions in terms that directly relate to organizational goals. The proposed approach is based on process-oriented analysis.

Functional requirements elicitation must start with finding out the business requirements. For this activity, business process modeling is an effective way. But modeling tools and techniques must be customer-oriented rather than analyst-oriented in order to better describe the business processes. These kinds of tools and techniques also help JAD sessions in which customer and developer are trying to find out the requirements of the target system. The proposed approach proposes a customer-oriented technique and tool, namely EEPC and ARIS toolset.

None of the CASE tools that were reviewed has the ability of business process modeling tool in terms of finding out the business requirements. Manual integration is necessary for these kinds of tools. Major deficiency of this type of integration is the transforming business requirements into the software-intensive system requirements. Our proposed approach can help customers or developers to generate the functional requirements of any target system automatically. Both customer and developer can formulate the system functional requirements easily on a standard format that can be easily understood by all the stakeholders; and the

specification document obtained can be easily verified and modified by making changes on the business process models. Functional requirements specification generated by *newhierarchy.rsm* script can be used in IS acquisition. Developers can use this specification as input to software requirements specification in software development life cycle.

## **6.1 FUTURE WORK**

Today, strategic planning is performed manually; there is no software tool support that can assist in linking vision, goals and strategies, that is strategic planning, with design of business processes. This challenge can be overcome by integrating modeling of strategic planning with business process modeling. That allows us to easily trace all functional requirements back to their related business strategies and goals on which strategies are developed. This approach will, of course, provide automation support for business-IT alignment.

Reporting script developed in this thesis can be further extended to generate functional requirements, currently expressed in table form, by using natural language.

## REFERENCES

- Anthes, G., 1994, "No More Creeps", Computer world, Vol. 48 Issue 18, pp. 107.
- Avison, D., Fitzgerald, G., 1995, "Information System Development: Methodologies, Techniques and Tools", McGraw-Hill Book Company, England
- Blessing, D., Österle, H., 1999, "Business Engineering Model", Report of the Institute for Information Management of the University of St. Gallen, St. Gallen.
- Booch, G., 1994, "Object Oriented Analysis and Design with Applications, 2<sup>nd</sup> Edition, Benjamin Cummings Pub., Redwood City, Calif.
- Brinkkemper, S., 1990, "Formalization of Information Systems Modeling", PhD Thesis, University of Nijmegen, Amsterdam.
- Christel, M., A., Kang, K., C., September 1992, "Issues in Requirements Elicitation", Software Engineering Institute, CMU/SEI-92-TR-12.
- Cummins, F., A., 2002, "Enterprise Integration: An architecture for Enterprise Application and Systems Integration", John Wiley & Sons, Canada.
- Davenport, H., T., 1993, "Process Innovation", Harvard Business School Press, Boston.
- Dorfman, M., Thayer, R. H., 1997, "Software Requirements Engineering", IEEE Computer Society Press, Los Alamitos, Calif.

Engler, N., Nov 1996, "Bringing in the Users", Computerworld, Vol 30 Issue 48, pp 3.

Goodrich, V., Olfman, L., January 1990, "An Experimental Evaluation of Task and Methodology Variables for Requirements Definition Phase Success", Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences, pp. 201-209, IEEE Computer Society.

Harrington, J.H., 1991, "Business Process Improvement", McGraw-Hill, Newyork.

Halpin T. A., 1995, "Conceptual Schema and Relational Database Design" 2<sup>nd</sup> Edition, Prentice-Hall.

Hammer, M., Cahmpy, J., 1993, " Reengineering the Corporation. A manifesto for Business Revolution", Harper business, New York.

Hannam, R., 1997, "Computer Integrated Manufacturing: from concepts to realisation", Addison-Wesley, Harlow, England.

Jeffrey, A. Hoffer, Joey, F. George, Joseph, S. Valacich 1999 "Modern Systems Analysis and Design" 2<sup>nd</sup> Edition, Addison-Wesley, Reading, Mass.

Keen, P., G., W., 1997, " The Process Edge", Boston, Harvard Business School Press, Mass.

Kirchmer, M., 1999, "Business Process Oriented Implementation of Standard Software", Springer, Berlin, Newyork.

Kotonya, G., Sommerville, I., 1998, "Requirements Engineering: Process and Techniques", Sons&Wiley, New York.

Leffingwell, Dean., April 1997, "Calculating the Return on Investment from More Effective Requirements Management", Cutter IT Journal (formerly American Programmer, Vol 10 No 4, pp.13-16)

Macaulay, L.A., "Requirements Engineering" Springer-Verlag London Limited, London 1996

Marshall, C., 2000, "Enterprise Modeling with UML: Designing Successful Software Through Business Analysis", Addison-Wesley, Massachusetts.

Olle, T. W., Hagelstein, J., Macdonald, I.G., Rolland, C., Sol, H.G., Van Assche, F.J.M. & Verrijn-Stuart, A.A., 1991, "Information System Methodologies: A Framework for Understanding", Addison-Wesley, Wokingham UK.

Pressman, R., S., 2001, "Software Engineering: a practitioner's approach", McGraw-Hill, Newyork.

Sadoe, K., Corbitt, G., Boykin, R., 2001, "Enterprise Integration", John Wiley & Sons, Newyork.

Scheer, A., W., 1992, "Architecture of Integrated Information System-Foundations of Enterprise-Modeling", Springer, Berlin.

Scheer, A, W., 1994, "Business Process Engineering-Reference Models for Industrial Enterprises", 2<sup>nd</sup> Edition, Springer, Berlin.

Scheer, A., W., 1999, "ARIS-Business Process Frameworks", Springer, Berlin.

Scheer, A, W , 2000, "ARIS-Business Process Modeling", Springer, Berlin.

Scheer, A, W., September 2001, "Aris Help Files .pdf", Saarbrücken, Germany.

Steele, P.M., 1999, “ Modeling Frameworks: The essential link between models and methodologies”, Proc.10<sup>th</sup> Australasian Conference on Information Systems.

Whitmore, S., May 29, 1995, "Readers Shed Development Woes", PC Week, Vol 12 Issue 21, pp55.

Wiegers, K., 1999, “Software Requirements”, Microsoft Press.

William, U, 2001, “Business Driven IT Integration and Realignment”, Executive Report, Vol. No.2, Business-IT Strategies Advisory Service, Cutter Consortium.

Yeates, D., Shields, M., Helmy, D., 1994, “System Analysis and Design eds.”, Pitman Publishing, London.

**APPENDIX A: OUTPUT OF *NEWHIERARCHY.RSM* SCRIPT**

**TARGET DESIGN OF 'INTELLIGENCE ORIENTATION' PROCESS**

Start path

**1. 1. 1 Recording Requests**

| OBJECT TYPE         | RELATIONSHIPS                        | OBJECT NAME  |
|---------------------|--------------------------------------|--|
| Data Input          | none                                 | none   |
| Data Output         | has output of                        | Table of Intelligence Requests/Cluster                           |
| Input               | gets input from                      | Intelligence Requests /Document                                  |
|                     | gets input from                      | Intelligence Request /Telephone                                  |
|                     | gets input from                      | Intelligence Requests /Electronic document                       |
| Output              | None                                 | none   |
| Organizational Unit | is executed by                       | Company Noncommisioned officer /Position                         |
|                     | is under technical responsibility of | Company Commander /Position                                      |
| Application System  | can be supported by                  | Company Intelligence Information System /Application system type |

### 1. 1. 2 Eliciting Clear Information Need(CIN)

by Function Recording Requests (Chapter 1. 1. 1)

| OBJECT TYPE         | RELATIONSHIPS       | OBJECT NAME  |
|---------------------|---------------------|--|
| Data Input          | has input of        | Table of Intelligence Requests/Cluster                           |
|                     | has input of        | Situation Map/Cluster  |
| Data Output         | has output of       | CIN,CCR/Cluster  |
| Input               | None                | none   |
| Output              | Creates output to   | CIN /Electronic document   |
| Organizational Unit | is executed by      | Company Commander /Position                                      |
| Application System  | can be supported by | Company Intelligence Information System /Application system type |

End path

Start path

### 1. 1. 3 Eliciting Clear Command Request(CCR)

by Function Recording Requests D (Chapter 1. 1. 1)

| OBJECT TYPE | RELATIONSHIPS     | OBJECT NAME                            |
|-------------|-------------------|--|
| Data Input  | has input of      | Table of Intelligence Requests/Cluster |
| Data Output | has output of     | CIN,CCR/Cluster                        |
| Input       | None              | none                                   |
| Output      | creates output to | CCR /Electronic document               |

|                     |                     |   |
|---------------------|---------------------|---|
| Organizational Unit | is executed by      | Company Commander<br>/Position  |
| Application System  | can be supported by | Company Intelligence<br>Information System<br>/Application system<br>type |

End path

## **APPENDIX B: EXTENDED PART OF MODEL HIERARCHY.RSM SCRIPT<sup>31</sup>**

```
Sub OutFuncData(oCurrentFuncOcc As Object, nDepth As Integer, nCurrentDepth  
As Integer, nModelLevel As Integer, sFuncLevel As String, ByRef oAsProzModelList  
As Object, ByRef sSourceFuncProc() As String, sBough As String)
```

```
Dim oCxnOccList As Object
```

```
Dim sIdentificationOfAssignedModels() As String
```

```
Dim sIDOfEvaluateFun As String
```

```
Dim sSearchLeftString As String
```

```
Dim sSearchRightString As String
```

```
Dim sSearchChar As String
```

```
Dim iIdentificationOfAssignedModelsNumbers As Integer
```

```
Dim bCallFunction As Boolean
```

```
Dim bDoneFunc As Boolean
```

```
Dim bDoneFunc2 As Boolean
```

```
' default settings
```

```
iIdentificationOfAssignedModelsNumbers = 0
```

```
bDoneFunc2 = CheckObj(oCurrentFuncOcc, sIDOfEvaluateFun, nCurrentDepth,  
nModelLevel, sFuncLevel, True, True, g_oDoneModFuncOccs, g_sDFuOccId,  
oCurrentFuncOcc.ObjDef().Name(g_nLoc))
```

```
bDoneFunc = CheckObj(oCurrentFuncOcc.ObjDef(), sIDOfEvaluateFun,  
nCurrentDepth, nModelLevel, sFuncLevel, True, True, g_oDoneFuncDefs,  
g_sDoneFuncIdent, oCurrentFuncOcc.ObjDef().Name(g_nLoc))
```

```
If Not(bDoneFunc2) Then
```

---

<sup>31</sup> Complete script, "Newhierarchy.rsm", can be obtained from the technical report numbered "METU/II-TR-2002-2"

```

sSearchChar = Chr$(9)
sSearchLeftString = ""
sSearchRightString = ""

bCallFunction = False
If nCurrentDepth <= nDepth Then
    If Not (oCurrentFuncOcc.SymbolNum() = ST_PRCS_IF) Then
        AssignedModelsIntoList oCurrentFuncOcc, nDepth,
nCurrentDepth, nModelLevel, sFuncLevel, oAsProzModelList, sSourceFuncProc
    End If
End If
If bDoneFunc = False Then
    g_oOutFile.OutputLnF(Str$(nCurrentDepth)+". "+Str$(nModelLevel)+". "+s
FuncLevel+" "+ oCurrentFuncOcc.ObjDef().Name(g_nLoc),"REPORT3")
    If g_sSelection = "EEPC" And Not(sBough = "") Then
        g_oOutFile.OutputLnF("by " & sBough,"REPORT3")
    End If
    If g_bDoneFunc = True Then
        StringCut g_sDoneFuncID, sSearchLeftString,
sSearchRightString, sSearchChar
        g_oOutFile.OutputLnF("leads to " & "function " +
sSearchRightString + " (Chapter " + sSearchLeftString+)", "REPORT3")
    End If

    g_oOutFile.BeginTable(100,C_BLACK,COLOR_TRANSPARENT,FMT_LEF
T,0)

    Set oCxnOccList = oCurrentFuncOcc.CxnOccList()
    If oCxnOccList.Count() > 0 Then
        OutOfRelationships oCxnOccList, oCurrentFuncOcc
    End If

```

```

        OutOfAssignedModels oCurrentFuncOcc, oAsProzModelList,
nDepth, nCurrentDepth, nModelLevel
        g_oOutFile.EndTable("",100, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

    Else
        StringCut sIDOfEvaluateFun, sSearchLeftString, sSearchRightString,
sSearchChar

        g_oOutFile.OutputLnF(Str$(nCurrentDepth)+". "+Str$(nModelLevel)+". "+s
FuncLevel+ " " + sSearchRightString + " See " + sSearchLeftString,"REPORT3")

        g_oOutFile.BeginTable(100,C_BLACK,COLOR_TRANSPARENT,FMT_LEF
T,0)

            Set oCxnOccList = oCurrentFuncOcc.CxnOccList()
            If oCxnOccList.Count() > 0 Then
                OutOfRelationships oCxnOccList, oCurrentFuncOcc
            End If
            g_oOutFile.EndTable("",100, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

        End If
    End If
End Sub
-----

Function isInSet(Index As Integer, TypeNum As Integer) As Boolean
    isInSet = False

    Select Case Index
        Case 1

```

```

        If (TypeNum=49) Or (TypeNum=222) Or (TypeNum=223)
Then isInSet = True
        Case 2
            If (TypeNum=50) Or (TypeNum=224) Or (TypeNum=225) Or
(TypeNum=226) Or (TypeNum=227) Or (TypeNum=228) Then isInSet = True
        Case 3
            If (TypeNum=53) Then isInSet = True
        Case 4
            If (TypeNum=28) Then isInSet = True
        Case 5
            If (TypeNum=65) Or (TypeNum=435) Or (TypeNum=10) Or
(TypeNum=148) Or (TypeNum=232) Or (TypeNum=233) Or (TypeNum=255) Or
(TypeNum=266) Or (TypeNum=316) Or (TypeNum=355) Then isInSet = True
        Case 6
            If (TypeNum=221) Then isInSet = True
    End Select

```

*End Function*

-----  
*Sub OutOfRelationships(oCxnOccs As Object, oCurrentFuncOcc As Object)*

```

    Dim oCurrentCxnOcc As Object
    Dim oAssignedModels As Object
    Dim oSubModFunc As Object
    Dim sCurrentFuName As String
    Dim sOutStr As String
    Dim sObjName As String
    Dim ObjectsType(6)
    Dim ObjectsExist(6)
    Dim ObjectTypeStr As String
    Dim UseAssigned As Boolean

```

*Dim n As Integer*

*ObjectsType(1)="Data Input "*

*ObjectsType(2)="Data Output"*

*ObjectsType(3)="Input"*

*ObjectsType(4)="Output"*

*ObjectsType(5)="Organizational Unit"*

*ObjectsType(6)="Application System"*

*g\_oOutFile.TableRow()*

*g\_oOutFile.TableCell("OBJECT TYPE",30, "Times New  
Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*g\_oOutFile.TableCell("RELATIONSHIPS",30, "Times New  
Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*g\_oOutFile.TableCell("OBJECT NAME",40, "Times New  
Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*For n=1 To 6*

*ObjectTypeStr = ObjectsType(n)*

*ObjectsExist(n) = False*

*sCurrentFuName = oCurrentFuncOcc.ObjDef().Name(g\_nLoc)*

*For i = 0 To oCxnOcs.Count()-1*

*Set oCurrentCxnOcc = oCxnOcs.Get(i)*

*If*

*oCurrentFuncOcc.IsEqual(oCurrentCxnOcc.SourceObjOcc()) = True Then*

*If isInSet(n, oCurrentCxnOcc.Cxn().TypeNum()) Then*

*g\_oOutFile.TableRow()*

```
g_oOutFile.TableCell(ObjectTypeStr,30,  
"Times New Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or  
FMT_VTOP,0)
```

```
ObjectTypeStr = ""  
sObjName = ""  
sObjName =  
oCurrentCxnOcc.TargetObjOcc().SymbolName()
```

```
g_oOutFile.TableCell(oCurrentCxnOcc.Cxn().ActiveType(),30, "Times New  
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
```

```
sOutStr =  
oCurrentCxnOcc.TargetObjOcc().ObjDef().Name(g_nLoc)  
If sOutStr = "" Then sOutStr = "without  
Namen"
```

```
g_oOutFile.TableCell(sOutStr+"/"+sObjName,40, "Times New  
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
```

```
ObjectsExist(n) = True
```

```
End If
```

```
Else
```

```
If isInSet(n, oCurrentCxnOcc.Cxn().TypeNum()) Then
```

```
g_oOutFile.TableRow()
```

```
g_oOutFile.TableCell(ObjectTypeStr,30,  
"Times New Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or  
FMT_VTOP,0)
```

```
ObjectTypeStr = ""  
sObjName = ""  
sObjName =  
oCurrentCxnOcc.SourceObjOcc().SymbolName()
```

```

g_oOutFile.TableCell(oCurrentCxnOcc.Cxn().PassiveType(),30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
sOutStr =
oCurrentCxnOcc.SourceObjOcc().ObjDef().Name(g_nLoc)
If sOutStr = "" Then sOutStr = "without
Namen"

```

```

g_oOutFile.TableCell(sOutStr+ "/" +sObjName,40, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
ObjectsExist(n) = True
End If
End If
Set oCurrentCxnOcc = Nothing
Next i

```

```

If (ObjectTypeStr <> "") Then
g_oOutFile.TableRow()
g_oOutFile.TableCell(ObjectTypeStr,30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
g_oOutFile.TableCell("none",30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
g_oOutFile.TableCell("none",40, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
ObjectTypeStr = ""
End If

```

```

ObjectTypeStr = ObjectsType(n)
Set oAssignedModels =
oCurrentFuncOcc.ObjDef().AssignedModels()

```

```

If (oAssignedModels.Count() > 0) Then
    UseAssigned = False
    For h = 0 To oAssignedModels.Count()-1
        If isInSet(n,
oAssignedModels.Get(h).TypeEnum()) Then UseAssigned = True

        Next
    Else
        UseAssigned = False
    End If

If UseAssigned = True Then

    g_oOutFile.OutputLn("", "Times New
Roman",8,C_BLACK,COLOR_TRANSPARENT,FMT_LEFT,0)
    g_oOutFile.TableRow()
    g_oOutFile.TableCell("OBJECT TYPE",30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
    g_oOutFile.TableCell("RELATIONSHIPS",30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)
    g_oOutFile.TableCell("OBJECT NAME",40, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

    For h = 0 To oAssignedModels.Count()-1
        Select Case oAssignedModels.Get(h).TypeEnum()
            Case MT_FUNC_ALLOC_DGM

                Set oSubModFunc =
oAssignedModels.Get(h).ObjOccListFilter(sCurrentFuName, OT_FUNC, g_nLoc)

```

```

Set oCxnOccs =
oAssignedModels.Get(h).CxnOccList()
For i = 0 To oCxnOccs.Count()-1
Set oCurrentCxnOcc =
oCxnOccs.Get(i)
If isInSet(n,
oAssignedModels.Get(h).TypeNum()) Then
g_oOutFile.TableRow()
If
oSubModFunc.Get(0).IsEqual(oCurrentCxnOcc.SourceObjOcc().ObjDef()) = True
Then

g_oOutFile.TableCell(ObjectTypeStr,30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

ObjectTypeStr=""

g_oOutFile.TableCell(oCurrentCxnOcc.Cxn().ActiveType(),30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

g_oOutFile.TableCell(oCurrentCxnOcc.TargetObjOcc().ObjDef().Name(g_n
Loc),40, "Times New Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT
Or FMT_VTOP,0)

Else

g_oOutFile.TableCell(ObjectTypeStr,30, "Times New
Roman",12,C_BLACK,COLOR_TRANSPARENT,0,FMT_LEFT Or FMT_VTOP,0)

ObjectTypeStr=""

```

*g\_oOutFile.TableCell(oCurrentCxnOcc.Cxn().PassiveType(),30, "Times New Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*g\_oOutFile.TableCell(oCurrentCxnOcc.SourceObjOcc().ObjDef().Name(g\_n Loc),40, "Times New Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*End If*

*End If*

*Set oCurrentCxnOcc = Nothing*

*Next i*

*End Select*

*Next h*

*If (ObjectTypeStr <> "") Then*

*g\_oOutFile.TableRow()*

*g\_oOutFile.TableCell(ObjectTypeStr,30, "Times New Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*g\_oOutFile.TableCell("none",30, "Times New Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*g\_oOutFile.TableCell("none",40, "Times New Roman",12,C\_BLACK,COLOR\_TRANSPARENT,0,FMT\_LEFT Or FMT\_VTOP,0)*

*ObjectTypeStr = ""*

*End If*

*End If*

*Next*

*Set oCurrentCxnOcc = Nothing*

*Set oAssignedModels = Nothing*

*Set oSubModFunc = Nothing*

*End Sub*

-----  
*Sub OutputModelData(oCurrentModel As Object, nCurrentDepth As Integer,  
nModelLevel As Integer,sSourceFunc As String, bFirstModel As Boolean)*

*Dim oSuperiorObjectList As Object*

*Dim oCurrentSuperiorObject As Object*

*Dim sOutString As String*

*Dim nModelZoom As Double*

*Dim bFirst As Boolean*

*Dim bDummy As Boolean*

*Set oSuperiorObjectList = CreateObject("ARIS.ObjDefList.6.0")*

*bFirst = True*

*If bFirstModel = True Then*

*If nCurrentDepth > 1 Then*

*g\_oOutFile.OutputLnF(Str\$(nCurrentDepth)+".Level", "REPORT1")*

*End If*

*g\_oOutFile.OutputLn("", "Times New*

*Roman",8,C\_BLACK,COLOR\_TRANSPARENT,FMT\_LEFT,0)*

*g\_oOutFile.OutputLn("TARGET DESIGN OF " &*

*oCurrentModel.Name(g\_nLoc)+ " PROCESS ", "Times New*

*Roman",14,C\_BLACK,COLOR\_TRANSPARENT,FMT\_CENTER,0)*

*g\_oOutFile.OutputLn("", "Times New*

*Roman",8,C\_BLACK,COLOR\_TRANSPARENT,FMT\_LEFT,0)*

*End Sub*

## APPENDIX C: USER DIALOGS

