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Partnership Enterprise Modeling Using FIDO-Integrated Systems Modeling Technique

Joong-In Kim[1] · Cheol-Han Kim[2†] · Kyung-Huy Lee[2]

[1]Department of MIS, Hongik University, Seoul, 339-701
[2]Division of Computer and communications engineering, Daejon University, Daejon, 300-716

FIDO 방법론을 이용한 기업 간 연계 프로세스 모델링

김중인[1] · 김철한[2] · 이경휘[2]

[1]홍익대학교 경영정보학과/[2]대전대학교 컴퓨터정보통신공학부

This paper utilizes the FIDO methodology (Function, Information, Dynamic, Organization modeling) which is an enterprise modeling tool that can describe inter-organizational interaction (specifically between prime and sub contractors in this experiment). FIDO follows the standard IDEFO rules in order to demonstrate how a cascading information flow can evolve from a customer to a prime to a subcontractor in a concurrent manner, in a supply chain environment. Background on these processes is presented, followed with the newly derived process and methodology. This is presented in a supply chain management context, and results from an actual experiment at Motorola utilizing subcontractors that supply custom machine parts is presented and reviewed.

Keywords: modeling methodology, supply chain management, IDEFO, enterprise modeling

1. Partnership Enterprise model

In the arena of highly information intensive manufacturing systems, a number of technologies such as information technology, modeling methodology, software engineering as well as manufacturing engineering has emerged to meet needs of markets: mass customisation on a global scale. These technologies enable enterprises to be inter-linked each other, because manufacturers no longer produce complete products in isolated facilities. They operate as nodes in a network of suppliers, customers, engineers, and other specialized service functions (Davidow, 1995).

Partnership enterprises comprise consortia of interacting businesses that need to operate coherently despite of their geographical distribution(Brown *et al.* 1994, Messina 1997). One approach to achieving coherence is to agree upon common definitions of business, engineering, logistical and manufacturing processes and for all partner businesses to deploy their human and technical resources so that they realize an agreed set of roles and responsibilities that collectively enact the common process definitions (Weston 1999). Generalized and process-oriented representation of partner businesses (co-operating in the life-cycle engineering of a range of products) was developed by an ICEIMT '97 (International Conference on Enterprise Integration and Modeling

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† Corresponding author : Professor Cheol-Han Kim, Division of Computer and Communications Engineering, Daejon University, Daejon, 300-716, Korea; Fax +82-42-280-2559 ; e-mail chkim@dju.ac.kr
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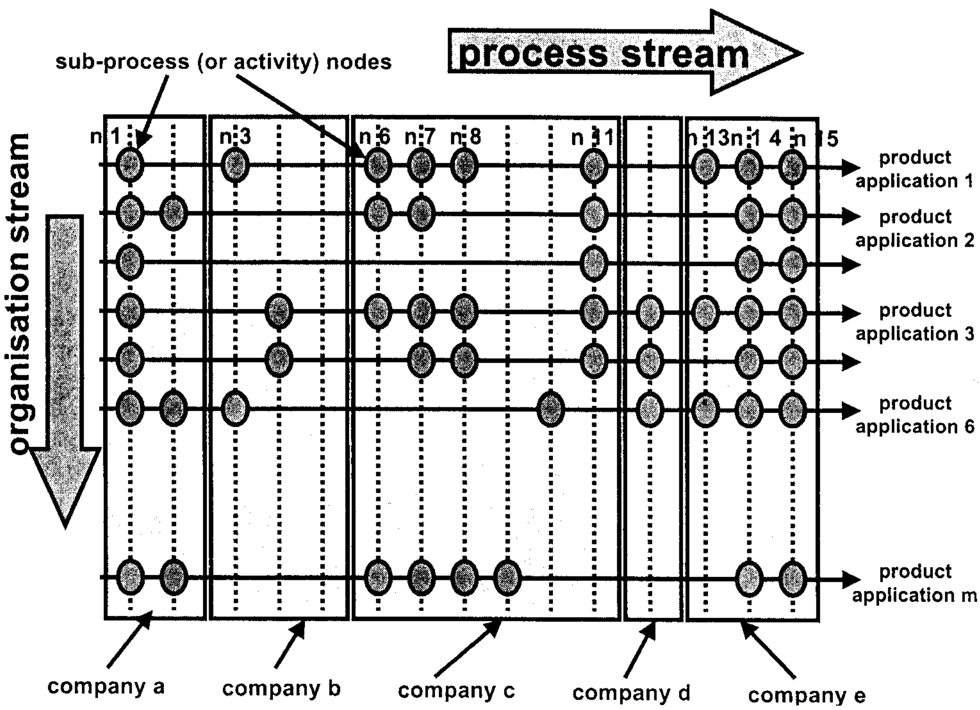

Figure1. Process Stream and Organisation Stream Concepts.

Technology) working group(Weston *et al.* 1997) as illustrated by <Figure1>.

This process-oriented model exemplifies important features of many multi-partner global businesses, albeit at a high level of abstraction. Firstly, it emphasizes the need to design and realize appropriate process streams' and organization streams'. With respect to process streams, units of enterprise activity (that typically cross organization boundaries) need to be logically and temporally ordered so that product realization operations result in products. For the organization stream, evidently the resources available to partner businesses must be systematically and repetitively assigned responsibilities for one or more instances of unitary enterprise activities. It follows that units of enterprise activity must be specified and realized at a level of granularity that facilitates management, control and change within multiple process streams. It also follows that the representation, communication, sharing and ongoing reuse of knowledge about business unit collaboration issues can be of major concern to a partnership enterprise.

The FIDO methodology, which stands for Function-Information-Dynamic-Organization modeling, is developed for enterprise modeling tool in order to describe interactions between companies, to analyze business process, and to design and implement enterprise system. FIDO represents the relationships between primes and subcontractors and demonstrates how functions and information must be integrated. It is a robust modeling tool that can represent inter-organizational interaction. FIDO provides a framework and a suite of tools for organizational modeling.

2. An Overview of the FIDO Modeling Methodology

An overview of the complete suite of FIDO Modeling Tools is shown in <Table 1>. This paper shall present each of the tools and demonstrate how this suit of tools can be used in a supply chain model example. The <Figure 2> shows the modeling framework for FIDO as fitted to system development. With this framework, the modeler starts with a FIDO1 model and from it creates a FIDO2 model and a FIDO4 model. The FIDO2 model is then used

Table 1. FIDO Integrated Modeling Tools

NAME	USE
FIDO1	Cross-Organizational Process Analysis
FIDO2	Cross-Organizational Information Analysis
FIDO3	OO Database & OO Repository Design
FIDO4	Performance Analysis of the Business Process

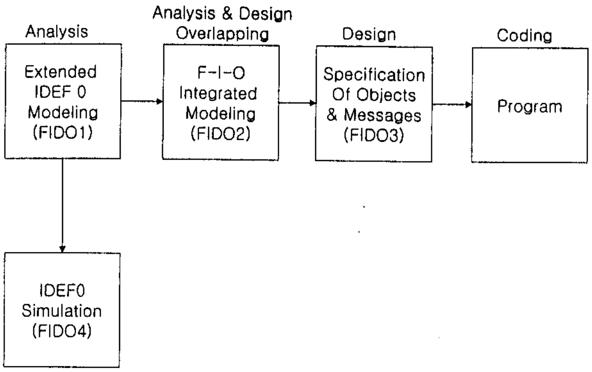

Figure 2. FIDO Process for Model Development.

to create the FIDO3 model. The FIDO3 is the system specification and is given to the programmer responsible for database development and the computer communication tools. The FIDO4 model is used to simulate the system to see how changes might effect it.

FIDO1

FIDO1 consists of development of an extended IDEF0 model of the companies and processes involved, which is an extension of the classical IDEF0 methodology(Ross, 1977; Shunk, *et al.*, 1986). System development starts with a primary component being the function box as shown in <Figure 3>.

In this figure it should be noted that an input is an object that is changed through the function and a control is something unchanged but used by the function. In addition to the general ICOM (Input, Control, Output, Mechanism) elements of the IDEF0 methodology, FIDO1 incorporates the following elements within the building blocks to describe the functions from the organizational and dynamic perspectives:

Function processing time: Each processing time can be defined with either a deterministic value or a probability distribution.

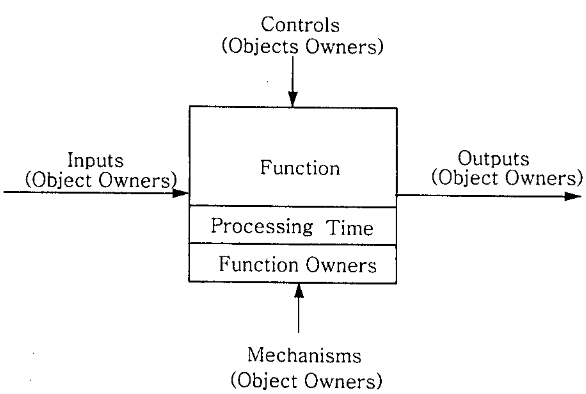

Figure 3. Building Block of Generic FIDO1 Model.

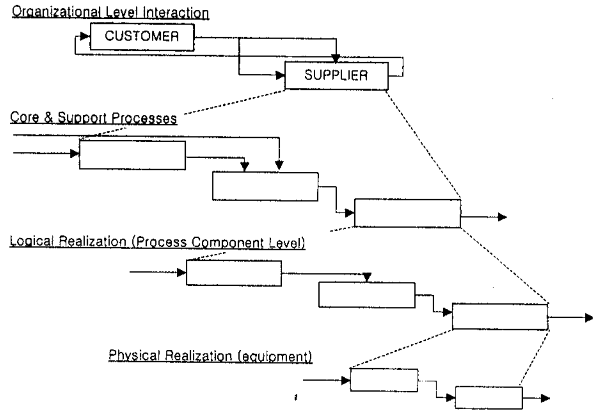

Figure 4. Decomposition of Function Blocks.

Object owners: They represent the departments or persons that have the authorities and responsibilities for the ICOM objects.

Function owners: They represent the departments or persons performing the functions.

Decomposition is performed to the level of detail deemed necessarily by the modeling team. The supply chain decomposition is demonstrated in <Figure 4>.

The top level represents the context diagram of the organizations. These organizations are individually decomposed as shown in the figure until the level of detail required (and scope of system) is included. The process flows for the individual organizations are then combined to create a cascading model as shown in <Figure 5> for each level.

This integrates the individual companies so that inter-organizational processes can be identified. A critical element of Supply Chain Integration success has been identified to be the interaction of companies.

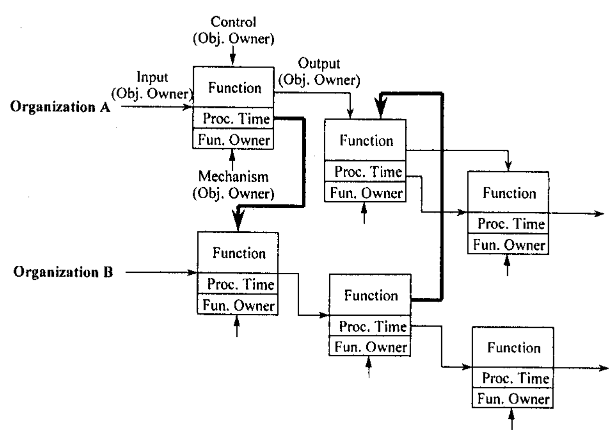

Figure 5. Cascading Combined Inter-organizational Model.

FIDO accommodates this very easily.

Therefore, FIDO1 starts with the context diagram and through the interview process decomposes operations until the desired level of detail is included. Because it is difficult to identify all exchanges between operations at the higher levels of the model, lower level exchanges should be added to the parent activity in a bottom up fashion until all exchanges are included on all levels(Shunk, *et al.,* 1986). After individual models have been combined and exchanges are consistent between the levels, the FIDO1 model should be verified by the companies involved.

FIDO2

The lowest level of the FIDO1 model is used to create the function-information-organization, FIDO2, model which is used to relate the different views of the organization. This model is created from the lowest level of the FIDO1 model by converting the ICOs(inputs, controls, and outputs) into objects. This is a straight one-to-one conversion from FIDO1 to FIDO2 as shown in <Figure 6>. However, the relationships between the objects now need to be included. This can be done with any object oriented analysis, OOA, methodology (Coad, 1991; Dillon, 1993; Sutcliffe, 1991; Wang, 1994). The legends from Coad and Yourdon's(1991) OOA methodology

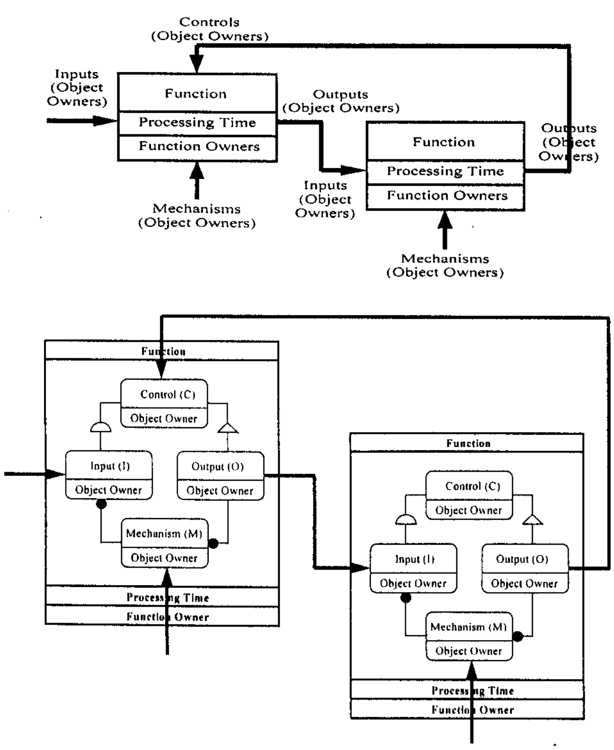

Figure 6. Conversion of ICO's into Objects with Relationship.

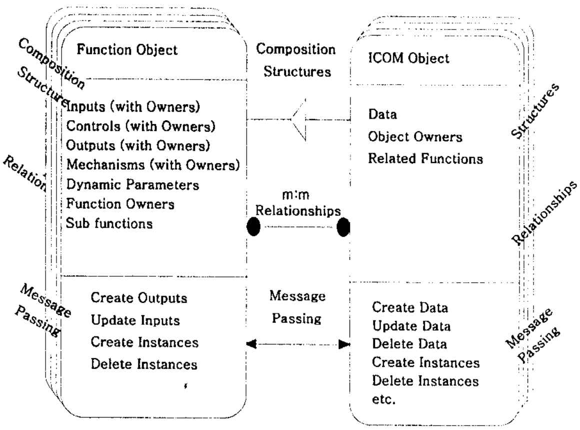

Figure 7. FIDO3 Class Specification.

were used for this project.

Once the lowest level of the FIDO1 model has been transformed into the lowest level of the FIDO2 model it is bottom up aggregated into the FIDO2 context diagram. During this bottom up aggregation redundant object classes are removed, and new relationships and structures between objects are identified. The FIDO2 model is completed when the class requirements for each organization for an integrated database are identified. This is seamless and straightforward as far as the methodology is concerned.

FIDO3

The specification, FIDO3, for the distributed processing or database application is then created. Using the objects identified in the FIDO2 context diagram, class specifications are developed which contain attributes and methods. These attributes and methods come from the relationships between objects as identified during the creation of the FIDO2 model. This process is shown in <Figure 7>.

These specifications may then be turned over to a software programmer for application development. If off-the-shelf packages are to be used, they should correspond to the model developed in FIDO2 and the specification developed in FIDO3. If this is not the case, then, due to the one-to-one correspondence of FIDO3-FIDO2-FIDO1 models, shortcomings can be seen in the extended IDEF (FIDO1) model by tracing backward from the FIDO2 & FIDO3 models to the FIDO1 model.

FIDO4

The final tool included in the FIDO framework is a conversion mechanism, FIDO4, which takes as input

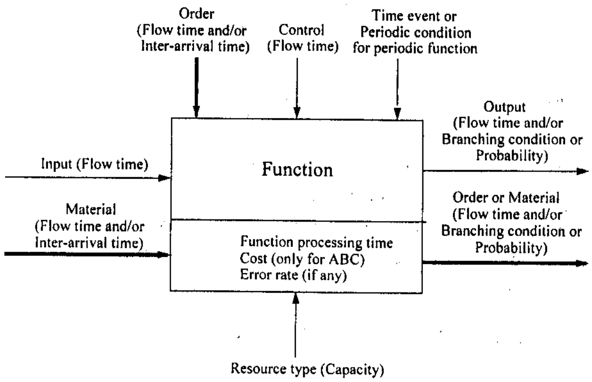

Figure 8. Generic FIDO1 Building Block for FIDO4 Models.

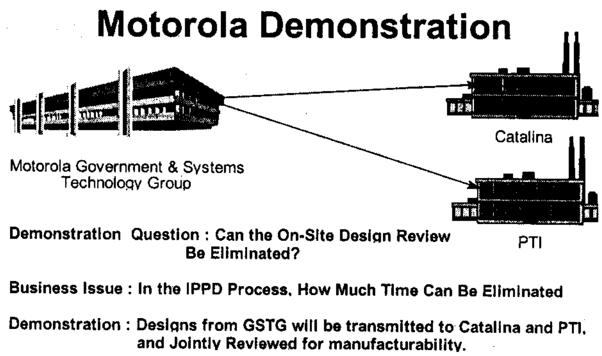

Figure 9. Motorola Experiment.

the FIDO1 model and creates a SLAM II simulation model(Pritsker, 1986). This model may then be analyzed to estimate improvements which may be realized by redesigning the system. If a FIDO4 model is created, additional function block information is needed and the new building block for FIDO1 is as shown in <Figure 8>.

3. A Case Study

The Motorola Experiment to Measure the Value of FIDO

The Motorola project centered around the design review process with sub-contractors that supply custom machined parts. The demonstration question for this pilot project was, “Can the on-site design review be eliminated?” In the process of developing a custom machined part, many face-to-face design reviews must be held by commodity and project manufacturing engineers, designers, buyers, and fabricators. These reviews require extensive coordination and travel on the part of Motorola and subcontractor personnel. If travel and coordination can be eliminated then significant time can be saved through this electronic process and overall product cost will be reduced due to the efficiencies. Motorola was hopeful that using Electronic Commerce (EC) technology would reduce travel and mailing costs, reduce errors, and provide time compression for the work to be done. The demonstration is summarized in <Figure 9>.

Motorola selected two of its primary custom parts suppliers to participate in the experiment; Catalina Manufacturing in Phoenix and Precision Technology Incorporated (PTI), in Tempe, Arizona. With the development of the new system each of the sites could communicate with each other with electronic mail. Prior to the project, the sub-contractors did not have this capability. With the new EC tools, design review work was done using video, audio, and shared whiteboard capabilities. With these capabilities, both Motorola and the sub-contractor at their individual sites viewed a shared document or part. As the document or part was viewed by both organizations, modifications were jointly made and agreed upon. Audio software facilitated voice communications during the process. Adding the video component, personnel at both locations viewed subject parts, and a remote video camera at the sub-contractor facility provided the ability for Motorola to roam on the production floor to review any process that required review and discussion.

The Supply Chain Integrated Business Models

Now that we've presented FIDO we will show some of the models built for the Motorola pilot. Through a set of interviews with the companies involved, an analysis of the current system was completed. As a result of the interviews an As-Is model of the current acquisition process was created. During interviews information relating to business transactions, such as contracts (RFP, RFQ), product description data (blueprints, CAD files, and production travelers, and finance (PR, PO, Receivables, Payables) was gathered.

Full FIDO1 and FIDO2 models of these organizations were developed and later used in the redesign and system development phase. It was NOT the objective of the modeling effort to model the details within the organizations, but to model the EC and material flow linkages between the organizations. Therefore, we did not do a fourth level decomposition. The Context Diagram (1st level FIDO1) and the Cascading FIDO1 Model (for the 2nd level) are shown in <Figure 10> and <Figure 11>. The 2nd

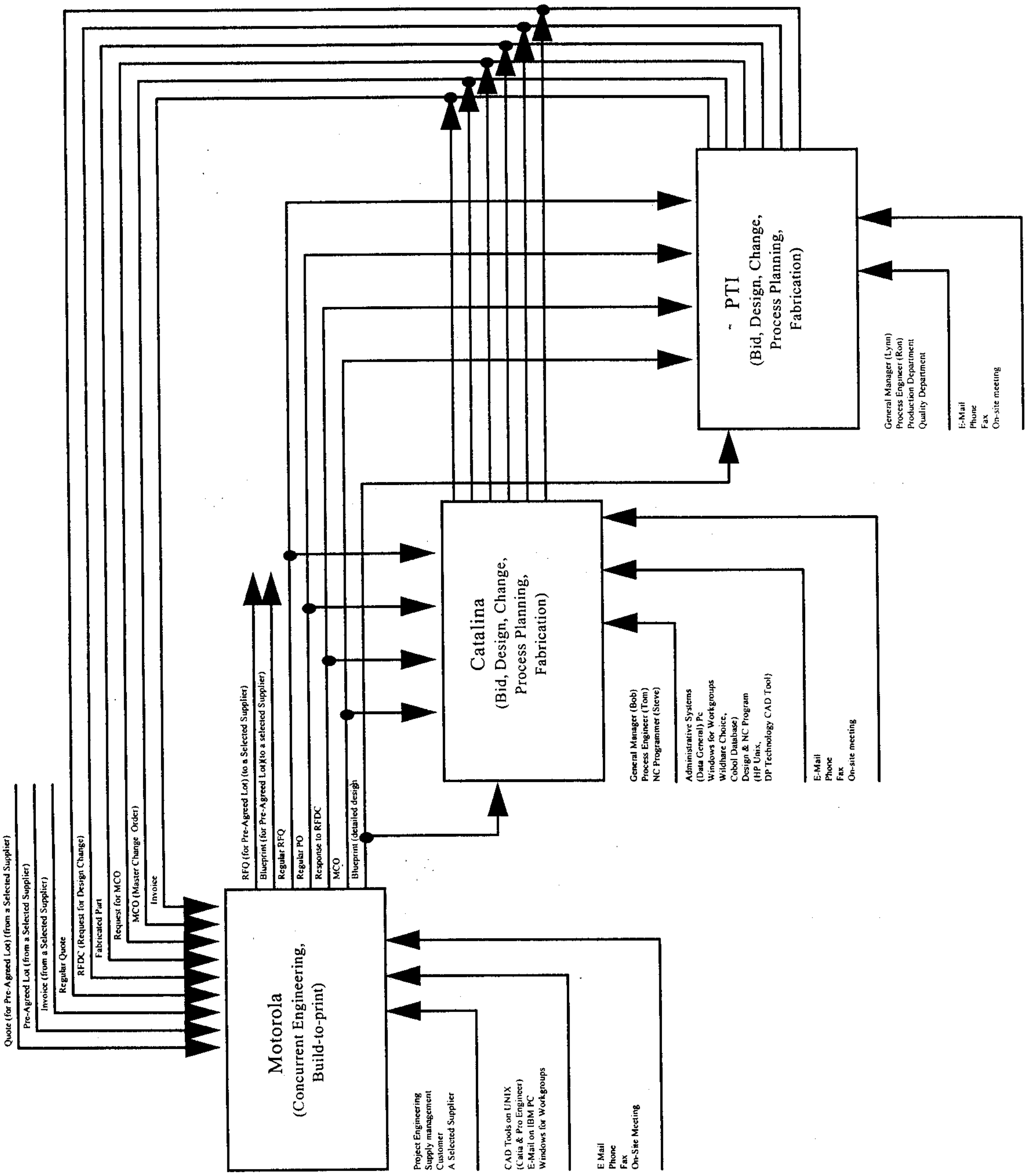

Figure 10. Context Diagram--Supply Chain FIDO1 Model.

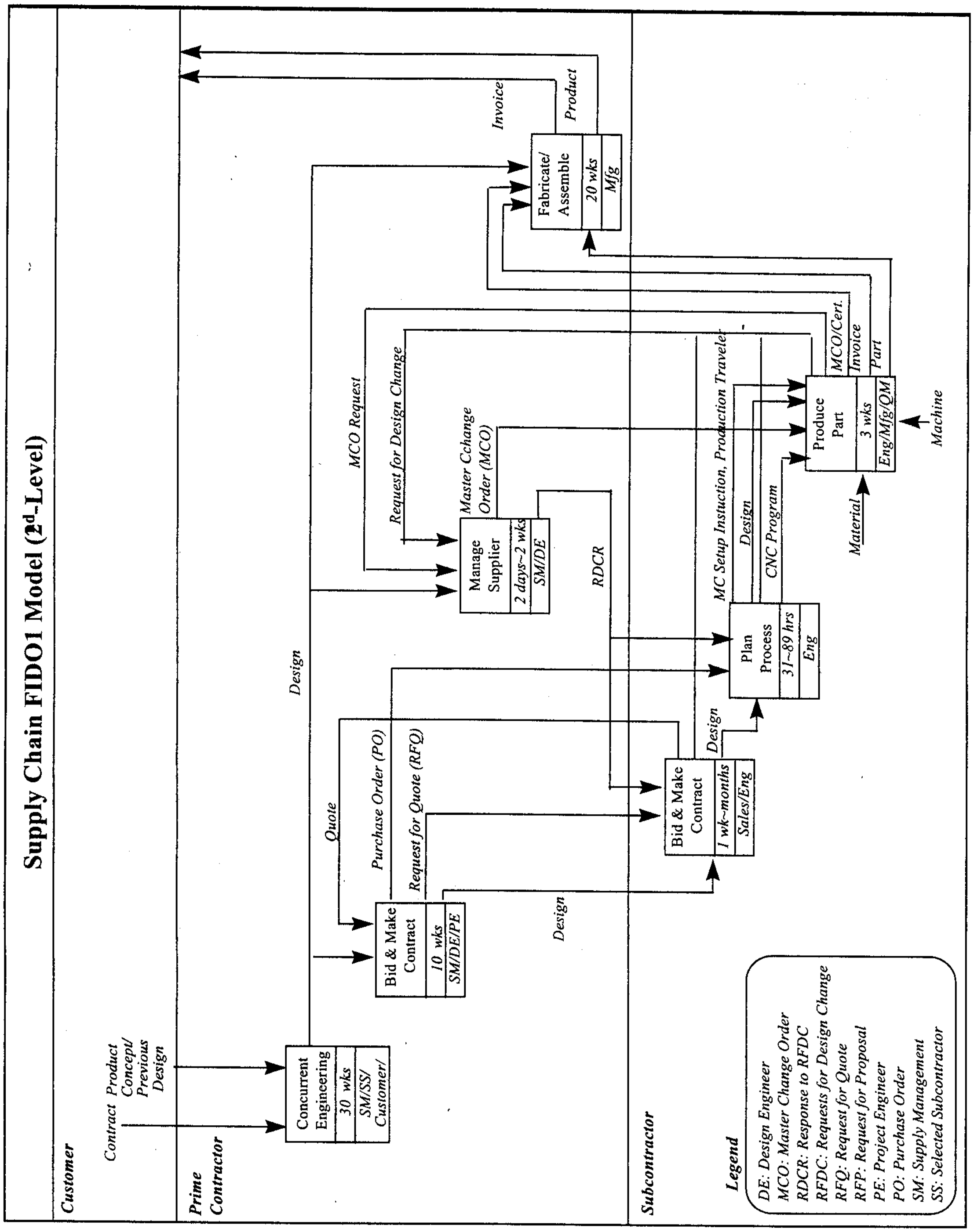

Figure11. 2nd Level of FIDO1 Model.

level FIDO1 diagram contains only a summary representation of subcontractors as they both have similar high level functions. The 3rd level FIDO1 diagram was created and used to develop the FIDO2 model. Due to the size of the 3rd level diagram and proprietary information contained on it, it has not been included in this report. Since it was not the intent of this project to develop a comprehensive databases for these companies the FIDO3 model was not developed. Additionally, since we were more interested in point estimates for improvement attained with EC tools and not with distributions, we did not create a formal simulation, FIDO4 model. The point estimate, along with the users perception of system worth, would give us a good idea of system desirability. Moreover, as a result of this project we would understand the costs involved and any barriers or other issues that may need to be addressed when implementing such a system. Information on the issues involved is provided in the Results chapter of this document. However, during the modeling phase and before our business process redesign phase we needed to come up with system performance measures. This is the subject of the next chapter.

4. The Results

The final results show that the new system did reduce the time involved in resolving a problem. Moreover, it reduced the amount of time orders were late on average. Specifically, the results of the experiments show a logical progression of benefits as the extent of electronic linkages increases (Shunk, 1995). The model baseline is of the process that spans the supply chain from identification of need, depicted by the initiation of a Request for Quotation (RFQ) through to receipt and ultimate assembly of the prototype product. Interaction between Motorola and the two key, strategic suppliers occurs in three generalized categories:

1. Quotation interaction
2. Request for design change interaction
3. Delivery and inspection interaction

The metrics used in this process are time . Significant interaction between Motorola and these strategic suppliers occurs-as it does for all strategically aligned partners when developing prototypes. Multiple requests for design changes cause many personal interactions that ultimately lead to slippage in the

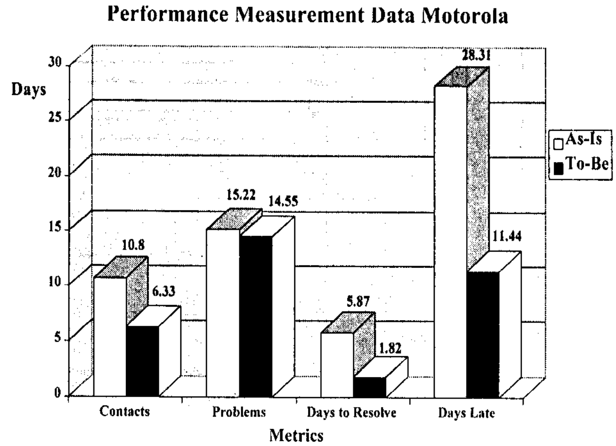

Figure 12. Performance Results from the Motorola Experiment.

schedule. On average the parts that are needed in 60 days are coming in 80 days - or a 20 days late penalty. This is a staggering number at first glance. But because they are in prototype and because they require highly precision parts, there is a significant need for engineering collaboration. All say this is the normal way of doing business and that this type of interaction takes time - the schedule slippage is expected. By employing state-of-the-market electronic commerce tools to allow Motorola engineers to interact with talent at Precision Technologies and Catalina we achieved significant reductions in time needed for precision machined parts. We have been able to statistically prove that the introduction of electronic commerce linkages can significantly reduced the time required by Motorola to produce a prototype part. This reduction of 17 days per part is shown in <Figure 12>. The source of the reduction was in the utilization of the electronic commerce tools to reduce the delays in getting problems resolved, not in the number of problems encountered. This is an intermediate usage of electronic commerce that requires less fundamental business process change and may pave the way to more dramatic changes that we outline later in the paper.

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김 중 인
한양대학교 산업공학과 학사
한양대학교 산업공학과 석사
Arizona State University 산업공학과 박사
한국전자통신연구원(ETRI) 선임연구원
현재: 홍익대학교 경영정보학과 조교수
관심분야: 전자상거래, 정보시스템개발, 시스템 분석 및 설계

김 철 한
한양대학교 정밀기계공학 학사
한양대학교 정밀기계공학 석사
포항공과대학교 산업공학 박사
LG 소프트웨어 공장자동화실
삼성 SDS SM전략실 책임연구원
MSIRI 객원연구원, Loughborough University, UK
현재: 대전대학교 컴퓨터정보통신공학부 조교수
관심분야: 정보전략, Information Modeling, ERP, e-Business

이 경 휘
서울대학교 산업공학과 학사
한국과학기술원 산업공학과 석사
포항공과대학교 산업공학과 박사
경북산업대학교 전임강사
국방과학연구소 연구원
현재: 대전대학교 컴퓨터정보통신공학부 조교수
관심분야: PDM, e-Business, Process Modeling