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USING SYMBOLIC MODELING IN BUSINESS RE-ENGINEERING

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ABSTRACT

This paper describes the use of a symbolic modeling tool and a methodology we developed for modeling processes in business re-engineering projects. DECmodel, a symbolic modeling tool, was used to build dynamically activated, working scale models of processes. Models were developed for business, systems, and organizational processes at several levels of detail, and integrated into a large dynamic model. Basic model specification, development, simulation, and animation techniques are discussed. The dynamic models created with this tool were invaluable in validating and communicating process designs, complementing and working in harmony with more traditional, static modeling methodologies.

This paper also describes a methodology we have developed for using a symbolic modeling tool for business re-engineering projects. We have documented specific procedures for utilizing process modeling for a whole spectrum of activities ranging from depicting the "as-is" process to brainstorming breakthrough design concepts to documenting functional specifications for MIS implementation teams.

1 INTRODUCTION

At Grimes Aerospace we have redesigned our order management process through the use of business re-engineering principles and a symbolic process modeling tool. Michael Hammer (1992) defines Business Process Re-Engineering as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance. Throughout our order management redesign, we utilized DECmodel, a tool for building dynamic models of processes. This tool embodies a multi-disciplinary approach including artificial intelligence techniques, design methodologies for process description, and traditional simulation methods. DECmodel's various techniques are similar to techniques used by upper case tools. We have also described a methodology developed for symbolic modeling in the context of business re-engineering projects.

The next section describes the DECmodel tool in detail followed by a section that documents the methodology that we have used and developed. The next three sections describe the structure and development of our models, validation of the models, and the use of the models for functional specifications, respectively. The remaining sections of the paper describe issues, implications, recommendations, and conclusions.

2 DECMODEL

DECmodel, available from Digital Equipment Corporation, is a symbolic modeling tool that can be used to demonstrate the flow of information or materials through a process. Models built with DECmodel can integrate multi-level models of business, systems, and organizational processes into a dynamically activated, working scale model. Models are extensible, permitting the addition of more information to the model at any time. After building and running a model, it can be integrated with a graphical front end for presentation and analysis.

DECmodel uses three basic objects to create a model: processes, activities, and messages. A process is a discrete function or operation representing a stage in a business. Processes are made up of activities. An activity is a discrete work step. Activities are the building blocks of processes and define their behavior. A message is information and/or data communicated from an activity to a process. Processes, in turn, trigger activities when they receive messages.

DECmodel uses standard enterprise modeling methodologies in conjunction with object-oriented simulation and modeling tools. Models can be animated showing how transactions represent business events, including start and stop times, sequences, dependencies, initial conditions, behaviors, and changes to the output. Models can be easily and quickly modified to reflect actual design changes as they are developed, test potential alternative designs, or answer specific what-if questions about a process design.

DECmodel is currently built on top of Knowledge Craft as a layered VMS application and requires the VMS operating system, VMS workstation software, VAX Rdb/SQL software, and MOTIF. It has a DECwindows MOTIF interface. Hardware required is a VAX-based workstation: VAX, Micro/VAX, VAXstation, or VAXserver. A PC/Windows version written in C++ is under development.

3 METHODOLOGY

Large and complicated business processes, like order management systems, cut across the entire enterprise. Re-designing them is a complex and complicated undertaking. No one person in the organization has complete functional or operational knowledge of the entire process and typically, no one person can dictate all changes that are needed. Many need to understand and "buy-in" to the new design, making development and implementation of these business processes complex and time consuming. In short, there are numerous factors that can significantly impede, or even prevent, the linking of strategic requirements with tactical implementation.

Improvements in design quality early in the development cycle result in significant savings. In fact, the rule of thumb is that the cost of correcting even minor design errors increases ten-fold at each successive stage of the development life cycle. Similar to computer-aided-design (CAD) tools used in engineering design, symbolic modeling of business processes provides a way to test, verify, and validate ideas for improving business process *before* extensive investment.

DECmodel (and other similar tools) is a tool for describing both a current process design to ensure common understanding and the desired future design so that participants share a common goal. An important capability of DECmodel in this regard is providing multiple levels of abstraction. Different levels of personnel (from operational to senior management) have *unique* and *valid* understanding of business processes, yet they are describing the same work. We have found that constructing dynamic models at all needed levels of abstraction provides clear, unambiguous characterization of processes. In our work we have constructed models with enough abstraction to represent the entire order management process as a single process, others with some abstraction, and on the other extreme, models with virtually no abstraction. In much the same way, multiple *logical* views have been constructed to reflect the language of various process reviewers.

Another important feature of DECmodel is the ability of emulating dynamic interdependencies among process activities and data over time and cost. Timing is a significant component of any process and dynamically modeling interdependencies were useful in understanding and communicating critical aspects of concurrence, synchronization, and coordination. Cost associated with the various process activities, within the models, provides visibility to the user for value added and non-value added tasks. All of the following were built into various models: message and entity passing, activation rules, decision logic, durations, and resource utilization. Additionally, graphical animation of process event networks were developed to facilitate design reviews.

Finally, documentation of characterized processes in DECmodel is automated. All activities, resources, and entity flows are cataloged; two dimensional diagrams of process interdependencies are available as well as flow diagrams showing the sequence of process event networks. The tool was also used to capture, catalogue, and dynamically display assumptions used in constructing the model.

Using all of the methods and capabilities described above, DECmodel was used to gain design acceptance at all critical review stages. Initially there were periodic presentations to senior management followed by sign-offs from key functional management groups. Next, there were detailed design review and sign-offs for each process with appropriate personnel. Lastly, in what we feel is a unique use of the technology, DECmodel was used as a critical tool in developing and communicating functional specification information needed by the MIS implementation team. The functional specification document consisted of printed process flows, screen views, trace statements, process assumptions, and dynamic simulation walk-throughs.

4 MODEL DEVELOPMENT AND STRUCTURE

Our sales order management process was a combination of various functions ranging from quoting prices for a potential order to receipt of payment for the order. Due to this complexity, several models were created with corresponding levels of abstraction. Figure 1 displays the order management process at the highest level of abstraction. This enables one to visualize the various sub-processes/resources that interact in the order management process. This level would normally be simulated for an audience that is less concerned with detail and more concerned with the overall process . In figure 2, a lower level of detail is simulated for an audience that requires knowledge acquisition of the business functions with other functions and systems. In figure 2 note that the detail deals with functions like customers, other departments, and various systems. This model is used to simulate the detail of the sub process. For example, functions such as 'Customer-Order-Status' (i.e. customer inquires about the status of his order) would be simulated at this level. The order management process model is an integration of different models developed for three basic process classifications: business processes, organizations, and systems.

4.1 Business Process Models

The first classification, business process models, requires input and output activities to and from organizations and systems. As a result, one of the first modeling activities of our re-engineering effort, at Grimes, was to construct a high-level business process model, to provide a conceptual view of the order management process and its relationship to organizations and systems (see Figure 1). Within this model, various colors were used to depict different process types. i.e. internal processes, external processes, and systems, etc. Icons were also created to allow transformation to various levels during simulation. After switching to a level-1, detail view, (see figure 2), the simulation demonstrates a more in-depth view of the business sub-process.

Due to the complexity of some business processes, numerous levels may be required in the simulation model. Modeling tools are flexible enough to permit lower levels of detail to be abstracted at higher levels and be simulated at this higher or the lower level. Multiple levels also eliminate the confusion from cluttered models and provide a clear, but detailed view of the simulation. Each level of our model was tiered to an appropriate degree of detail, which in our example, required five levels.

4.2 Organizations

The next classification, organizations, was defined in the simulation model, to represent the organizational interactions within the business process. (see Figure 3) These views give the simulation audience the ability to ascertain the activities communicated between the detailed organizations and the business process. Changes made to the business process during the design phase were numerous, therefore, it was advantageous to maintain the organizational structures within the model, to periodically evaluate impact on them.

Our business organizational charts were inserted within the order management process model, to provide the simulation audience an in-depth view of the organizational structure and how they relate to the business process. As of now, our model contains only level-2 organizational views, but with the flexibility, of the simulation tool, addition of detail will not pose a problem. Icons, as characterized above, were also developed, to enable the user, to view the organizational presentations, during the process simulation. Organizational views may be retrieved at any time throughout the simulation, but exist only for reference.

4.3 Systems

Although organizational structures and business sub-processes may require modifications periodically, the final classification, systems, typically requires continual modification. Due to the rapid development of improved systems in the information technology arena, changes to a business system is inevitable. Subsequently, these changes will require modifications to the business process, and possibly organizational structures.

Systems may also be structured at multiple levels to permit the audience, which may be users or technical staff, to view interfaces to organizations or other systems. This is extremely powerful during development of new systems, since technical experts can provide feedback and gain knowledge of the business process during the system design phase.

In the order management model, all systems utilized within the business process, were represented within the model, but were not restricted to software. These systems ranged from system files, to printers, to full system modules. Once constructed, the simulation was presented to our technical staff, who concurred or altered the system process flow, and acknowledged that the design was proceeding accurately.

In summary, each of the three classifications are truly interrelated. The simulation model maintains relationships between the business processes, organizations, and systems, and helps illuminate the affects of one on the others.

5 VALIDATION

Accuracy, flexibility, and productivity are critical to the successful implementation of a project. Simulation models can play a significant part in this success. Lets take the design phase for example. Most traditional methods use tools such as data flow diagrams, context diagrams, and structure charts. Although, these tools are quite helpful, they are limited in their usefulness.

In today's world, simulation models must reside in the workplace. Not only do they provide the connectivity between organizations and systems, they perform this simultaneously within other models, displaying detail without confusion. Traditional tools can tend to confuse users with an overabundance of detail.

In our order management re-engineering project, as with traditional methods, design was initiated by interviewing functional end users. The dissimilarity between the two, begins in the steps following the interviews. In a traditional environment, once the interviews are conducted, the charts are constructed, and approval is received. Many of these charts prove to be incorrect, simply because breaks in the process flow exist. These breaks may be inputs or outputs that are inadvertently left open. In our order management model, the model would not simulate to completion, if breaks existed in the process flow. This enable us to readily identity the discontinues in our process flow.

During the design phase, interviews and brainstorming occurred almost daily, as a group, to obtain consensus on the business processes. Subsequently, the process designs were added to the model and simulated for the user group. If any corrections were required due to differences in interpretation or faulty logic, the users had the opportunity to make immediate corrections to the model. Versatility was an important strength with the simulation tool, since these modifications required immediate attention. As soon as the modifications were effected, the simulation was demonstrated again and reviewed with the users until consensus was reached. If existing traditional methods had been used, similar modifications would have resulted in the diagram being discarded and redone. Therefore, more traditional methodologies jeopardize accuracy and are less productive and cost effective.

After validation was complete, the models were further enhanced to allow them to be utilized as functional specifications during the transition from the design phase to MIS system implementation.

6 FUNCTIONAL SPECIFICATIONS

One of the most difficult tasks at the close of the system design phase is the transition to a functional specifications document needed by the information systems group.

Traditionally, an analyst prepares a functional requirements document and then transfers it to a group of programmer/analysts, who in turn, use it to create a detailed design document, to begin development of the system. Logically, this methodology seems straightforward and should work well, but it usually does not. Fortunately, with the aid of simulation models, the transition task is more easily accomplished. Not only is the simulation modeling tool dynamic and permits multiple detail levels to store the information required for the functional specifications, it provides adequate diagrams and descriptions, which when combined, can allow creation of a hard copy functional specifications document.

Before the document can be constructed, the simulation must be demonstrated to the system developers. This allows activities in the model to be modified, as well as being instrumental in aiding their comprehension of business process knowledge. In traditional environments, system developers were regarded simply as developers, therefore, they did not require understanding of the business process as a whole. Their sole responsibility was an understanding of the business systems, not processes. With the simulation tool, process misconceptions by the programmer/analysts are minimized. Since the system developers have an opportunity to view the simulation, the functional specifications can be accurately created, allowing a smooth transition flow to be achieved.

It was also advantageous to utilize the simulation tool from a cost standpoint. With conventional methods, the functional specification document is generated on paper. With the simulation tool, the system is the single point of storage for the process information. Therefore, a *living document* is created inside the model, in which modifications can be directly made. This *living document* is continually updated and is accessible to any person in the workplace who requires viewing for knowledge transfer. This technique saves time and money and shifts the methodology to a dynamic, paperless environment.

When a system developer initiated a change within the traditional environment, the documents rarely got modified, making the original document useless, particularly if these activities are contracted to an outside firm and they use conventional design techniques. In this scenario, the functional requirements can change so many times over the course of the project, that they are virtually useless by implementation. By substituting the simulation methodology, a corporation can reduce costs that normally would result due to material and productivity loss.

Using simulation technology to build process models, a corporation can have clear, concise, and dynamic documents, as functional specifications. Subsequently, all processes and standards reside and are maintained through a single point of storage, and allow these simulation models to be a focal point for business knowledge.

7 WEAKNESSES

During the order management process redesign, several key weaknesses were discovered with the DECmodel simulation tool. Even though the tool satisfied our needs and provided the flexibility we required, the tool does have some disadvantages. The following sub-headings are weaknesses we have encountered, which warrant further development:

7.3 Document Printing

The task of printing the hard copy documents is not complex, but labor intensive and time consuming. To capture the complete simulation package, each screen during the simulation must be captured and then printed. The most time consuming effort occurs when multiple decision points reside in the simulation.

7.2 Initiating a Simulation

Once a simulation session is initiated, the simulation must complete before another simulation may begin. Since the simulation cannot be stopped and restarted, many times if becomes frustrating if the simulation is lengthy and one desires to restart the simulation or start a new simulation.

7.3 Simulation Tool Productivity

The performance of the simulation tool can be sluggish and may periodically become "hung-up" on an activity. If a simulation is run multiple times, the performance seems to gradually improve.

7.4 Unavailability of Code Generation

Even though the DECmodel tool's techniques are similar to an upper CASE tool, DECmodel does not have the capability to interface with another CASE tool or generation program code. This would be most beneficial to the MIS Implementation Team following functional specification development.

7.5 Limitation of Decision Logic

Occasionally, it is necessary to input slot values into the model for various decision logic. DECmodel provides this feature, but it is quite limited. For example, allocations cannot be measured or calculated from slot input to retrieve solutions. In DECmodel the slot values are representative by text only. The DECmodel tool is continually being improved by Digital Equipment Corporation's Modeling and Visualization Group, and hopefully these enhancements will be corrected.

8 CONCLUSIONS

The methodology utilized in the order management re-engineering effort, along with the business simulation tool, DECmodel, enabled Grimes to achieve a successful design as well as, a smooth transition to the system implementation phase. The primary benefits in using the simulation tool and our methodology were cost and time savings, enhanced communication through process visualization, and more robust designs.

At present, our design methodology is still fairly dynamic. Although we would like to achieve some measure of standardization in methodology, we want to stay flexible enough to incorporate new ideas and refinements and also allow for the uniqueness of each major process.

REFERENCES

Hammer, M. 1992. *Re-Engineering: The Implementation Perspective, Conf. Proceedings*, Dallas, Texas.

AUTHOR BIOGRAPHIES

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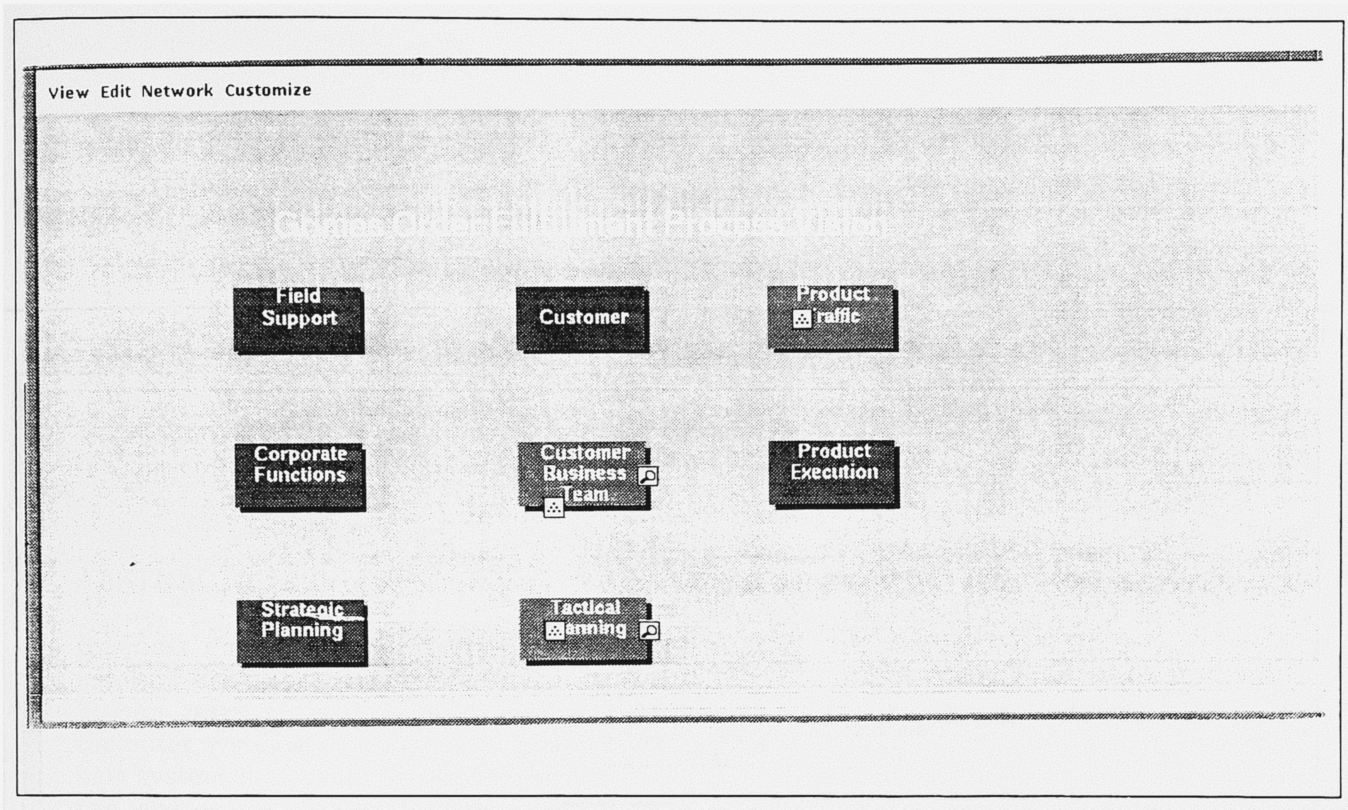

Figure 1: Process Model-Top View

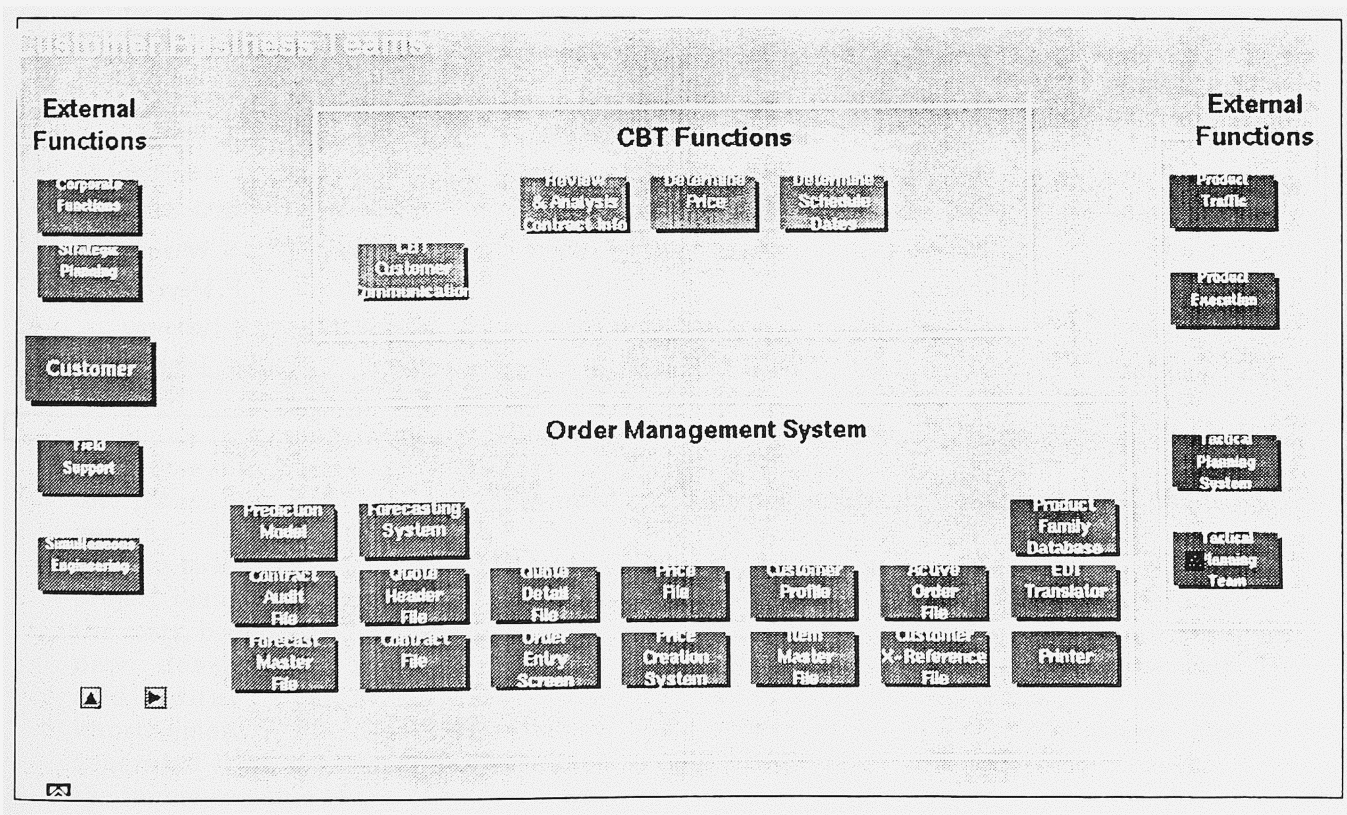

Figure 2: Process Model-Detail View

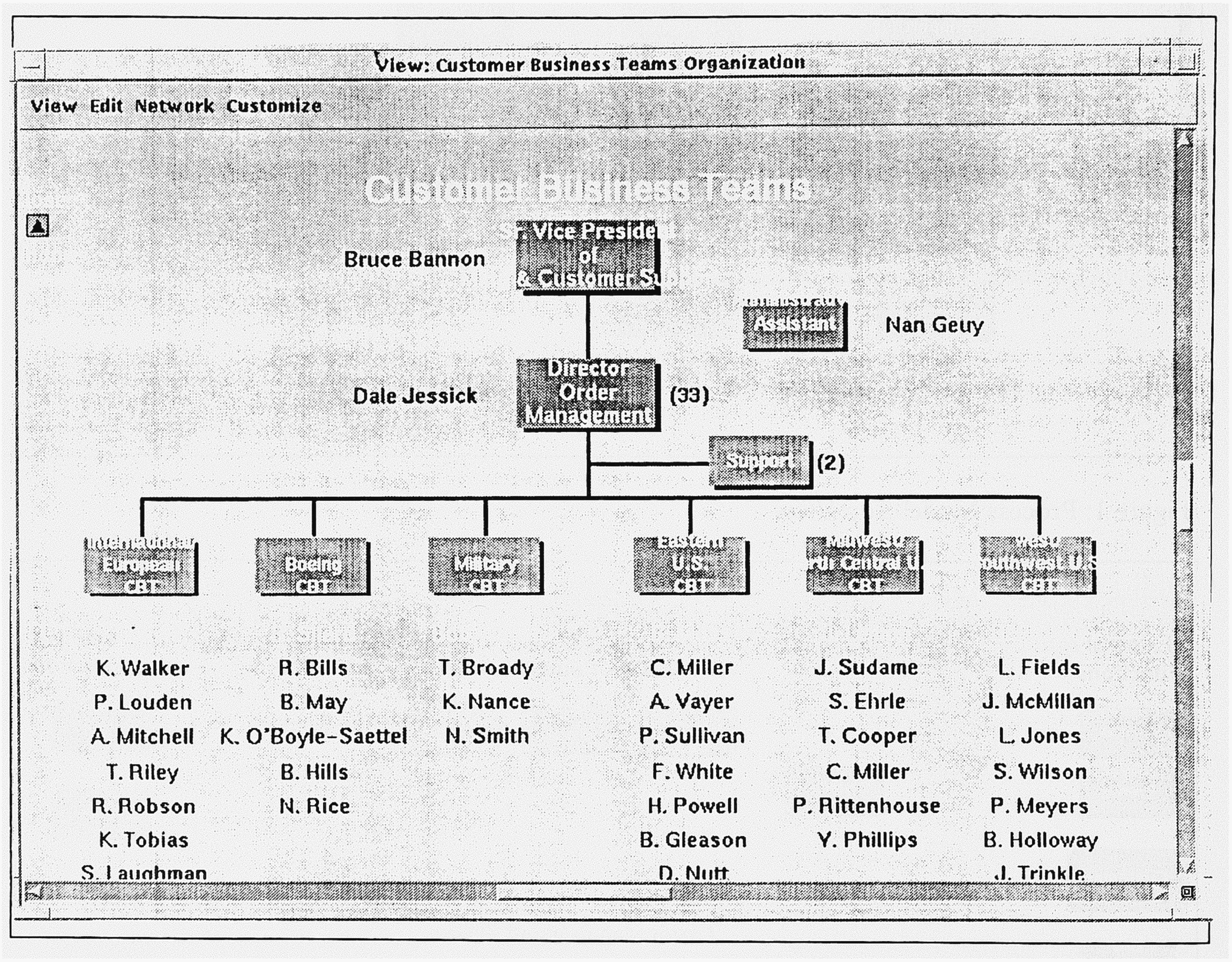

Figure 3: Process Model-Organizational View