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INTEGRATING PROCESS MAPPING AND SIMULATION

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ABSTRACT

This paper presents two different yet successful approaches that have been taken for integrating process mapping technology and simulation technology. The discussion is based on two actual implementations in which two different process mapping tools were separately integrated with ProModel simulation software. The process mapping tools used in the integration were Design/IDEF from Meta Software Corporation and ABC FlowCharter from Micrografx, Incorporated. Both of these tools have been widely adopted in government and private industries for process reengineering. Also, both tools are based on different paradigms which present unique challenges for use with simulation. Design/IDEF is based on the IDEF-0 modeling paradigm which is highly structured with limited adaptability. ABC FlowCharter is an unstructured process diagramming tool which is adaptable for doing all types of diagramming. In effect, they both plug into ProModel as a front-end interface. The implementation of the bridge is different in both instances, however. One approach uses a modified version of the process mapping tool while the other utilizes OLE automation without having to modify either the process mapping software or the simulation software.

This presentation deals with the issues and challenges encountered in each integration effort. We will also discuss how these challenges were addressed and how a successful solution was implemented. Finally, we will assess the suitability of integrating process mapping and simulation and compare the relative outcome of each. The successful integration of process mapping and simulation is a major step towards a complete integration of process reengineering technologies.

1 INTRODUCTION

With all the improvements in simulation software to simplify the modeling process, simulation is still largely perceived as a complex and sophisticated technology by most managers and engineers. Process reengineering tools such as process mapping software, on the other hand, have proliferated in recent years due largely to their ease of use and comprehensibility.

One of the reasons for the lag in application of simulation technology is that it has not been effectively integrated with more general purpose process mapping tools. Consequently, even though much of the process definition used in a simulation model is contained in a process map, a decision maker must start over from scratch in building a simulation model. The successful marriage of process mapping and simulation would extend the usefulness of process mapping and make simulation more acceptable among those doing process reengineering since it would be based on a familiar interface and a more simple paradigm.

Advances in software technology to support product interoperability has opened the door for integrating technologies such as process mapping and simulation that previously functioned only as stand-alone applications. Of particular importance is the development and acceptance of Microsoft's OLE technology which is opening the way for massive software integration. Many business planning tools are beginning to take advantage of these integrating technologies. This new capability holds the promise of being able to seamlessly integrate process mapping and simulation software without having to modify either product.

2 INITIAL EFFORTS TO COMBINE PROCESS MAPPING AND SIMULATION

The concept of combining process mapping with simulation technology is not new. Several attempts have been made to integrate process mapping with commercially available simulation products. Unfortunately, none of them has met with the degree of success that was anticipated. This is due largely to incompatibilities in both purpose and paradigm. Since insufficient data is provided in process map for running a simulation, additional information had to be manually added on the simulation side. This inevitably required some knowledge of the simulation product as well as the process mapping product.

In addition to a partial integration of process mapping and simulation technology, some process mapping products have recently been introduced with extremely limited simulation capability. Unfortunately, trying to model real world situations with such limited capability is almost futile. It is likely that simulation capability will continue to be enhanced over time. Meanwhile, the opportunity for tapping into the power of existing simulation products would be a real benefit to those doing process reengineering.

3 PROCESS MAPPING

One of the most widespread practices employed among leading businesses today is process reengineering. Process reengineering is the activity of radically rethinking how business processes are performed and even whether they should be performed at all. All aspects of the process are questioned and carefully designed. Many tools are becoming available for supporting business process reengineering activities including benchmarking software, CASE tools and process mapping tools.

Process mapping is perhaps the most widely practiced reengineering method, simply because it so quickly and easily captures and communicates a process flow. Process mapping essentially provides a graphic depiction of a process. A process is defined by process reengineering pioneers, Hammer and Champy (1993), as a collection of activities that create an output based on one or more inputs. There may be many uses of process mapping including documentation, visualization, analysis and communication.

Process maps are *static* models in that they are unable to capture the dynamics of the system. They are also *qualitative* in that their intended use is for conceptualization and documentation, but provide little or no quantitative analysis. Many commercial tools are available for use in process mapping. Inexpensive and easy-to-use flow charting software has made process mapping very popular.

Process mapping tools can generally be classified as either structured or unstructured. Structured process mapping tools impose a specific methodology for representing a process while unstructured tools leave it up to the modeler as to how to represent a process.

4 STRUCTURED PROCESS MAPPING

Several methodologies have been developed to structure process mapping. One established method of flow diagramming, defined by the American Society of Mechanical Engineers (ASME), utilizes the symbols shown in Table 1.

Table 1: Standard Process Flow Symbols

Symbol	*Description*
○	Operation
⇨	Transportation
▽	Storage
D	Delay
□	Inspection
▢	Combination Operation and Inspection

Another structured technique, which is the one used in this study, is the ICAM DEFINITION language (IDEF) developed by the US Air Force through its ICAM program. This language is essentially a schematic modeling tool used to provide a universal modeling language. The techniques developed by the Air Force pertain to the concepts of planning (IDEF-0), information system design (IDEF-1), and stochastic system evaluation (IDEF-2). The IDEF-0 methodology is the one used for process mapping and is based on a paradigm of activities, inputs, outputs, controls and mechanisms or resources (see Figure 1).

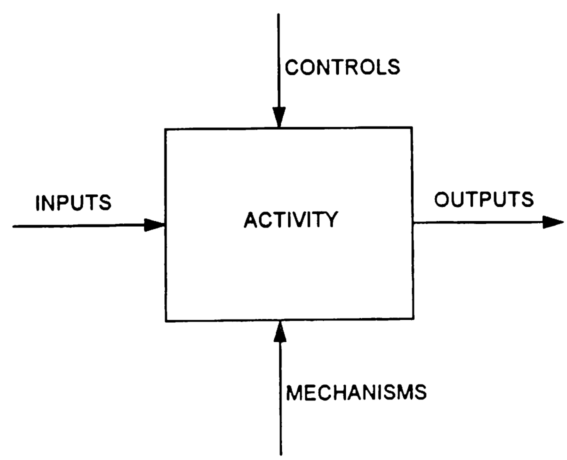

Figure 1: IDEF-0 Modeling Paradigm

As illustrated in Figure 1, inputs, outputs, controls and mechanisms must always enter or leave on the sides indicated. According to the paradigm, all processes can be defined in terms of these components. Figure 2 shows an example of a simple IDEF-0 diagram.

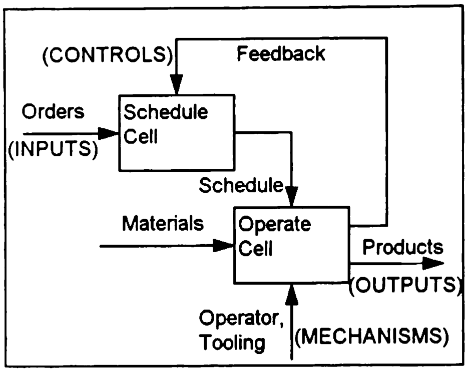

Figure 2: Example of a Flow Diagram

Diagrams can be constructed hierarchically so that a process can be decomposed into subprocesses.

There are certainly advantages to having a formalized method for diagramming a process. For one thing, it imposes structure on the process and provides categories for all of the elements of the process. It also standardizes process mapping so that diagrams are easily communicated and are consistent. The problem with structured modeling methods such as IDEF from a simulation point of view is that they may provide more or less information than what is needed for running a simulation. In order to use a structured process mapping tool directly with simulation, some modifications to the methodology may be necessary.

On the positive side, there are many close parallels between the IDEF-0 paradigm and common simulation paradigms. They may be summarized as follows:

- Both utilize inputs and outputs
- Both have activities
- Both utilize mechanisms or resources in performing activities
- Both use controls to determine where, when and under what conditions the activity is performed.

While many of the same components are present in both paradigms, they are not always thought of in the same way due to the differences in use of the models being created.

5 UNSTRUCTURED PROCESS MAPPING

Many unstructured process mapping or flow charting tools are available which provide a simple and versatile interface for diagramming business processes. Most of these flow charting tools support free diagramming which follows no strict rules as long as the process relationships are communicated clearly. The most simple diagrams consist only of boxes representing the activities performed, diamonds representing decisions, and arrows depicting the activity sequence (see Figure 3). These diagrams can become extremely complex and can be enhanced by built-in or user-defined data fields to include additional information such as costs, activity times, etc.

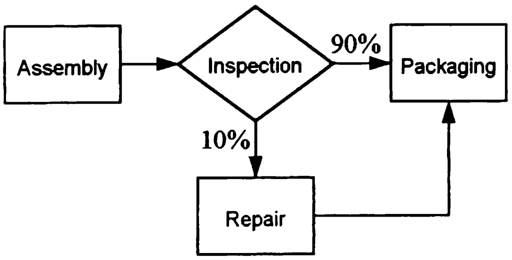

Figure 3: Example of a Flow Diagram

Obviously, an unstructured diagramming tool is more suitable for integration with simulation since it can be more easily adapted to a simulation paradigm.

6 PROCESS SIMULATION VS. SYSTEM SIMULATION

Regardless of whether a structured or unstructured process mapping tool is used, there is still a fundamental difference in perspective when shifting between process mapping and simulation (Harrell and Tumay 1994). This difference lies in the fact that process mapping by nature is *process* oriented while simulation tends to be *system* oriented. A process orientation focuses on the *logical flow* of entities or work items through a series of *activities*. A system orientation is based on the *physical flow* of entities through a series of *work stations*. This difference is not arbitrary but rather is a direct reflection of the nature and purpose of the activity. Process mapping is generally a high level depiction of a process defining only *what* happens to entities. It doesn't have to deal with *how*, *where* and *when*. Simulation, on the other hand, must have information on the mechanics of the process in order to imitate the actual drivers of the process. The most natural way to define the physical operation of a process is at a system level which is the detailed implementation of the process level (see Figure 4).

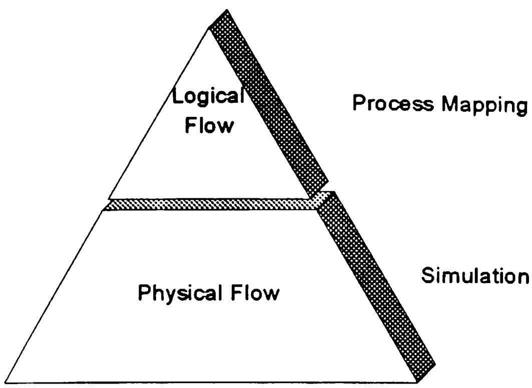

Figure 4: Relationship between Process Mapping and Simulation

7 INTEGRATING DESIGN/IDEF AND PROMODEL

Since Design/IDEF is based on a structured modeling methodology, the challenge was to extend the definition capability without deviating from the basic IDEF methodology. Some of the extensions made are as follows:

- The addition of entity attributes.
- The addition of input buffers to every activity.
- A way to model different entity types.
- The addition of data fields to capture dynamic information.

The implementation of the integration was to have the entire model built using Design/IDEF and then create a simulation model file that could be read in and executed by ProModel. The downside to this approach is that the Design/IDEF code had to be modified to allow input of simulation data within Design/IDEF. On the positive side, the user doesn't need to get into ProModel and hence deals with only a single user interface for both process mapping and simulation.

8 INTEGRATING ABC FLOWCHARTER AND PROMODEL

The ABC FlowCharter integration with ProModel ended up providing a more intuitive interface than the Design/IDEF integration because ABC FlowCharter is not based on a structured methodology. A paradigm for process mapping was developed to be able to support dynamic modeling.

The integration was performed using OLE automation technology which provided the advantage of not having to modify either application. A separate application was written that communicated with ABC FlowCharter using OLE automation to display simulation-related property sheets that are displayed as shapes and connections are created in ABC FlowCharter. Once the model is defined, it is translated by this separate application to a ProModel model and simulated.

The methodology used for defining a simulation model is very similar to that used to define a process flow diagram. A simulation model consists of shapes and connections where shapes define the objects in the model (i.e. activities, resources and entities) and connections represent relationships between the objects (i.e. arrivals, routings and resource usages). The OLE automation enabled intelligent connections to be made based on the object types connected. The graphic properties of connections could be modified automatically to provide feedback to the user as to the type of connection made.

9 CONCLUSIONS

The problems encountered in integrating process mapping and simulation were due primarily with attempting to maintain a process mapping paradigm. This was necessary in order to build utilize process mapping as the basis for doing process simulation. Since Design/IDEF enforces a particular paradigm, it didn't provide as much latitude to work with.

While the integration works well for modeling even complex process logic, process mapping tools are not well suited for capturing the dimensional and many other physical aspects at the system level.

In conclusion, the integration of process mapping with simulation technology at the process level was successful. Both implementations, while based on different methodologies and implemented differently, provide seamless, single-interface modeling. Both implementations also provide considerable modeling flexibility including activity-based costing, parallel processing and hierarchical modeling. The growing use of these two applications attests to their suitability for use as an effectively integrated process mapping and simulation tool.

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