Nakano, M., Kubota, F., Sato, S., Roser, C., 2005. A Method and Tool to Visualize and Analyze Business Processes, in: Proceedings of the Advances in Production Management Systems: Modeling and Implementing the Integrated Enterprise. Presented at the Advances in production Management Systems: Modeling and Implementing the Integrated Enterprise, International Federation for Information Processing (IFIP) WG5.7, Washington DC, USA, pp. 1–9.

A METHOD AND TOOL TO VISUALIZE AND ANALYZE BUSINESS PROCESSES

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Keywords Business Process Modeling, Enterprise Modeling, Business Process Simulation, Lean Production System,

Abstract The paper proposes a method and tool to visualize and analyze intra- and inter-organizational process interactions to make manufacturing enterprises more efficient. The key issue is not a support tool led by a methodology, but a methodology to deeply understand the processes, supported by a software tool. The methodology provides a standard thinking flow model and figure models to find the fundamental problems and to propose improvements, and a supporting system to both evaluate the business processes and to provide easy visualization. The method and tool is currently validated for a number of different examples. The paper also describes the findings from the experiments.

1 INTRODUCTION

The modern manufacturing enterprise has a complex business process architecture highly integrated for the product and production development process, which is in need of constant improvement to stay competitive. The decision making process in the enterprise or between enterprises can proceed along different axes; time wise and space wise. The time wise decision making process starts with the business process establishment, and continues to planning and control, until it reaches fully implemented systems. The space wise decision making process starts with the products, and continues to workers and machines, followed by production lines, factories, an enterprise and multi-enterprise networks. The manufacturing enterprise are modeled, evaluated and optimized with respect to both the time wise and the space wise view. The combination has been studied in [1] [2] as a design agent system which supports engineers to evaluate entire information systems in the both directions, focusing on space wise approach using a distributed simulation technique. This paper proposes a method and tool to visualize and analyze intra- and inter-organizational process interactions, based on only a time wise approach as an extension of the design agent system.

There are many conventional methods and tools which manage the entire knowledge base used for the decision making through enterprise activities or supply networks. The engineering data are shared by different divisions and different companies so they can be retrieved easily any time. However, merely digitalizing the existing business process may not always be the best solution, even using up-to-date IT technology, because the current processes may either be outdated or may be suboptimal and should be completely changed. A methodology is needed to visualize the hidden problems in order to eliminate inefficiencies and to approach the global optimum. The key issue is not a supporting tool led by a

methodology, but a methodology to deeply understand the process, supported by a software tool.

The methodology in this paper provides a new and novel method and tool including a standard thinking flow model, figure models, and a supporting system to both evaluate the business processes and provide easy visualization. The authors studied conventional methods [3] and found there was no holistic methodology to resolve all the problems. The proposed method selects some of those conventional methods, and extends, changes or shrinks them to fit the methodology in terms of combination.

The paper is organized as follows. Section 2 describes the difficulties in finding the bottlenecks and improve them by visualizing the business processes. Section 3 proposes a method and tool to provide engineers with a new and novel thinking process for global optimization of the enterprise business model. Section 4 provides some results from experiments on the business process reengineering by using the method and tool. The paper closes with a discussion of the future research.

2 PROBLEMS ON VISUALIZING BUSINESS PROCESSES

From our experience, there are many cases which have problems to visualize business processes in order to help the understanding and improving of the processes. It happens especially when many different divisions are involved. The problems are, for example,

- Difficulties in determining where to focus
- Difficulties to persuade the staff in other divisions to collaborate
- Large and complex process descriptions, which causes exhaustion of the staff and makes it almost impossibility to extract the primary bottleneck.
- Too simple and not enough detailed process descriptions, which lead to banal findings that are already well known
- Too much time in analyzing the processes while obtaining few deliverables, and failing to obtain support from superiors for further analysis

To resolve these problems, the paper proposes a new and novel methodology, whose features include:

- Holistic methodology that allows the staff to understand the reengineering process easily
- Figure models to support discussion among many divisions
- Algorithms to improve the efficiency of the business processes and to win the support of the staff
- Software tool for reducing the time to create and update figures and to collect data for the modules

The many conventional ideas based on the knowledge building process are integrated in the proposed methodology as needed. They include the theory of constraints [4] applied to problem description methods, the unified modeling language [5] of a software specification language, the design structure matrix [6] of a representation method for the dependency relations among engineering tasks, and a business process simulation technique [7]. All the techniques have already been developed, but based on our experience their independent use lacks practical success, especially if applied by engineers not skilled and highly trained in the area.

This paper describes a novel way to combine these methods to increase their usability and provides additional functions for all methods. The conventional figure models are

fundamentally new ideas and currently not yet supported by any software system. The method provides a supporting system to interface, evaluate, and investigate data for all the methods.

3 METHOD AND TOOL

The methodology provides a method and tool including a standard thinking flow model, figure models, and supporting software modules for easy visualization and evaluation of the business processes. All figure models are supported with the corresponding software module. Figure 1 illustrates the outline of the models with the figures and tables which appear in the modules.

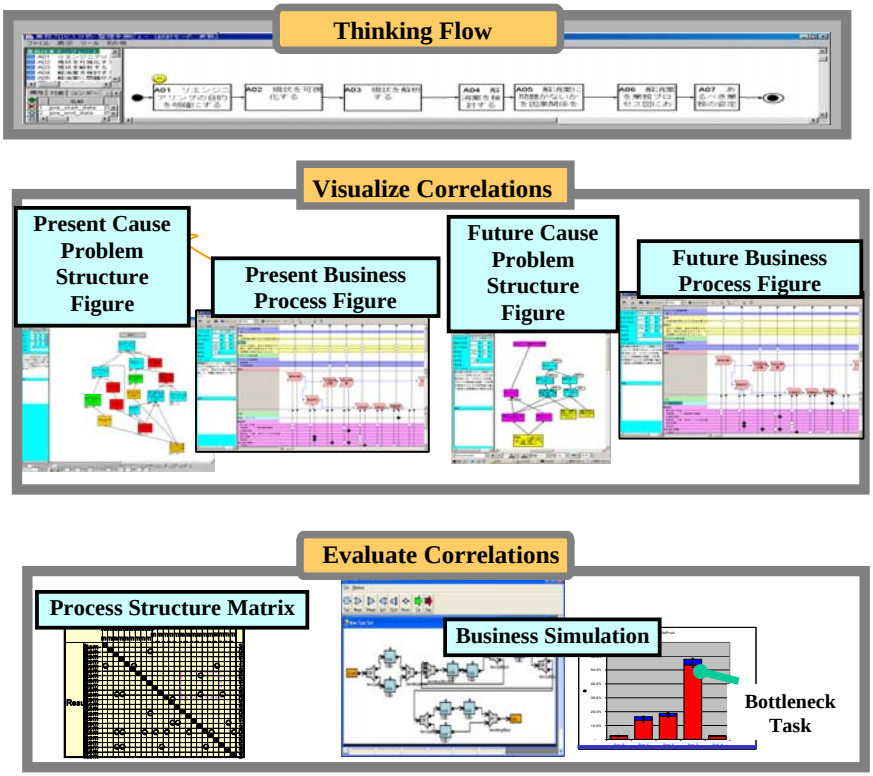

Figure 1. Outline

The thinking process model is designed to aid those unfamiliar with the business modeling or reengineering. The main steps are: visualization of the correlations, analysis of the correlations, change of the correlations, and verification of the new correlations. The correlations can occur between tasks, between organizations, between physical components, between functions, and between different staff. The underlining idea is to change the correlations with any problems to make the process slim and efficient. This approach originates from the lean production system pioneered by Toyota. Therefore the authors call the idea a lean business reengineering methodology.

The figure models of the structure of the cause of present and future problems are based on the reality tree in the TOC [4]. The figures of present and future business processes

describe the activities in the process, linked to all the information about *5W2H* (Who, when, where, what, why, how, and how much). The notation in the process figure model follows the specification with UML [5]. Note that the business process is a target process flow to be improved, while the thinking process model described before is the upper level process flow. The idea to view the multiple processes originally comes from the design agent technology [8].

The process structure matrix describes the dependency relations between the activities to analyze the feedback loops in the process. The matrix is improved by exchanging the activities or arranging meetings at the right time to coordinate all the tasks in order to minimize the length of the return paths in the process and subsequently improve the lead time which may also cause problems about costs and quality. The feedback can be eliminated to make the system more efficient by specifying appropriate standard rules which help the staff in a division to make a decision without the need for coordination with other divisions. More detail about the matrix can be found in [9] [10]. It specifies the activities with stochastic working times and stochastic branches. Although there are some business simulators as for example [7], the special functions are skill based evaluation, automated bottleneck detection and automated sensitivity analysis. The algorithms are extended from previous studies by the authors in the field of manufacturing system simulation [11]. See [12] to [14] for more detail.

The supporting software provides an useful interface to download automatically from other figures. The main causes of the problems are easily visualized in the cause problem structure figure and also shown in the business process figure linked to related activities and information. The activities in the business process figure are also shown in the process structure matrix and the business process simulator.

Figure 2 visualizes the usage flow of the method and tool in a standard reengineering case for the product development processes such as software implementation. Most sources for problems about quality, lead time and cost in large- and middle-size enterprises are caused by miscommunications and misunderstandings among divisions or associate companies.

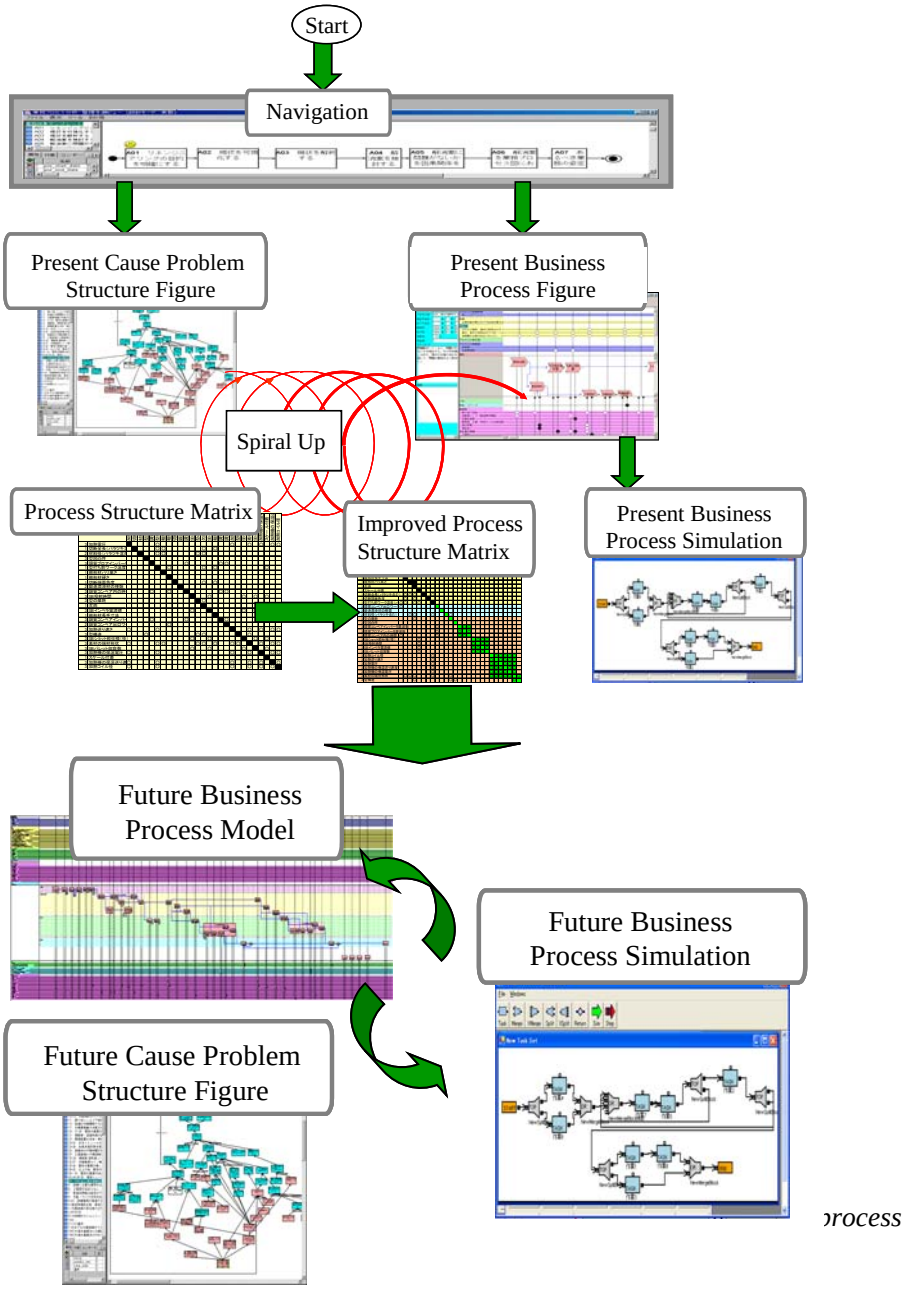

Figure 1. Standard flow to use the tools

The method begins with describing both the present cause problem structure figure and present business process figure in parallel using the thinking process navigator. The present cause problem structure figure is used to divide the apparent problems into secondary problems and primary problems that cause other secondary problems. It is often difficult to devise the structural figure in sufficient detail without describing the process figure because the activities of other divisions are unknown. On the other hand, it is also difficult to keep the process figure from being too complext to understand without the help of the cause problem structure figure that aids in focusing on the central issues and to avoid trivial matters In

addition, it is difficult to validate the business process as is without using the process structure matrix. Besides, even for experts it is difficult to create the matrix is by hand without the process figure. Therefore the two figures and the matrix are developed in parallel and improved simultaneously. After sufficient consideration and discussion, the process figure is updated to the next version. The future cause problem structure figure is considered to check the remaining problems. To evaluate the future process, a simulation is used to calculate the cause and effects related to cost and errors, sum up effects of process improvement, and reduce the lead time and risk of delays in due dates.

4 EXPERIMENTS

The methodology is currently verified using many different examples such as manufacturing preparation processes and software implementations. Different applications require different software modules based on their complexity or expertise. The following conclusions are based on a number of experiments:

- If you do not know how to start, navigate along the thinking process flow model.
- If you do not find a primary problem, begin by describing the present cause problem figure and the business process figure.
- If the search for the bottleneck problem is too complex, concentrate on the description of the cause problem structure figure in order to reduce the complexity of the business process reengineering. This may happen if outside consultants are participating.
- If you do not find the primary cause of the problems because of the lack of detail in the process description, follow the thinking process model and continue with the description of the business process figure model for both the present and future cases. This may happen if commercial knowledge management software is used.
- If you find a bottleneck but do not know how to improve the process, describe the business process figure model in both the present and future cases. This situation may happen if commercial software such as a 3D CAD system or an ERP system is used.
- If you desire to make the business process more efficient in a division that you are very familiar with, focus on the process structure matrix and the business process simulation.
- If you consider to outsource your processes, the business process simulation may be the most promising analysis approach.

5 CONCLUSION

The paper proposes the method and tool to aid engineers in understanding the processes of manufacturing enterprises and to visualize and analyze intra- and inter-organizational process interactions in order to make the business processes more lean. The key issue left for future research is a method to add new ideas for collaboration, though in our experience the proposed method has features suitable to resolve this issue due to its holistic approach of thinking processes. There are many IT firms which consult companies about new business models using IT software tools. However, a business process can never be understood only

from mechanical application of software tools, but requires a method involving all the staff in the enterprise to deeply understand the business processes.

6 ACKNOWLEDGMENTS

Useful discussions with members in the Toyota group, in particular, Mr. Ochiai, Mr. Shimada, and Mr. Hayama of Toyota Motor Co. are much appreciated. The authors would like to thank Mr. Inamori, Mr. Araki, and Mr. Wada in Toyota Central R&D Labs., Inc. for the collaboration.

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