Understanding Strategy for a Manufacturing Based Learning Organization in Transition in the Twenty First Century

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ABSTRACT

Manufacturing strategy offers a means for integrating operations management decisions and linking them with the firm's business strategy to attain a competitive position. The goal of this paper is to develop a model using Systems Thinking which can be utilized to better understand what constitutes manufacturing strategy, and why certain decision choices better mesh and lead to a superior competitive position. The model focuses on understanding linkages among operation management decisions which will include the decision areas of process, materials management, quality, workforce management, and maintenance.

THE NEED FOR MORE RESEARCH

There are firms such as General Electric, Chrysler, Outboard Marine, and Allen-Bradley that are adopting the integrative approach. The recent successes in the plants owned by these U.S. companies and Japanese companies (Wheelwright 1981) are an evidence of how an integrated approach can lead to competitive success. The integrative approach subscribes to the argument that manufacturing decisions must mesh with each other and with the firm's business strategy. The effectiveness of an integrative approach in some of the examples cited above is one reason for conducting research on how to integrate actions in manufacturing. If theories are made available, then manufacturing firms may be better able to achieve superior performances more consistently.

A lack of knowledge or explanation of relationship among widely disparate and dispersed elements of production in a firm has been cited as one of the key reasons why manufacturing slipped to being a millstone rather than a source of competitive advantage (Skinner 1978 and Hill 1985). Research scholars must bear blame for this lack of knowledge base. A theory about integrating actions in manufacturing is needed. Such a theory will help managers transform manufacturing from a millstone to a source of competitive advantage. In essence there is a need to develop theory to guide systematic planning and implementation of manufacturing strategy to bring manufacturing to the level of other function's as being a source of competitive advantage.

Developing a theory on integrating actions in manufacturing means understanding the relationships among operations management decisions. Porter (Porter 1980) suggests that firms are better able to develop sustainable competitive positions if the decisions mesh with each other. The soundness of Porter's argument is one reason for studying linkages in manufacturing.

Up until recently, the majority of research on manufacturing strategy, such as that by Abernathy (1976) and Skinner (1969, 1974), has mainly relied on case studies. Recently there have been some empirical studies (Miller et al. 1983, 1984, 1985, 1986; Hayes and Clark 1985; Roth et al. 1987; and DeMeyer et al. 1987) that have statistically analyzed data collected from many organizations. There also have been some studies that have employed analytical (Cohen and Lee 1985) analysis to gain insight into the linkages in manufacturing. A significant weakness of the above mentioned research is that most of the research was conducted from a disjunctive point of view rather than of a holistic nature.

RESEARCH METHOD OVERVIEW

This paper utilizes system dynamics to develop a model that can be used to better understand relationships among the decision areas of Process, Quality, Materials Management, Maintenance and Workforce Management in manufacturing strategy. The simulation language used for this model is STELLA.

According to the Executive Summary of the 1987 North American Manufacturing Futures Survey; competitive priorities based on quality, and delivery time will be the theme of the nineties. Delivery time denotes the elapse time between receiving a customer's order and filling it. Speed of delivery is viewed as a means of achieving superior quality (Hayes and Schemmer 1978). Krajewski and Ritzman (1987) considers fast delivery as an independent basis of gaining competitive advantage.

A key measure of delivery time is the cycle time for a product. Cycle time is defined as the time required to manufacture one part or product unit. Cycle time is being proposed as the measure to examine relationships among and within the decision areas of Process, Quality, Material Management, Work Force Management and Maintenance.

In formulating the model, two distinct avenues were pursed in selecting variables for the decision areas under examination. Variables for the decision areas of Process, Quality, and Materials Management were deductively derived from the existing knowledge base. Since there seems to have been little published effort to date, if any, to relate workforce management and maintenance to manufacturing strategy, the variables identified in the model are of an exploratory nature. Case studies with manufacturing firms and survey analysis were the research methodologies utilized to propose the variables for workforce management and maintenance.

INFLUENCE DAIGRAMS FOR DECISION AREAS

As previously mentioned, time based competitiveness was rated highly as a competitive priority for businesses in the nineties. To be effective in time-based competition, managers must carefully define steps and time involved in processing customer orders. Next, they must critically analyze each step to see whether production time can be shortened without compromising the quality of the product or service. Significant time reduction in operations can often be achieved by changing the way current technologies are used, by turning to automation, by identifying and reducing non-value added time, by effective maintenance and by effective management of workforce. With these thoughts in mind, the following sections describe the variables identified for the decision areas of process, quality, material management, workforce management and maintenance.

The next section illustrates an influence diagram of the Decision Areas of Manufacturing Strategy that are being examined. Following are influence diagrams of the Decision Areas of Process, Quality and Materials Management that were deductively derieved from the existing knowledge base on manufacturing strategy. A brief description explaining the variables identified for Workforce Management and Maintenance follows since they are of an exploratory nature.

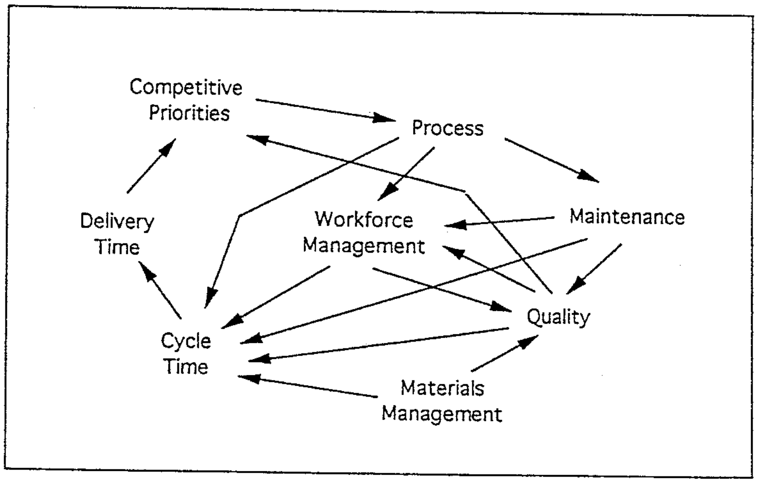

Figure 1. Influence diagram of Decision Areas of Manufacturing Strategy

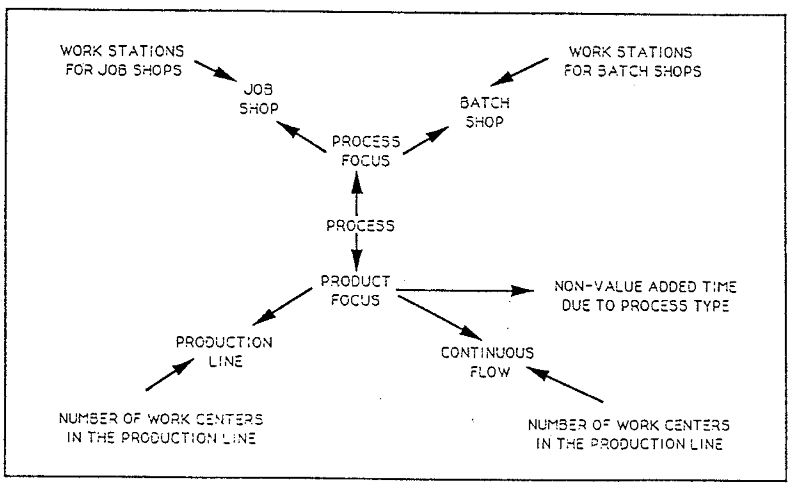

Figure 2. Influence diagram of the Decision Area of Process

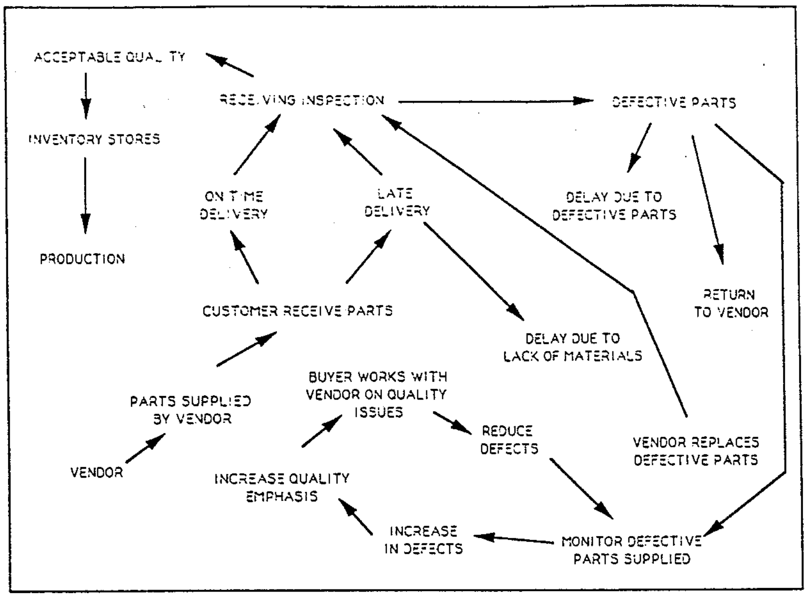

Figure 3. Influence diagram of the Decision Area of Materials Management

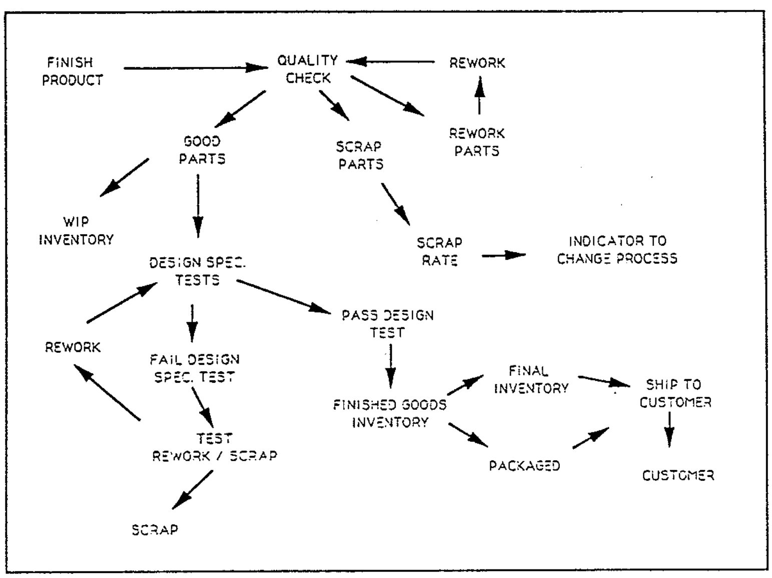

Figure 4. Influence diagram of the Decision Area of Quality

MAINTENANCE

Maintaining production capacity, regardless of the degree of capital intensity is essential to a firm's long term growth and profitability. Maintenance managers must continually find ways to ensure adequate output performance while minimizing maintenance activity cost and system failure costs. Maintenance activity costs are the costs incurred in attempting to maintain the desired output rate. System failure costs are the costs incurred when the system fails to perform at the desired output range. System failures never happen at a "good time", typically require emergency measures, and can be extremely costly. Hundreds of workers on a production line can be idled, along with expensive equipment, and customer shipments delayed just because one machine fails.

As previously mentioned, cycle time is a key measure of delivery time which an increasing number of companies are using as a basis for gaining competitive advantage. The time required by machinery to process a product significantly affects cycle time. Based on the case studies completed for this paper, the efficiency of a preventative maintenance program, work order efficiency, machine operator's involvement and levels of automation.are being proposed as variables that can significantly affect the machine time to process a product.

Preventative Maintenance involves a pattern of routine inspections and servicing at regular intervals. These activities are intended to detect potential failure conditions and take steps to prevent their occurrence. Traditionally, preventative maintenance programs are set up to carry out equipment maintenance, on a regular calendar schedule or by hours of operation, based on the manufacturer's recommendations. These recommendations are usually based on an average operating environment. Routine inspections often highlight problems that may cause equipment to operate below its normal efficiency, thereby, affecting process time.

The variables work reduction factor and work induced factor are proposed to examine the effects of a preventative maintenance system on generating maintenance tasks. Hypothetically, maintenance tasks (sometimes refer to as machine repair activities) should decrease if scheduled preventative maintenance work orders are completed as per schedule and vice-versa.

In this study, maintenance tasks, also refer to as work requests are grouped into four major categories: emergency, operations, scheduled, and shutdown. The emergency tasks (usually unplanned critical production machine breakdown) are usually performed when the equipment fails to operate, often at a premium cost. Operation tasks are those that are generated from the daily operations of the plant. Scheduled tasks are maintenance tasks that are scheduled to be completed sometime in the future due to lack of resources or materials. Shutdown tasks involve work that can only be completed during plant shutdowns.

Training hours is proposed as a variable to examine the effects of motivation and the effectiveness on backlog hours. Theoretically, productivity increases are equated to training hours to describe a potential increase in productivity. It is assumed that when a worker receives training there will inevitably be some form of improvement.

Resources represent the available number of tradesman. If this number changes for whatever reasons (retirement, fired or better opportunity) then there is automatic hiring to satisfy the original amount of workers. Resource hours are determined by the number of workers multiplied by five days per week and eight hours per day. Available hours which determine the available hours that can be assigned to completing work requests or preventative maintenance work orders is calculated from resource hours plus any allowable overtime minus any hours dedicated to training.

Improperly operated equipment may not only cause breakdowns but also can significantly affect machining time for a process. Therefore, poorly operated machinery could possibly have a compounding detrimental affect on cycle time. Not only is the cycle time increased from an increase in machining time but also machine breakdowns which increases the need for maintenance repairs causing a reduction in machine availability for production; hence lengthening the time it takes to manufacture a product. It is being proposed in this study that training procedures for operators and their attitudes can significantly affect the way in which the equipment is operated.

Since technology is changing so rapidly, it is more important than ever for operations managers to make intelligent, informed decisions about automation. Many new opportunities are the result of advances in computer technology. Deciding whether to take advantage of such opportunities can significantly affect cycle time and the work force. Cycle time may decrease dramatically with automation. Automation however, affects jobs at all levels. Some are eliminated, some are upgraded and some are downgraded. Even where the changes resulting from automation are small, people related issues become large. For example, poorly trained and poorly motivated workers can cause enormous damage. The transition is easiest when automation is part of capacity expansion or a new facility and doesn't threaten existing jobs. In other situations, early education and retraining is essential. The effects of different levels of automation on cycle time is examined in this study. The influence diagram below (figure 5) indicates the variables of the efficiency of a preventative maintenance program, work requests (maintenance tasks) efficiency, machine operator involvement, and different levels of automation in relation to machine processing time.

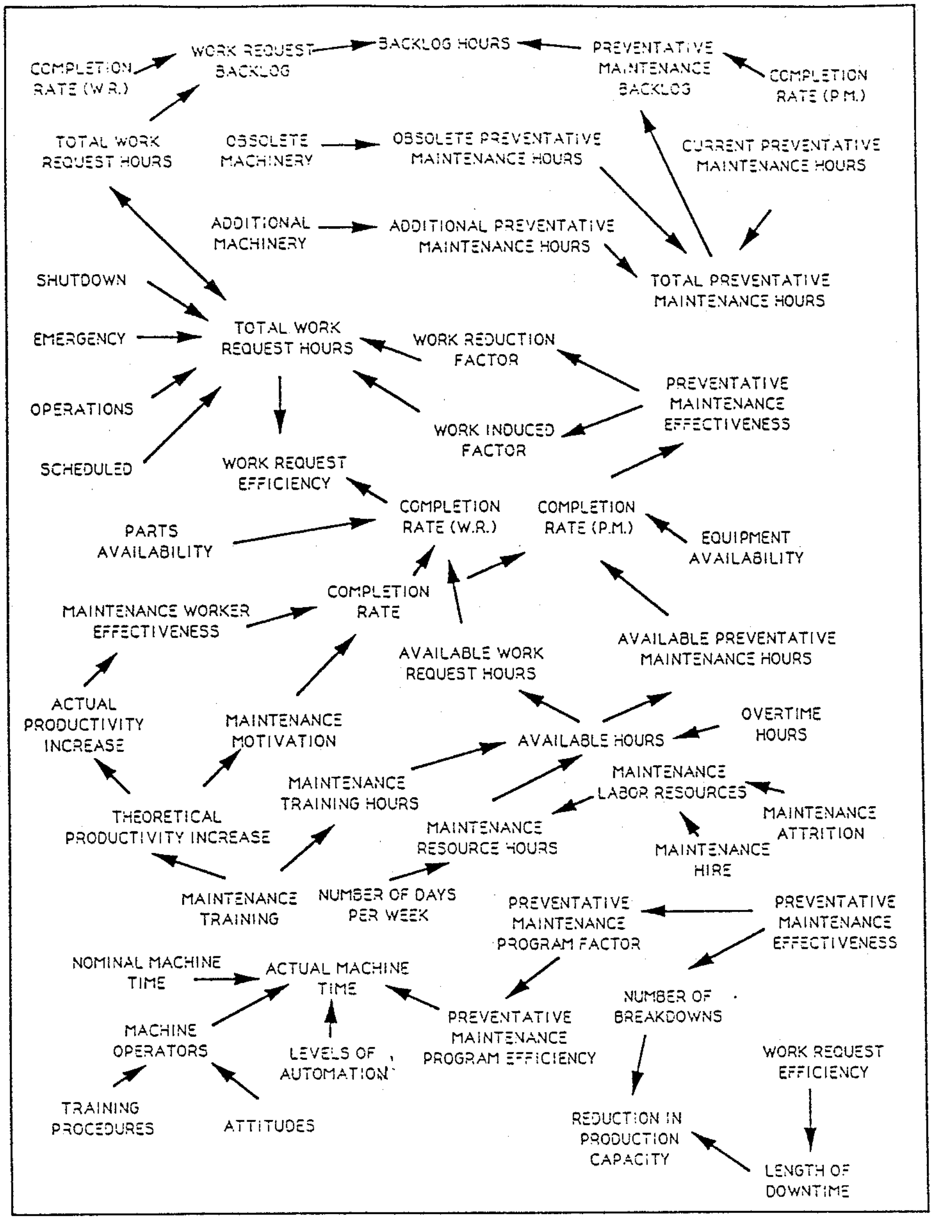

Figure 5. Influence Diagram representing Maintenance Management

WORKFORCE MANAGEMENT

This section explores the human side of manufacturing today . Competing on science and technology means competing on the organization of information; invariably one thinks of a battle of computers. But the machine is not at the center of competition; knowledge workers are the only corporate assests that lasts. This study proposes that people are both a source of strategy and the means to achieving its goals - even a technology - based strategy has its foundations in people. Without the right people, the most streamlined processes make no difference to the bottom line. The ability to reduce cycle time is necessary to make the changes required by customer demands and desires. In order to acquire the ability to reduce cycle time, an organization must be flexible. A flexible organization leads to an improved strategic position and a competitive advantage that helps to ensure long term viability. Three values essential to a corporation in pursuit of flexibility are diversity, discourse and empowerment.

Business is increasingly complex; and work that individuals used to perform is now done on teams. For this reason, companies may need to transform a collection of individuals of both genders and of different ethnic, racial, and religous backgrounds into a cohesive team sharing a common goal, trust and interdependence. Companies must attract and motivate the best and brightest people from every available source and coax the greatest contribution from each person. Companies can't afford to have people working at 50 percent capacity because they feel that certain of their abilities and attributes aren't welcome. What should companies hope to accomplish by valuing diversity? First and foremost, companies will be creating an environment in which every employee can make his or her fullest contribution to the company goals. This will boost productivity immediately and enormously. Secondly, diversity will change the psychological contract between employees and employer. When an employee works to create an environment in which diverse people and talents are valued, people get motivated and energized. They work at full capacity and get something back from the system in terms of career and personal growth. People will play hardball if they know that they are truly on the company team.

The second value essential to corporate flexibility is communication. Communication too often becomes a one-way street; emanating from the top down. Communication gives rise to the belief that information sharing is right and necessary. Sharing the corporate vision, strategies and goals is fundamental, as is getting input and reactions to refine them. People believe that listening is a way to learn and that ongoing learning keeps an individual and an organization vital. They believe that the exchange of ideas leads to innovation and discovery and that no one person has all the answers.

More than any other variable, communication drives flat organizational structures. Information that travels by the shortest distance and most direct is the freshest, most accurate, and most relevant. Given the distance between the top and the bottom of organizations in pyramidal, hierarchial structures, it is not suprising that the top and bottom are disconnected, don't understand each other, can't communicate, and (more often than not) are working on entirely different agendas, goals, and programs. A flat structure, with its quick access, puts everyone back on the same team on the same playing field on the same day. It is a huge step toward a winning attitude and the success that results.

The third value essential to corporate flexibility is empowerment. Technically, to empower means to invest with legal power, or to authorize. In today's human resources vernacular, however, the word is used more for its connotative than literal sense. Empowered people operate out of the passion and courage of their convictions. They do the right thing, live out their values and beliefs, behave authentically, and follow through on commitments. They are honest and fair with themselves and others, upfront and nonmanipulative. The definition of empowerment is difficult to pin down exactly because it deals with the elusive world of feelings. People feel empowered when their head and heart and gut are synchronized and they are centered in the power that results. Everyday people all around us are empowered as they accomplish their potentials.

The culture that springs from empowerment is a meritocracy. It invests in humans and their growth and development, takes a long-term perspective, and supports personal commitment and responsibility. The behaviors in this culture revolve around high motivation with low supervision. This results from the combination of teamwork, shared vision, and self-determination. People rotate in and out of full-time status. They express loyalty and achieve quality and excellence in processes and products. They follow through on commitments and take initiative by signing up for work that contributes to company goals. They seek innovation and renewal.

The final link in the chain leading to flexibility is the human resources practices and programs. It is difficult to predict accurately just what programs and systems an organization shoud design. However, it is important to note that whatever programs are chosen, they should be tied together into a system, and must all be directed at achieving flexibility. Some of the most powerful tools that an organization can use to motivate employees are: recognition and reward systems, benefits and training.

Based on the above information, five variables are being proposed to develop the workforce management decision area of the model: skill levels, motivation, variances, tooling and empowerment illustrated below in figure 6.

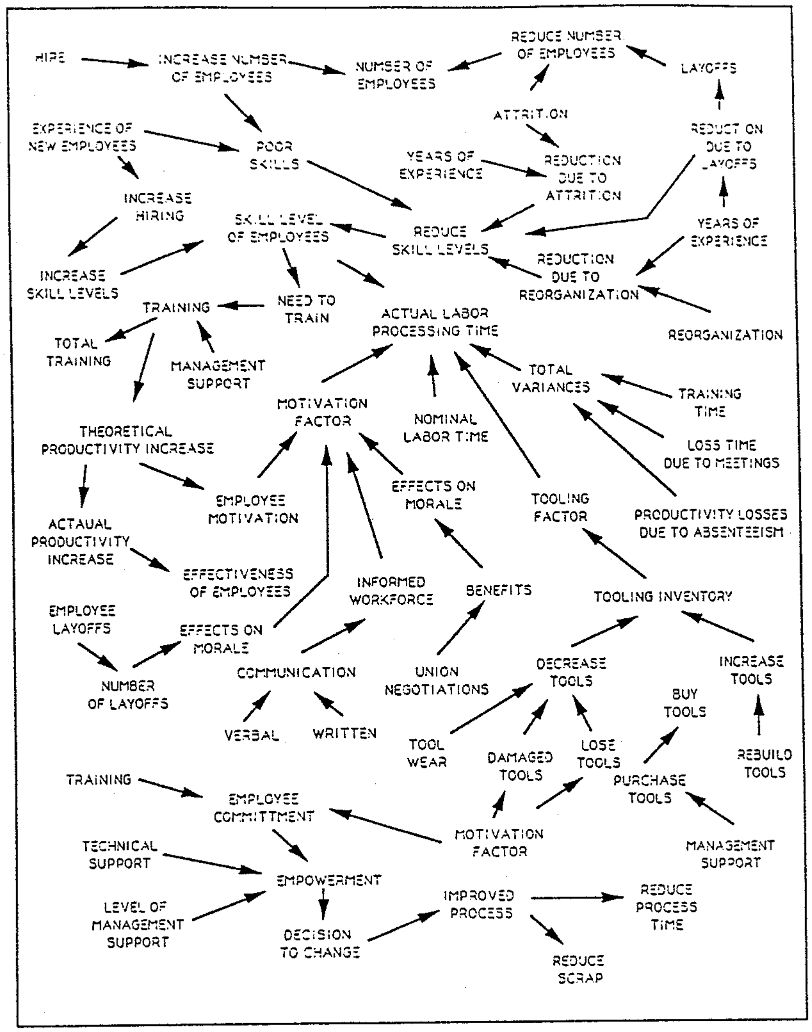

Figure 6. Influence diagram representing Workforce Management

BASE RUN

The results of the base run are illustrated in figure 7. Key variables to this simulation model in relation to cycle time are the hiring and layoff of employees, communication, union relations, training, variances (meetings, sicktime, and training), equipment availability, maintenance overtime hours, maintenance training hours, operator's attitudes and their training procedures, defective parts supplied by vendors, vendors delivering parts late to customers and inspection errors during the receiving inspection of supplied parts. Cycle time includes labor time, machine time, non-value added time due to the type of facility layouts, material handling systems and delays either from parts being delivered late or poor quality parts supplied by the vendor.

Cycle time varied over the ten year period with the exception of a few periods in which they were significantly higher. The excessively long cycle times were as a result of the cumulative affects of poor operator training procedures, layoffs, poor union relations and a number of experienced and highly skilled employees leaving due to attrition. The downward trends (i.e. reduction in cycle time) were due to good union relations, a period in which suppliers supplied good quality parts and on time, reliable maintenance, high level of communication, ample and effective training for employees and good operating procedures by machine operators. The upward trends (increase in cycle time) were due to layoffs, highly experienced and skilled employees leaving due to attrition, and poor operating procedures by machine operators. The instances where there was a significant reduction in cycle time was as a result of a process change due to continuous quality improvements. These improvements were from a combination of actions such as high employee involvement, good technical support, high degree of empowerment and management support to implement the changes. The erratic behavior of the system is due to the randomness of union relations, operator's operating procedures, variances (meetings, sick leave). Figure 8 illustrates the systems flow diagram of the proposed model .

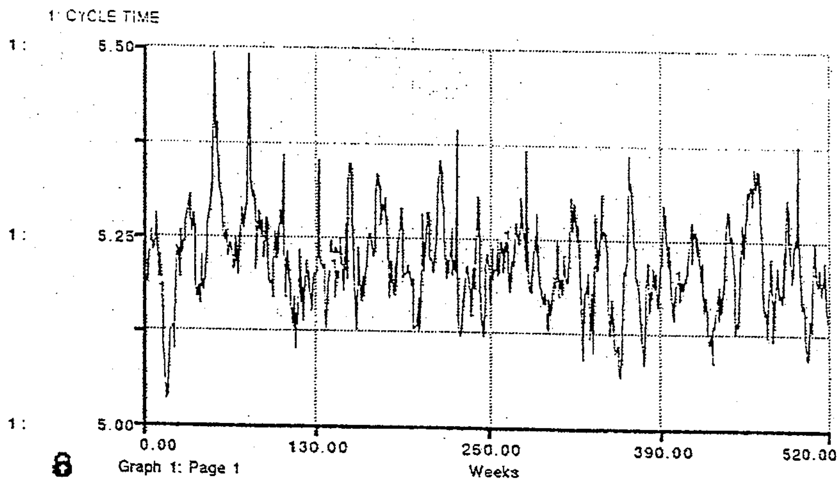

Figure 7. Base Run.

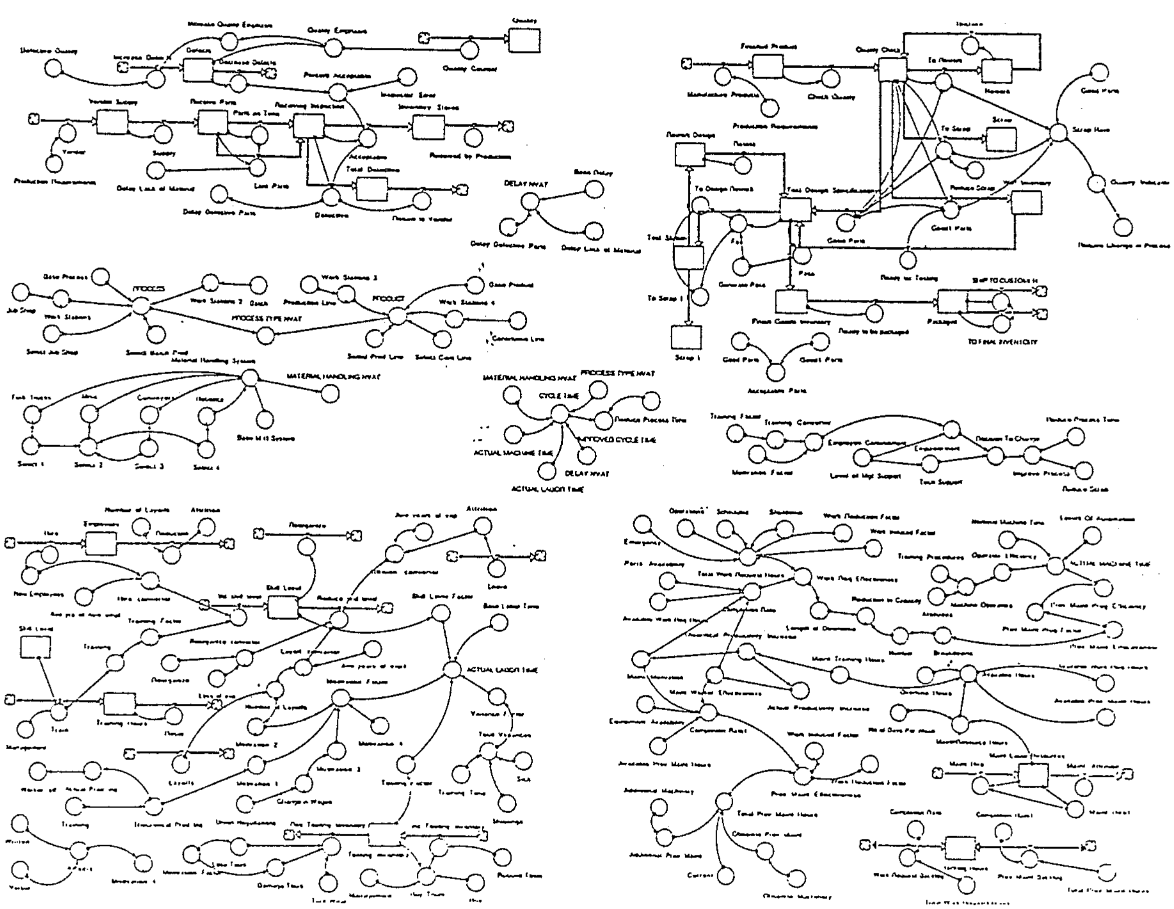

Figure 8. System Flow Diagram of Proposed Model of Manufacturing Strategy

CONCLUSION

This paper proposes a model using Systems Thinking that can be utilized to better understand the interrelationships among decision areas of manufacturing strategy. The framework presented is in its conceptual stage, and further efforts are currently being pursued to validate the model. The intent of this paper was to demonstrate the potential of studying manufacturing strategy from a Systems Dynamic point of view; and to propose a conceptual framework on such an approach.

REFERENCES

Abernathy, W.J. 1976. Production Process Structure and Technological Change. Decision Sciences. Vol. 7.

Cohen, M.A. and H.L. Lee. 1985. Manufacturing Strategy: Concepts and Methods. The Management of Productivity and Technology in Manufacturing. Ed. P.R. Kliendorfer.

DeMeyer, A. and K. Ferdows. 1987. Mangerial Focal Points in Manufacturing Strategy. France: INSEAD European Institute of Business Administration.

Hayes, R.H. and K.B. Clark. 1985. Adversaries in Alliance: Managing the Productivity Technology Dilemma. Boston: Harvard Business School Press.

Hayes, R.H. and R.W. Schmenner. 1978. How Should You Organize for Manufacturing. Harvard Business Review. Jan-Feb.

Hill, T. 1985. Manufacturing Strategy. London: Macmillan Education Limited.

Krajewski, L.J. and L.P. Ritzman. 1987. Operations Management and Analysis: Strategy and Analysis. Addison-Wesley.

Miller, J.G. et al. 1983. 1983 North American Manufacturing Futures Survey: Summary of Survey Responses. Boston: Boston University Manufacturing Roundtable Research Report Series.

Miller, J.G. et al. 1984. 1984 North American Manufacturing Futures Survey: Summary of Survey Responses. Boston: Boston University Manufacturing Roundtable Research Report Series.

Miller, J.G. et al. 1985. 1985 North American Manufacturing Futures Survey: Summary of Survey Responses. Boston: Boston University Manufacturing Roundtable Research Report Series.

Miller, J.G. et al. 1986. 1986 North American Manufacturing Futures Survey: Summary of Survey Responses. Boston: Boston University Manufacturing Roundtable Research Report Series.

Porter, M.E. 1980. Competitive Strategy. New York: The Free Press.

Roth, A. et al. 1987. Differentiated Manufacturing Strategies for Competitive Advantage: An Empirical Investigation. Boston: Boston University School of Management Research Report Series.

Senge, P.M. 1990. The Fifth Discipline. New York: Doubleday/Currency.

Skinner, W. 1969. Manufacturing - Missing Link in Corporate Strategy. Harvard Business Review. May-June.

Skinner, W. 1974. The Focused Factory. Harvard Business Review. May-June.

Skinner, W. 1978. Manufacturing in the Corporate Strategy. New York: Wiley.

Wheelwright, S.C. 1981. Japan - Where Operations Really are Strategic. Harvard Business Review. July-Aug.