KEY WORDS

Lean manufacturing, socio-technical systems

SUMMARY

Most companies attempting to implement lean manufacturing have focused on the manufacturing process (the technical system) and have ignored the organizational factors (the social system) of the change management process. This has resulted in the less than complete success they have experienced in their efforts to become lean. The authors of this paper will present a socio-technical approach for evaluating and managing both the technical and organizational factors necessary for the successful implementation of lean manufacturing.

INTRODUCTION

America’s manufacturing firms face unprecedented pressure for change as a result of combined economic and technological forces. As companies increasingly compete globally, firms face increasing pressure to supply products that meet ever more stringent cost, quality, and delivery requirements. The drive toward agility in manufacturing (i.e., the capacity for fast response to market and other changes) also means that firms must cope with the need for continuous improvements in product and process design, while simultaneously reducing the cost and time required to achieve these improvements. Increasingly rigorous quality standards also require that each generation of new designs have fewer defects than the generation before. These are difficult standards to meet, even for the most able of companies. As a result many organizations have jumped on the lean production bandwagon.

Lean production is a term that was first introduced by Jim Womack, Dan Jones and Dan Roos in their book “The Machine That Changed The World.” Lean manufacturing describes the production system that Eiji Toyoda and Taiichi Ohno developed at the Toyota Motor Company in Japan.

Lean production, compared with mass production, “uses less of everything... half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time.” “Also, it requires keeping far less than half the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products.” It is no wonder that a great many manufacturing companies around the world are trying to become lean producers.

“Those who forget history are doomed to repeat it.”

The widespread interest and activity in lean manufacturing closely resembles the quality movement in the United States in the 1980’s and early 1990’s. And, many of the same mistakes made in the zest to improve quality are being repeated in the quest to become lean.

Many companies started their quality movements by trying to copy the techniques they had seen at successful Japanese firms. First it was quality control circles, then Statistical Process Control. These were followed by ever more sophisticated techniques such as Design of Experiments.
Real progress however, had to wait until the more progressive companies realized that quality improvement required more than techniques. Quality improvement was only achieved after companies implemented comprehensive change management programs (such as T.Q.M.) that addressed both the organizational and technological aspects of quality management.

With that said, many barriers are encountered when companies attempt to implement lean techniques without accounting for the organizational issues present. Perhaps the most insidious barrier is the mass production mindset embedded in almost everyone’s minds that constitute the dominant paradigm of organizational efficiency. Batch and queue thinking is so pervasive that if we ask our children to design a process for assembling a mass mailing they will perform the various steps in batches and queue the stock (letters, envelopes, stamps) rather than perform the operation in “batches of one”. This mindset is carried forward throughout life into the industrial world where it influences our thinking so greatly that lean techniques are often judged to be inefficient.

Another social system barrier that often thwarts lean techniques is the uniquely American desire for autonomy. Lean techniques call for standardization of processes so they may be performed efficiently and perfected. The perceived creativity and opportunities for improvement that come from individual autonomy is threatened and thus resisted. It is difficult for people to see the increased opportunities for participation, autonomy, and creativity that accompany kaizen activities performed in teams.

One last example we would like to share is the management mindset that employees do not need information beyond the narrowly defined “need to know” case. This prevents the essential visual control elements of lean thinking by virtue of not displaying process and business information on boards throughout the manufacturing area. Without these visual cues we cannot expect people to be motivated to make decisions and care about the company’s interests.

We could go on for nearly forever with examples of social and organizational issues that make perfectly appropriate lean techniques for improvement infinitely more difficult to implement.

**SOCIOTECHNICAL SYSTEMS**

Socio-technical systems (STS) integration is a conceptual model that enables organizations to introduce the new processes and methods of lean manufacturing more effectively. The benefits of a socio-technical systems approach include faster and more complete utilization of lean methods, and greater economic impact. The STS method is based on the assumption that all work organizations are socio-technical systems that combine a technical system and a social system. The technical component of a socio-technical system includes the organization’s technology and work process. The social component of a work organization includes its people, organizational structure, and cultural elements.

These two types of systems—the technical and the social—are interdependent; neither can perform the work of the organization without ongoing inputs from the other. When lean methods are introduced, there is a need to consider the interaction of the new methods with a) the existing work process, and b) with the existing social system.

Where the characteristics of the existing social subsystem are capable of supporting and sustaining (i.e., adopting) the new technical system then lean methods are more likely to yield promised benefits. As an illustration, organizations that have a good history of collaborative approaches to problem solving and teamwork have a social system that is basically in alignment with the introduction of work cells and the teams which staff them. Such organizations are more likely to enjoy rapid deployment after the introduction of work cells.

Where there is a misalignment between the social and technical subsystems, however, the introduction and implementation of lean methods can be problematic and promised economic gains may not materialize. Thus, for example, an organization in which there is a history of labor-management strife filled with mistrust and recrimination is less likely to experience rapid implementation of lean applications, and the benefits of full functional utilization. In such cases, changes in the social system (i.e., healing the wounds and trust building) may be needed to enable full use of lean techniques.
The process of mutually adjusting the social and technical subsystems to create an overall work organization that is capable of high performance is known as joint optimization. Joint optimization recognizes that a work organization which attempts to optimize the technical subsystem at the expense of the social subsystem (or vice versa) is likely to have sub-optimal performance overall, since high performance requires both subsystems—technical and social—to be operating effectively together. Organizational alignment among the various technical and social system facets—new technology, work processes, reward systems, personnel practices, and organizational structure—is a necessary requirement for lean adoption.

HIGH LEVEL CHANGE PROCESS

Any new lean project must proceed according to some plan or roadmap. The one you choose should feel comfortable and contain some essential elements. The one we like to use has six phases: Agree, analyze, design, develop, implement, continuous improvement. To describe each step in detail is beyond the scope of this paper.

First, the process is one in which the project sponsors agree (agree phase) on what the end results must be. They create the framework for the project, determine outcomes, deliverables, and boundary conditions. In the analysis phase organizational members perform an analysis of the existing socio-technical system. They analyze the technical system by creating a current state map of the organization’s value stream. In the design phase a preliminary future state map is created and it is tested against the current social/organizational/cultural system to determine the fit between the proposed technical system and the current social system. This is an essential step in the joint optimization process. Then an implementation/integration/transition plan is developed (develop phase) and implemented (implementation phase). Last, improvements are made as time passes (continuous improvement phase) through a process often referred to in the lean vernacular as kaizen.

This paper is not intended to be a comprehensive roadmap to the implementation of lean principles. We will focus on the core components of the lean implementation process, specifically the analysis and design phases. Note that the process of analysis is not rigorously followed in strict sequence. An initial analysis of the existing technical process is conducted through the creation of a current state map. Then a future state map describing the ideal technical system is created. At this point one further analysis is required – an analysis of the existing social system juxtaposed against the future state map (the ideal technical system). It is here that mismatches between the existing social system and the ideal technical system are identified. At this point two kinds of changes are defined for incorporation into the “final” future state – changes in the organizational practices (e.g., job roles, reward systems, appraisal systems, organizational structure) that define the organization’s social system as well as changes to the preliminary ideal state mandated by the inability of the organization’s social system to respond or adapt to the required technical changes.

TECHNICAL ASSESSMENT PROCESS -- HOW LEAN ARE YOU?

The technical assessment begins with the creation of a value stream map of your manufacturing system (a current state map). The current state map documents your current performance in terms of inventory levels, lead time and labor productivity. The current state map is analyzed and redrawn using the lean manufacturing philosophy and technologies. The result is a future state map that describes the manufacturing system once you are employing the lean manufacturing technologies. The gap in performance between the current and future states documents the improvements in inventory, lead time and labor productivity that you can expect from the application of lean manufacturing technologies.

HOW MUCH CAN YOU EXPECT TO IMPROVE?
Traditional mass producers can expect improvements of: a 90% reduction in inventories, a 90% reduction in lead time, a 90% reduction in the cost of quality and a 50% increase in labor productivity.

**WHAT ARE THE TECHNICAL CHANGES NECESSARY TO IMPLEMENT LEAN (PRELIMINARY TECHNICAL DESIGN)?**

The preliminary technical design phase is completed through the creation of a project plan for transforming the production system from the current state to achieve the future state.

The technical changes necessary to achieve the future state include:

1. Transforming the traditional batch and queue production system into a continuous flow system where possible.
2. Implementing supermarket pull systems wherever continuous flow is not possible.
3. Leveling the demands on the production system through the adoption of standard quantities and mixes of work orders (standard pitch quantities).
4. Improving the flexibility of the production system through quick changeover technologies.
5. Improving the reliability of the production system through total productive maintenance technologies.
6. Improving the repeatability of the production system through process controls and pokyoke quality technologies.

**ANALYSIS OF JOINT OPTIMIZATION**

After completing the preliminary technical design it is time to test it against the existing social system. Again, this is done to ensure that the anticipated changes will be successfully implemented. Too often organizational factor impede the implementation of lean practices. It is far better to try to predict which organizational factors will obstruct the implementation of lean and adjust for them in the design phase than during the implementation phase (often described as the “oh shit what do we do now” phase).

The first step in conducting the joint optimization analysis is to determine conceptually the individual, organizational, cultural variables relevant for implementing lean. These variables or potential issues are gleaned from the literature, experience, knowledge of the organization, and good common sense. Our reading of the literature and experience tells us that the following variables are potential roadblocks to lean implementation:

- Mass production mindset
- People’s need for autonomy that inhibits standardization
- Managerial mindset that employees do not need business information on visual control boards
- Sales bonuses that create variable demand for goods
- Technical specialists’ feelings of status that makes them resist cooperation with personnel on the factory floor
- Bigger is better mindset when applied to technology
- Full utilization mindset that machines and people must always be busy
- Accounting rules that feed the full utilization mindset
- All the well known barriers to teams and teamwork at all organizational levels

And this list is not complete.

After completing this list the variables must be measured. A variety of methods can be utilized to determine the strength or value of these variables. Questionnaires, surveys, interviews, and focus groups are just a few of the various methods we have employed.

To determine whether these variables facilitate, impede, or are neutral with regards to the ideal future state a matrix is constructed. At the top of the matrix the various features of the ideal lean organization are entered. Along the left hand column the social variables are entered. Then a
determination is made in each cell whether the social system variable facilitates, is neutral, or impedes the lean principle at top.

In cells where there are mismatches identified; for example, the existing social system may be characterized by individuals performing individual jobs when cellular manufacturing requires the implementation of work teams, there are two choices that the new system designers face. First, they can make changes to the functioning of the social variable; a deeper analysis of the social system would be required to determine how to change this social variable in order to make the technical change work in this organization. In addition, a host of ancillary changes may be required to implement work teams: such as skills building for workers and management, changes to the labor agreement, etc.

The second choice would be to modify the preliminary technical system design. In cases where it is determined that the organization will be too resistant to changes some compromises in the ideal technical future state may be needed. This is often disheartening to system designers and management. If it is remembered that the change process incorporates a continuous improvement phase, which is ongoing, many of these ideal technical features can often be implemented later in kaizen activities.

CONCLUSION

This paper highlights an alternative approach to implementing lean manufacturing. It emphasizes a total systems approach in which both the technical features and social features of an organization can be jointly optimized to produce satisfactory results. Past experience in the field of quality has proven this to be the better approach.