"Summary of article by John Paul MacDuffie and John F. Krafcik: Integrating Techology and Human Resources for High-Performance Manufacturing: Evidence from the International Auto Industry" in Frontier Issues in Economic Thought, Volume 4: The Changing Nature of Work. Island Press: Washington DC, 1998. pp. 129-132

Social Science Library: Frontier Thinking in Sustainable Development and Human Well-being

"Summary of article by John Paul MacDuffie and John F. Krafcik: Integrating Techology and Human Resources for High-Performance Manufacturing: Evidence from the International Auto Industry"

Since the mid-1980s, the International Motor Vehicle Program (IMVP) based at the Massachusetts Institute of Technology has been studying auto manufacturers to find and measure indicators of emerging production methods. These researchers developed the concept of *lean production* to characterize a cluster of techniques that originated with Japanese auto makers and that today are being adapted, adopted, and debated around the world.

THE ORGANIZATIONAL LOGIC OF LEAN PRODUCTION

The recent rapid advance of microprocessor-based technologies raised expectations that lower costs and greater quality would follow for firms that adopted them. These expectations have not been realized and many analysts have concluded that to maximize the benefit of new technologies, skills and organizational context must be compatible and capable of evolving in concert. Lean production, a concept that emerged from a study of seventy auto assembly plants from twenty-four companies in seventeen countries, improves productivity and quality and "takes as a premise the existence of a skilled, motivated, and flexible work force, following a logic quite distinct from traditional mass production."[209]

Lean production integrates a firm's human resource strategy with its technology strategy. It promotes skill, motivation, flexibility, and problem-solving and continuous improvement activity in the work force. This model contrasts with mass production technology which seeks to enhance management control, reduce labor costs, and diminish reliance on the workforce. A key part of the organizational logic of lean production is to minimize use of the buffers commonly found in mass production systems to protect the process as a whole from disruption in one of its segments. Some examples of buffers are utility workers who take the place of absentees, repair stations for managing product defects, and storage of a large numbers of parts in case of delivery delays. Buffers are costly in terms of additional space, personnel, and inventory, and they create slack and mask problems. Lean production relies on an insight first put into practice at Toyota, that disruptions are learning opportunities. "The minimization of buffers, as exemplified by just-in-time inventory policies, therefore serves a cybernetic or feedback function, providing valuable information that can be used for continuous incremental improvement of the production system."[211]

This approach is linked to human resource policies; workers must be able to identify and solve problems on the spot since there are few reserve parts and few places to hide mistakes. Responsibilities like product inspection are carried out by workers who are trained for multiple tasks and willing to rotate jobs and work in teams. Lean production demands mental as well as physical effort, and workers must be well motivated. To encourage commitment, lean production systems include reciprocal policies such as job security, fewer status barriers, performance-based compensation, and company investment in workers' skills. Paradoxically, lean production is both fragile and resilient. Knowledge that a minor problem can spawn a system-wide disruption, creates an incentive to maintain communication and solicit problem solving skills.

Mass production uses division of labor and specialized equipment to produce high volumes of standardized products. Lean production uses multi-purpose or programmable equipment which can easily be switched among several product designs. This provides product variety and speeds up feedback throughout the production process. While there is " a tendency for mass production plants to rely on more specialized equipment and for lean production to use more general purpose equipment," [214] differences between mass and lean production can persist no matter what type of equipment is used. General purpose tools in a mass production environment tend to be used in specialized ways, while specialized tools in a lean production environment are modified to increase their versatility. Problem-solving is applied to analyze hardware idiosyncracies and make incremental improvements, a process known as "giving wisdom to the machine." Workers subject their own detailed job specifications to continual analysis.

RESEARCH QUESTIONS, METHODS AND EVIDENCE

Two hypotheses have been investigated and researched at sixty-two car assembly plants. First, lean production (human resource development linked to minimal use of buffers) contributes significantly to high productivity (measured as hours per car for a standard set of production activities) and high quality (measured as assembly defects per car). Second, advanced technology is more effective when coupled with lean production.

Several indices were constructed to investigate these hypotheses. The Production Organization Index is an average of two measures: the Use of Buffers Index, which includes variables like the percentage of floor space for repair stations or the frequency of parts delivery; and the HRM Policies Index, which includes variables for human resources practices and work organization. High scores on each indicate lean production. Two indices measure technology: the Robotics Index indicates the presence of newer, more flexible technology; the Total Automation Index reflects the percentage of production steps that are automated.

It is commonly believed that high productivity and high quality are incompatible. However, in this sample they are positively correlated, with many plants scoring better than average on both measures and a few considered world class with outstanding scores on both indices. The Production Organization Index and technology indices are significantly correlated with quality and productivity. Buffers and HRM Policies are strongly correlated with each other and contribute almost equally to the organization-productivity relationship. However, HRM Policies are more influential in the organization-quality correlation. Unexpectedly, Buffers were found to be less important to quality than to productivity. This suggests that if buffers are minimized solely to cut costs, human resource policies that support problem-solving should be used to maintain quality.

To examine the second hypothesis, the sample was split at the average value on the Production Organization Index into lean production and mass production subgroups. These were then split by the average value for Total Automation giving four quadrants whose average productivity (hours per car) and quality (defects per car) can be compared:

	High Tech		Low Tech	
	Mass	Lean	Mass	Lean
Hours	30	22	41	35
Defects	79	49	104	73

As can be seen, the best performing plants on this scale combine advanced technology with lean production.

When plants were arrayed along productivity and quality axes four analytical categories emerged: low productivity-low quality, high productivity-low quality, high productivity-high quality, and world class. Average values for the indices used in this study were calcualted for each category. This comparison also indicates that technology has the most beneficial impact on performance when combined with lean production.

CONCLUSION

High performance and even world class plants are found both in and out of Japan, so it is apparent that the lean production method is not restricted by cultural factors. However, in order to move successfully from a mass to a lean production strategy, everyone involved must understand the differences in philosophy between the two work systems. The best education for managers and union officials occurs when they have exposure to lean production through joint ventures or geographical proximity. For production workers, hands-on experience with elements like statistical process control or the job specification process seems to work best.

Two kinds of crises can test the fragility of lean production. When problems in production occur, it will be tempting to restore buffers, but a commitment to problem-solving will strengthen the firm and reduce vulnerability in the long-run. In times of economic downturn, the high-commitment employment relationship can only survive if management makes a good faith effort to protect the jobs of employees.