Industry and Innovation, Volume 11, Numbers 1/2, 89–107, March/June 2004

Carfax Publishing
Taylor & Francis Group

DEVELOPING SUPPLIER CAPABILITIES: MARKET AND NON-MARKET APPROACHES

SUSAN HELPER AND JANET KIEHL

In recent years, there has been a great deal of attention directed towards the changing structure of supply chains in US manufacturing.[1] For a variety of reasons, many researchers argue that original equipment manufacturers (OEMs) now desire a greater amount of skill from their suppliers than in the past.[2]

From the 1950s through to the mid-1980s, OEMs (especially automakers) primarily wanted simple parts from their suppliers, built to customer-designed prints and delivered infrequently (e.g. once a month). Suppliers were often asked to deliver 10 percent extra to make up for defective parts. But beginning in the late 1980s, standards began to rise. Suppliers were asked to design their own parts, to deliver "just-in-time" (sometimes as often as three times per day within windows as small as 15 minutes), and to deliver nearly defect-free parts (defects of just a few parts per million) (Cusumano and Takeishi 1991; Helper 1991). These new standards were not accompanied by price increases; particularly in the last 5 years, many contracts have required that prices fall 2–5 percent per year.[3]

Meeting these new demands has been a challenge for suppliers. In this paper, we report on interviews we conducted with firms in the northeast Ohio (Cleveland) area. We will look at how these firms have responded to the challenges of meeting their customers' demands for dramatic improvements in quality, cost, and delivery.

Suppliers have attempted to meet these challenges in a variety of ways. Some firms have improved their standing with customers by developing their capabilities, leading to improvements in efficiency (doing more with fewer resources). For example, methods for improving quality such as total quality management, statistical process control, and six sigma aim to remove the root causes of defects. Methods such as

1 We are grateful to participants of the Supply Chain Governance & Regional Development in the Global Economy Conference at the University of Wisconsin (September 2002), especially Jonathan Zeitlin and Gary Herrigel, for comments. The Sloan Foundation provided generous financial support.

2 These reasons include:

- More volatile and fragmented demand, leading OEMs to want to share the risk of investment with suppliers who can hedge by supplying multiple firms and/or industries (Sabel and Piore 1984; Whitford and Zeitlin 2004).
- Increases in global competition in component markets and in final product markets, both of which increase the profitability to OEMs of having skilled suppliers (Helper and Levine 1992).
- Exogenous technical change has speeded up product life cycles, requiring OEMs to focus on core competences and outsource other tasks to skilled suppliers (Fine 1998).
- Diffusion of innovation from Japan (Womack *et al.* 1990; Dyer 2000).

3 The level of the producer price index for automobile parts was the same in 2002 as it was in 1991, despite an overall rise in the producer price index of 18 percent (see www.bls.gov/ppi/home.htm).

1366-2716 print/1469-8390 online/04/01/20089-19
DOI: 10.1080/1366271042000200466

reducing set-up times and adopting manufacturing cells allow firms to improve their delivery responsiveness by reducing the cost of producing in small batches. Together, these techniques often lead to significant reductions in scrap and inventory costs.

In an optimistic scenario, firms combine several of these techniques to produce "pragmatic collaboration" with their customers (Helper *et al.* 2000). In this type of relationship, buyers and suppliers employ techniques for continuous improvement to generate data that both advances their knowledge and combats opportunism. Thus, firms collaborate to produce a virtuous cycle in which performance gains are: (a) ongoing (as opposed to one-time) and (b) efficiency-enhancing (as opposed to cost-shifting).[4] As Whitford and Zeitlin (this issue) emphasize (and parts of Helper *et al.* also point out), such collaborations can be both difficult to start and fragile to maintain.

Instead, many suppliers respond to customer demands not by upgrading capabilities as discussed above, but rather by shifting costs to other parties (such as workers, suppliers, or the environment). For example, these firms may meet increased demands for quality by increasing inspection, rather than looking for root causes. They may deliver more frequently simply by scheduling trucks to arrive more frequently, shifting inventory costs from their customers to themselves and their suppliers. And they may reduce costs by reducing wages, or increasing the pace of work, rather than reorganizing it.

Firms may adopt a mix of capability-developing and cost-shifting approaches—or they may not adopt any kind of systematic approach, and simply watch as their sales dwindle. And even if firms do improve their capabilities, some stakeholders may suffer (as in the case of workers displaced by automation). Many of the capability-developing approaches are at least loosely inspired by Japanese practice. However, both the content of the approaches and the mechanisms of their diffusion are different in Cleveland than in Japan.

In our interviews, we found a surprising pattern. The levels of performance demanded by US OEMs are similar to those demanded by Japanese automakers since the 1970s. However, the methods by which suppliers are trained to meet these standards are very different. In Japan, none of the methods used to teach improved capabilities (such as total quality management, just-in-time, quick die change) could be thought of as market-based; in most cases no fee of any kind was paid. In contrast, the diffusion of techniques to meet the new demands in Ohio was brought about in many cases by market means: firms hired consultants, recruited employees from other firms, and bought books and training programs from other firms who were trying to make a profit directly by providing this service.[5]

In this paper, we describe this "market for supplier development", and discuss its advantages and disadvantages. In the next section, we describe our methods and define our terms: "component manufacturing", "supplier development", and "market" and "non-market" methods for improving supplier capabilities. The third section

4 That is, firms are able to perform the same tasks with fewer resources as measured in physical terms (in contrast to simply shifting costs to others).

5 As we will discuss, the difference in diffusion mechanisms is only partly due to differences in national systems of innovation. Whitford and Zeitlin (this issue) describe a US government-funded training consortium that has successfully diffused many aspects of lean production.

presents our overall findings, and the fourth section looks at one case in more depth. The fifth section concludes.

In this paper we focus on the development of what we call “systematic production capabilities”—skills to achieve repeatable, good performance on outcomes that are heavily influenced by plants: quality, delivery, and production cost. We will not discuss suppliers’ efforts to improve their product development capabilities. Similarly, we will not discuss firms’ product strategy (see Herrigel this issue, for a discussion of these themes).

DEFINITIONS AND METHODS

By “component manufacturer”, we mean firms that produce parts for sale to other firms, rather than to final consumers. These firms are the base on which much of manufacturing rests; they make parts that go into automobiles, airplanes, agricultural equipment, etc. Firms in this sector fabricate and/or assemble molded, forged, formed, and machined goods made of metal and plastic. In 1997, the sector claimed close to 2 million employees, or more than 10 percent of US manufacturing employment.

In contrast to the OEMs they serve, most of these firms have fewer than 500 employees. In part because of their small size, they are often deeply anchored in their regions, and dependent on surrounding regional institutions for obtaining new knowledge. The sector faces stagnant demand and fierce competition (both domestically and internationally); employment declined by 20 percent between 1997 and 2002.

We believe our sample can be considered somewhat representative of northeast Ohio component manufacturers.[6] We interviewed eight of the nine component manufacturers with annual sales greater than $1 billion and headquarters in northeast Ohio, and visited 11 of their plants. We also contacted smaller firms (50–250 employees) randomly drawn from a list of area component manufacturers. More than one-third agreed to be interviewed. One of us (Helper) had visited eight of these firms in the course of a study performed in 1995. Finally, we added three firms that we happened to come into contact with during the course of our study. These firms were not different from the others in terms of their response strategies.

In all, we gathered data from 27 plants located within a 2-hour drive of Cleveland.[7] These plants were part of firms that ranged in sales from $3 million to $6 billion. Our interviews lasted from 2 to 4 hours. We usually spoke with the top operating executive (and often others as well), and toured the plants. In addition we gathered secondary sources prior to our visit. Finally, we conducted an in-depth case study at one multinational firm; one of us (Kiehl) conducted 39 interviews and a focus group with personnel ranging from operators to the Chief Operating Officer (CEO).

We asked about three types of systematic efforts to improve production capability:

- Systematic efforts to reduce inventory through such efforts as reducing set-up times, rationalizing the flow of product within the plant, or shrinking the size of inventory buffers between workstations.

6 Similar analyses of other regions in the US Midwest were undertaken by other members of the Advanced Manufacturing Project: Jonathan Zeitlin, Gary Herrigel, Joel Rogers, and Dan Luria.

7 We also have had numerous discussions with the president and employees of CAMP (Cleveland Advanced Manufacturing Program) since 1990, and four employees of three consulting firms.

- Systematic efforts to reduce scrap and re-work (for example, tracking quality data statistically, determining the root cause of quality problems, and instituting measures to insure that they do not recur).
- Systematic efforts to achieve not just a one-time performance boost, but to continuously improve delivery, quality, and cost performance. These "kaizen" efforts can take the form of learning from operators, through such means as quality circles or on-line teams, and/or a suggestion program that was taken seriously, or they may be more directed at engineers and technicians, as in the "six sigma" process.

We also looked for evidence that firms were shifting costs to others, either in the course of adopting the practices mentioned above, or independently. Management is often reluctant to talk about these efforts, so our evidence here is less complete. We asked about changes in wages, and job duties, and observed the pace of work. We asked about relations with suppliers and who held inventory (but did not obtain independent evidence from suppliers).

The capabilities mentioned above (systematic efforts to reduce inventory, improve quality, and to continuously improve performance) are often associated with the "lean production" techniques pioneered by Toyota and described by Womack *et al*. (1990). In this view, the three capabilities are complementary. However, firms can and do adopt the practices singly, and there are ways of improving quality, cost, and delivery without using Toyota-inspired techniques.[8] Since Womack *et al*. (1990) was influential both in the USA and among firms in our region, below we briefly describe the logic of lean production and some critiques of it.[9]

In the view of lean production developed by Taichi Ohno at Toyota and popularized by James Womack, working to achieve "one piece flow" (instead of producing in large batches) is the key to manufacturing success. Steadily reducing inventory will force suppliers and workers to continuously improve their quality. Reducing inventory will increase quality for several reasons: (1) shortening the time between when a component is produced and when it is used in production will facilitate finding the root cause of the problem, because memories will be fresher if the defective part was made an hour ago than if it was made a month ago; (2) workers will feel more pressure to make each part good if they know there is not a huge buffer between them and the next work station; and (3) if production occurs more quickly, then defective parts will be identified quickly, before a large supply of them is created.

A somewhat different view underlies the production methods practiced by Honda and discussed by Mair (1994) and by Kenney and Florida (1993). Here, continuous improvement is the critical capability (see also MacDuffie and Helper 1999). A key task of managers is selecting and motivating workers and suppliers to contribute their

8 For example, the "six sigma" technique for reducing variability in production was developed at Motorola. Thanks to Gary Herrigel and Jonathan Zeitlin for pointing this out. The term "systematic capabilities" comes from Luria and Wiarda (1996).

9 Womack personally consulted for 2 of the 18 plants we interviewed that attempted to develop systematic production capabilities. He advised (and provided materials to) CAMP and at least one of the consulting firms used by four other plants, and people at three other plants mentioned (without prompting) that they had been enormously influenced by his books.

ideas. Some of these ideas will concern inventory reduction, but more importantly, others will lead to improved product features, lower defect rates, etc. (At Honda, achieving one-piece flow is not of particular importance; Honda's US assembly plants aim to produce in batches of 60 identical cars.) In this view, reducing inventory does not automatically produce continuous improvement; if workers and suppliers are not correctly motivated and trained, it will simply produce a production line that is stopped for a long time.

In the views of both Womack *et al.* (1990) and Kenney and Florida (1993), lean production is entirely efficiency-enhancing, and is incompatible with efforts to shift costs to workers and suppliers. Because inventory is so low and the plant is so dependent on the ideas of these partners, the system will simply grind to a halt without their active cooperation. The "management by stress" view argues against this rosy picture (Parker and Slaughter 1988). In this view, the gains cited above come at the expense of workers. Costs fall not because of suggestions that lead to "working smarter", but because workers are placed in a position where they must push each other to work faster to compensate for the lack of buffers between stations.

Boyer and Freyssenet (2002) argue that lean production (what they call the "Toyotian model") is only one of several sustainable strategies in the automotive industry. Each strategy has in the past demanded different attributes of suppliers. For example, the Toyotian model required suppliers to excel at incremental reduction of costs at the same volume, but did not require significant innovations or risk-taking. The "Hondian model" involved building innovative car models to capture niche demand, and the flexibility to exit quickly if the model did not gain market acceptance. Suppliers in this model needed to be flexible in the sense that they could shift quickly from making parts for one type of car to another, and needed to be willing to accept risk. In the "Sloanian model", the automaker produced a variety of cars "for every purse and purpose", but these cars did not change rapidly over time. Suppliers in this model needed to be able to produce variety. However, systematic efforts to reduce inventory, improve quality, and to continuously improve benefit suppliers in each strategy.

Williams *et al.* (1992) argue that the success of Toyota is based on good designs and high capacity utilization as well as on minimal inventory, which they argue undermines the conclusions of Womack *et al.* (1990) that lean production performs significantly better than mass production. However, MacDuffie (1995) controls for these factors, and finds a significant (though smaller than Womack *et al.*) effect of lean production methods on quality and productivity.

Thus lean production has a complicated relation to the ideal of pragmatic collaboration between suppliers and their customers. To the extent that lean production teaches skills at identifying and solving problems, it is a prerequisite for advancing knowledge and curbing opportunism. But to the extent that lean production means merely increasing worker effort, it helps managers and powerful OEMs extract rents from workers and suppliers. Below, we will argue that the implementation mechanism has an important effect on which outcomes predominate.

Non-market and market methods of supplier development

In Japan, the key concepts behind supplier development (or the Toyota Production System) were developed at Toyota beginning in 1938 and continuing into the 1950s and 1960s. In the 1970s, other Japanese automakers adopted the system and made their own modifications (Cusumano 1985; Smitka 1991; Nishiguchi 1994).

For example, Honda developed a program called BP, in which employees from several Honda departments formed a team with supplier employees to work for several weeks at the supplier's facility. The BP team focused on improvements at a few specific work areas, and initially avoided projects that would require extensive capital investment or extra personnel. Instead, BP tried to cover all aspects of a narrowly defined project—technology, work organization, problems with second-tier suppliers, or workforce issues (e.g. motivation, training, compensation, and employment security). The narrow scope allowed quick results, which provided motivation for BP participants, and data to convince skeptical managers to continue backing the effort. BP's deep analysis (only feasible for a narrowly defined project) helped teach systemic thinking, which could then be applied to other areas within the supplier's plant. For the lines on which the BP team focused, performance improvements were large: Honda reported productivity increases averaging 50 percent at the 53 Honda suppliers that had participated in BP as of 1994 (MacDuffie and Helper 1999).

In the BP program, the knowledge conveyed remained largely tacit. It was transferred via one-on-one, hands-on tutoring by a sensei, or wise teacher. This teacher was not unlike a guru, sometimes speaking in riddles, and teaching by example. "I learned to use all 5 senses", said Rick Mayo, the head of BP at Honda of America in the 1990s, describing his experience with his sensei. "He showed me how to use my eyes, ears, even my sense of smell and taste, to see if a factory was running well." Honda spent a lot of time trying to transfer this intuition to suppliers. "We do the first 80%, and leave the rest for the supplier to figure out", in hopes that the supplier would be able to learn how to improve its own lines.[10]

Customers were not the only group that played important roles in diffusing improved capabilities to suppliers in Japan. Teams of government experts worked with Nissan managers to upgrade suppliers in the 1950s (Wada 1991). Quality-control experts learned a great deal through programs sponsored by their association (Cole 1985). And unions at Toyota played a key role in explaining the Toyota Production System to their counterparts at suppliers (Sako 2002). None of these methods involved a market, that is, the firms receiving the assistance rarely paid for it directly. The organizations providing the assistance did not aim to make a profit from providing it. No prices were set, and no complicated incentive contracts were designed.

Sako (1999: 115) argues that the non-market nature of the diffusion process was key to its success, since the Toyota Production System was "a distinct and hard-to-imitate asset . . . which is inherently difficult to diffuse through market mechanisms . . . due to the tacit nature of the knowledge involved". For example, Toyota both provides individual assistance to key suppliers, and also involves them in study groups called "Jishuken", where suppliers learn from each other. Sako quotes a Toyota manager who explained why Toyota has both programs:

> Individual assistance is good when we are looking for quick results. When a supplier's profits have plummeted suddenly, or when a supplier is not keeping up with the launch

10 Interview with Helper (1997).

> of a new model, we send in our trained experts and tell everyone to watch quietly ... Suppliers feel that they have improved by doing what they are told, but do not understand why, and things come to a halt when the experts go home. By contrast, Jishuken is good for developing and training people ... It would most certainly be quicker for an expert to take a lead and provide answers, but this would not result in developing the skills of those who are led. (p. 120)

In contrast, as we will see, non-market methods played a much less significant role in diffusing lean production in northeast Ohio. Instead, more “market” methods were used: firms bought books about lean production, hired consultants, and hired employees skilled in lean production away from other firms. Below, we describe the results of our interviews.

SUPPLIER UPGRADING IN NORTHEAST OHIO

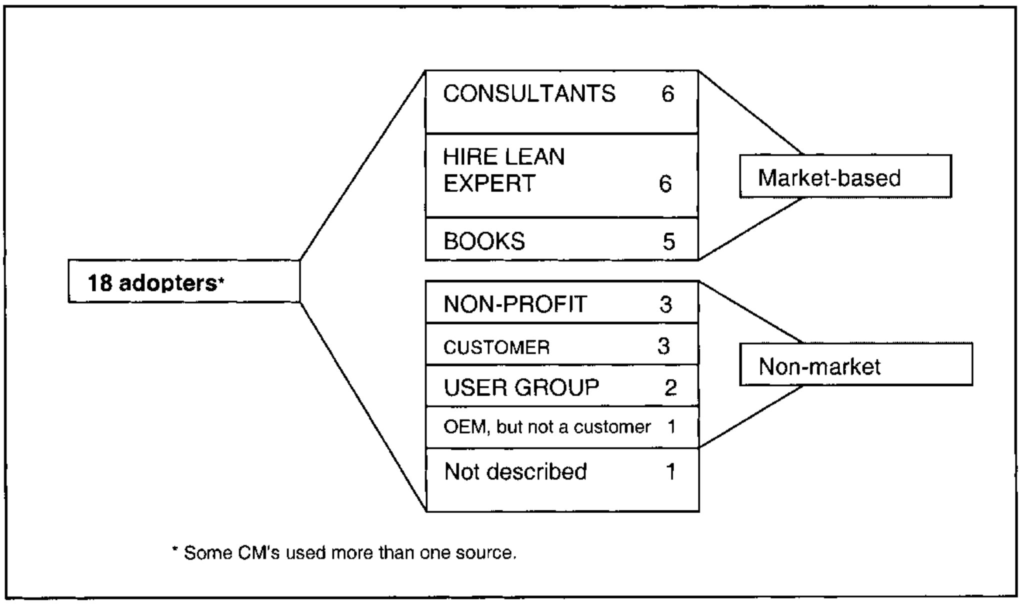
Of the 27 plants we interviewed in 2001, 18 had undertaken to improve their capabilities in one of the three ways mentioned above.[11] Six of the 18, all of which were owned by billion-dollar corporations, started their efforts in 1998 or later; before that they had been traditional mass-production plants, where improvements were of course made, but not by using a systematic discipline to try to reduce inventory or achieve across-the-board reductions in defect rates. Eight other plants made no efforts to upgrade their production capabilities, 11 years after the publication of *The Machine that Changed the World* in 1990, the book that popularized the Toyota Production System in the USA.

Two of the eight plants with no upgrading activity belonged to large multinationals. In both cases, the plants had been shrinking for a decade (the work was being gradually moved to Mexico or China). Efforts to introduce lean methods such as quality circles and teamwork were stymied by union–management conflicts. Many union workers saw no benefit in participating in employee involvement programs, which they did not see as stanching the loss of jobs. (We heard several examples of ideas from Ohio workers being used to facilitate the movement of work to low-wage countries. In addition, both unions felt that management had violated agreements in which unions had made concessions on jobs and work rules in exchange for saving jobs.) Thus, the reason for not upgrading production capabilities in these plants was not that corporate management was unaware of the concepts; in fact, both of the firms had other plants with exemplary lean operations. Rather, lack of investment in lean production was consistent with other decisions to disinvest in the plant.

The other six non-adopters were single-plant firms with 50–150 employees. These were plants where the owner wore many hats, ranging from marketing manager to design engineer to human resource specialist. These plants were full of inventory; we saw boxes dated several weeks prior to our visit, and piled in no particular order. Quality was achieved largely through inspection. In contrast to lean quality practice, the causes of defects were not tracked; there was no systematic effort to figure out the most common causes of defects and eliminate them. We saw few computers in

11 All but one of the 18 had systematic efforts to reduce inventory. Fourteen had programs in place to systematically search for continuous improvement; however, only nine of these programs emphasized understanding the root causes of poor quality; the others were focused on reducing inventory.

FIGURE 1: PRIMARY SOURCES OF ASSISTANCE FOR UPGRADING OF PRODUCTION CAPABILITIES.



these operations. One firm did make extensive use of computer-aided design, but in another, we watched as the president faxed hand-drawn design changes back and forth with his customer.

As Figure 1 shows, the firms that did attempt to upgrade their production capabilities received assistance in a variety of ways. We asked firms both what forms of assistance they had used in the past, and what forms they are using now. Of the 18 adopters, 17 told us their sources of learning. Over half of the sources mentioned were market sources—they were paid for directly, out-of-pocket, by the firm.

The first stage of lean diffusion started with the only repository of such knowledge, the Japanese OEMs. Honda and Toyota in particular set up extensive programs for technical assistance for their US suppliers in the early 1990s (MacDuffie and Helper 1999). However, only one of our northeast Ohio firms received assistance from a Japanese customer (Honda, in the early 1990s);[12] another firm had received assistance from Motorola (mid-1990s), and a third, from General Electric (starting in the late 1990s). This last-mentioned firm was the only one still receiving assistance from a customer.[13] The small presence of Japanese manufacturers in the region may explain why very few northeast Ohio firms adopted systematic improvement programs before the late 1990s.

The next stage of diffusion came after codification of the mechanics of the lean process, which was disseminated through books like *The Machine that Changed the World* and articles in both the academic and popular press. This allowed others to

12 Another plant managed to convince the Toyota Supplier Support Center to provide lean training in the mid-1990s, even though neither the plant nor its parent firm has ever had any Toyota business.

13 This firm has sales of almost $1 billion, and recently (spring 2002) started its own supplier development program—the only such program among Ohio-headquartered firms.

get involved in training and knowledge transfer. This resulted in the development of the second common source of lean implementers, government-subsidized (federal, state, and local), non-profit intermediaries (NFP). In Cleveland, CAMP (the Cleveland Advanced Manufacturing Program) was set up in 1984.

CAMP initially focused on helping manufacturers by making their mass production systems run better (for example, by improving factory layout). However, in the mid-1990s, CAMP began to offer lean programs as well. CAMP brought in Womack to give several talks. Also, CAMP and Honda negotiated for over a year (starting in 1996) to have Honda teach CAMP its BP supplier development methodology, and then have CAMP take over doing BP with both Honda suppliers and other firms. But ultimately, this deal did not work out.

According to Stephen J. Gage, CAMP's president, in the mid-1990s, CAMP's government funding (from both state and federal sources) began to fall. At the same time, CAMP decided to move away from its previous focus on small firms, and provide more services to larger firms, firms that had more long-run viability and ability to manage a complex transformation effort such as adopting lean production. In order to market to larger firms, CAMP needed a more skilled group of consultants. To attract these consultants, CAMP had to raise salaries, and thus prices.

The smaller firms we spoke with had trouble paying the higher prices. These firms tended to sign up for one project at a time with CAMP; most could not afford (and CAMP did not market) a package of projects in plant layout, training, accounting, and marketing that would result in lean transformation.

Only 3 of the 27 firms we interviewed had ever worked with CAMP, and only one is currently. We interviewed three of CAMP's industry board members; only one had had his firm engage with CAMP in the previous year. These CEOs viewed the time they spent on CAMP business as a charitable contribution, rather than as a strategic investment in improving their (or their suppliers') operations.

Starting in the late 1990s, the number of people knowledgeable about lean production grew. Some of them found it advantageous to take what they had learned and market it to other firms. So this opened up the third common way for firms to implement lean production. Six of the firms we interviewed hired consultants, who had learned about lean production at other manufacturers.

Six plants hired an individual who had been trained in process improvement by another company. (For example, one firm hired someone who had worked for many years at IBM, had been sent to several months of training with a sensei, and was implementing lean projects at IBM under the supervision of the sensei.)[14]

From the data above we see that both customer-provided and not-for-profit training and technical assistance are declining and were never very prominent in northeast Ohio. Market-based methods have become the main sources being used today.

What difference does it make how a firm learns to be lean? We will return to this question after examining the case of one firm in more detail.

14 In all cases, the training of these people was described as being in "lean production". In all but one case, these experts worked for corporate headquarters, and were dispatched along with other staffers to help with implementation at the plant. In all cases but one (that of a German-owned firm), at least one of the corporate staffers who helped with the improvement program had been hired away from another firm because of their experience with lean production.

LEAN IMPLEMENTATION—LARGE FIRM EXAMPLE

Background on OCM

In summer 2002 one of us (Kiehl) conducted a case study at a large firm which we will call Ohio Component Manufacturing (OCM) (Kiehl 2004). Founded in the early 1900s, this company has grown, both organically and through acquisitions, to become a $6 billion supplier to OEMs. They market and produce globally, though three-quarters of their sales are to North American-based firms, in many industries including aerospace, auto/transportation, and machinery. Although many of OCM's businesses are unglamorous (making hoses, for example), the company's ability to continually produce new variants for specialized uses has led to long-term financial success. During the decade ending March 2003, OCM's stock price grew 214 percent while the S&P index increased by only 82 percent.

The company has tried a wide variety of methods for learning lean production, including receiving tutoring from a Japanese company, hiring consultants, and recruiting employees experienced with lean from other companies. The company's long-time president was on the board of CAMP for many years. After several false starts, the company (including the plant studied in detail) has created a fairly successful program. OCM thus represents a best-case scenario for a firm navigating the northeast Ohio institutional environment.

OCM's early lean initiatives

In the late 1980s, the company was one of the first US firms to receive technical assistance from Honda. Many plants, though not the one that we studied, implemented BP with Honda's involvement. Over the course of 13 years, over 100 BP projects were undertaken. (Honda personnel frequently visited several plants in the first 3 years of the program; OCM carried on the program with little Honda involvement after that.) These projects led to double-digit percent reductions in defect rates and inventory levels. However, "we couldn't see these improvements in the bottom line", according to the firm's vice president for manufacturing and technology.

Why was Honda assistance not sufficient? We discussed this issue both with the OCM vice president mentioned above (in 2001), and with Honda personnel who had been involved in providing assistance to OCM (in 1995, as the period of intensive Honda involvement was ending).

The OCM vice president believed that the problem was that the focus of BP was too narrow. Many of the improvements were in areas that were not bottlenecks. For example, shortening the cycle time in the extruding process, which precedes the finishing process, would not improve total throughput or reduce inventory, if finishing could not go any faster. This difficulty in identifying bottlenecks was more severe at OCM than it was at Honda or its Japanese suppliers. These latter firms usually have production lines dedicated to a single product, so one can identify bottlenecks relatively easily. In contrast, OCM's products tend to have hundreds of variants and many customers. Thus products do not flow linearly from one station to the next; products can take very different routes throughout the plant. For example, some products are dyed, others are labeled, and some undergo both processes. In addition, OCM plants often supply each other; because of the decentralized nature of the firm, no one had the power or the incentive to work to reduce buffers between plants. Divisions, of which there are over 100, and individual plants are charged with delivering results through whatever practice they choose. Thus, the BP projects remained “islands of perfection”, surrounded by seas of inventory and defective products.

Another difference between Honda’s experience with suppliers in Japan and in the US is the greater US focus on financial performance, a focus that is particularly important at OCM. This was reflected at OCM in a strong tie between accounting systems and bonus payments. The accounting system treated inventory as an asset, and rewarded managers who achieved high capacity utilization. There was no effort in the accounting system to measure the cost of poor quality. These features made it risky for managers to embrace the lean precepts of producing only to customer order. BP was a manufacturing initiative, and the manufacturing vice president had trouble even getting on the Chief Financial Officer’s calendar to discuss these issues until a new CEO made lean production a corporate priority in spring 2001. (Note that OCM stuck with the BP process for 13 years, so the oft-cited preoccupation of US companies with short-term results did not occur in this case.)

According to Honda, the main problem was that OCM had little ability to transfer learning from one line to another. Our view is that this is perhaps because of the decentralization and entrepreneurialism discussed above. They also felt that OCM had suffered some from being one of the first US companies to receive BP assistance; the Honda personnel (all Americans) criticized themselves for being inexperienced with project selection.

Consultant-led capability development

OCM looked for other methods of improving their operations. During the mid-1990s, James Womack briefly assisted OCM, at the invitation of Honda. Womack’s efforts were focused on identifying key bottlenecks and improving flow through the plant as a whole. As a result of these and other influences, OCM introduced a broad “lean culture” initiative in 1998. One of us (Kiehl) studied the influence of this program at one of the firm’s hose plants in rural Ohio in 2002, which we will call “S” plant. The plant makes hoses, in hundreds of variants, for a variety of industries including trucks, aerospace, and industrial equipment. The facility was built in the 1950s, and was purchased by OCM in 1988. It is a union shop, an affiliate of the United Steel Workers. It employs about 145 hourly workers running two shifts.

Divisional management had seen a successful transformation at a sister plant, so in fall 1999 asked the same consultant to implement a similar program at “S” plant. This consultant had learned lean production techniques during a several month apprenticeship to a Japanese sensei (Shigeo Shingo) at a previous employer (IBM).

The consultant, plus people from division staff, worked at the plant intensively for 6–9 months. There was an initial kick-off meeting attended by everyone in the plant, at which it was made clear that the plant would be closed if the program did not succeed. The consultants then gathered suggestions from those who worked in the area, and then implemented their revised workflow. There was no formal mechanism for employees to vote on the plan, but a number of employees said that on some occasions they "pushed back" against the consultants, saying a proposed flow would not work, and got the consultants to modify the plan somewhat.[15]

The biggest changes were in the finishing area, where the hoses were labeled, cut, boxed, and then sent to shipping. This department was moved much closer to production, so that workers in production could see if there was too much or too little supply of the products they were making. The goal of this increased visibility was to create more motivation to keep both inventory and cycle time low.

In addition to redesigning process flow, the consultants also implemented a kanban system of scheduling production, established work teams that met regularly and had some power to make production decisions, including small purchases, and changed the focus of supervisors to support and teaching rather than ordering and deciding.

The result was a significant reduction in inventory (though the levels were still high by Toyota standards, even given the high variety in production). Between September 1999 and September 2002, throughput time fell from 12.7 to 8.1 days, and the value of work in process inventory fell 70 percent. The reduced inventory freed 70,000 square feet of space, which was filled with new work. Finished goods inventory fell from 2.7 to 2.2 months, despite a downturn in sales.

The program also seemed effective in increasing the level of communication and cooperation between management and workers. All but one of the 12 operators interviewed expressed support for the lean initiative. As one operator described the difference from the old system:

> We couldn't keep doing this [using the new production process] if we weren't a team; we—you can't pull against each other; it has to be management and us people too. I know any day I come in here, if I don't understand an order I have, or I look at my computer screen and I think "oh, I don't think that's right," all I have to do is call the scheduler and he will explain to me why. He takes the time to explain to me why he's doing this—my foreman, my supervisor (which we call them a coach now, because they are a coach) passes through several times a day ... they help me out, they don't just walk through like you're not there. If I have a problem they'll help me solve it.

According to the union local president:

> There may be a few [who feel taken advantage of by the company] but for the most part I think some people are feeling that their job is easier than what it was, because like I said there have been a lot of changes. And people having a lot more access to implementing changes so there have been a lot of ergonomic changes as well. It helps people do their jobs and reduces accidents ... [what] we were paying to worker's comp[ensation] have drastically reduced.

The transition was not without difficulties, however. A few workers quit or were fired, as was the plant manager.[16] And on the flip side, a key S plant supervisor was

15 There was some tension between top management at both OCM and the consultantcy, for whom this pushback was a desirable part of the process, and the consultants doing the implementation, who believed that they knew best.

16 Toward the end of the calendar year 1999, the manager worried that his bonus would not be very high, because in accordance with lean principles, production was not being scheduled without a customer order. In order to make his numbers look better, he ordered machines to be run at full capacity. This action caused an uproar both in the plant and among his superiors; as a result he ended up retiring early. (Interestingly, the formal bonus system at OCM still has not been changed; it still rewards managers for quantity produced, whether the output was needed or not.)

recruited to a higher position at another company, a job offer he believed was due to his experience with the OCM lean implementation. Negotiations over the union contract in September 2001 were not easy, and the contract was at first narrowly defeated by the membership, due in part to management's desire to consolidate job classifications and to reduce the role of seniority in job assignments. (Management eventually compromised on the latter, and the contract passed.)

While "S" plant is not an exemplar of workplace democracy, the new process does not shift a lot of costs to workers, either (in part due to management's perception that the change effort would not succeed without union support). Instead, it seems that the plant has succeeded in getting the workers to exercise "concertive control" (Barker 1993). In this case, the work teams agree on norms which constrain their actions to those that benefit the company in a way that is more effective than the previous system of direct supervision.

The plant continues to hold "kaizen events" regularly, to reduce inventory. In a kaizen event, a cross-functional team assesses a process, brainstorms about how to further improve flow, evaluates the suggestions, chooses several to implement, and then tries out the new process—all in the space of a few days. These events are led by one of a dozen OCM-certified consulting firms; managers rotate the firms regularly to insure a fresh flow of new ideas.

Consultants succeeded in making the plant profitable by focusing on inventory reduction. This focus is not surprising, since the consultants were not paid an hourly rate but instead were compensated based on money saved at S plant primarily through inventory reductions and improved cash flow. The consultants' contract gave them wide latitude in decision making about staffing, training, and redesign.

Removing existing management from direct responsibility for the change process was beneficial in two ways. First, the consultants offered different perspectives that were not tied to the history of the organization. And second, after the consultants left, the local management did not have to carry the burden of having made unpopular decisions (regarding assignments of personnel, or which suggestions were adopted) which are part of a transformative effort.

Despite significant operational gains made under the four years of the lean initiative, OCM has decided to close S plant. There were several reasons for the closure: continued low demand for hoses, increased productivity (due in part to lean initiatives elsewhere), and the purchase of a competitor with a similar product line.

We do not believe that the closing of S plant invalidates our arguments about the benefits of lean production. First, it meant that the plant was kept open for four years (rather than closed in 1999 as some in top management had advocated). Second, OCM management remain strong believers in the benefits of lean, and indeed have stepped up their strategic commitment to do lean in all of OCM's facilities, and across many functions beyond production. For these efforts, many lean experts are being hired and use of external consultants has increased as well.

CONCLUSION

Upgrading systematic production capabilities in the "brownfields" of Midwestern component manufacturers is a complex technical and behavioral task. It typically involves not just streamlining flows of work through the production process, but requires changes in embedded attitudes, incentives, and relationships throughout the plant, its suppliers, and customers.

We have observed that programs for manufacturing improvement at plants located in northeast Ohio are much more likely to be market-based than in other areas. In Japan, assistance is likely to be provided by the firms' customer, by the government, by unions, and/or by professional associations. In the US, some firms benefit from state financing of training (as in Illinois), or participation in state-backed training consortia, as in Wisconsin (Herrigel this issue; Whitford and Zeitlin this issue). These methods have in general not been available to northeast Ohio firms. The state of Ohio has focused its industrial policy expenditures on (1) generalized tax breaks for firms (such as enterprise zones), which are not tied to training and (2) developing science and technology rather than providing manufacturing technical assistance (Honeck 1998). Japanese firms have shied away from choosing northeast Ohio suppliers for a variety of reasons, including perceptions that the area is too heavily unionized and lacks an entrepreneurial culture (MacDuffie and Helper 1999).

Another reason for the lack of customer involvement in supplier development is that most component manufacturers in northeast Ohio supply customers located all over the world; the supply chain is not geographically concentrated. Instead of close vertical relationships, firms are clustered horizontally. For example, Cleveland has four times more specialization in stamping than the US average;[17] these firms supply a variety of industries all over the world. Customers are not particularly loyal to these suppliers, in part because they don't see their purchasing decisions as affecting the health of the region where they live. In contrast, in southern Wisconsin and northern Illinois, agricultural equipment firms and their suppliers are clustered together.

Instead of receiving assistance from customers or non-profits, northeast Ohio firms have turned to a patchwork of services they can buy from profit-seeking providers: consultants, sellers of training courses, and new employees recruited from outside firms. What is the impact of this market-based system for teaching lean production, compared with a system in which training is provided by a key customer or not-for-profit entity?

Fewer firms are likely to undertake a transformation effort

OCM's success is instructive. The firm did ultimately succeed in making impressive performance gains at S plant, but only after more than a decade of experimentation in the firm as a whole. The firm was able to identify a high-quality consultant, and also had people from divisional staff assigned to help with implementation at the plant. The 6 months of intensive effort at this small plant cost the firm about $350,000 (plus another $150,000 provided by the state of Ohio).[18] Few single-plant firms could afford this expenditure; in fact, of the six single-plant firms we visited, none had implemented lean production.

OCM's size and degree of market power enables them to support change with inside and outside experts, and in a general sense, to experiment "safely" with new

17 That is, it has a location quotient of 4.0.

18 From data provided by the plant, it appears that inventory savings in the first year exceeded this total.

strategies and projects (Cyert and March 1992). (Nohria and Gulati 1995) On the other hand, the availability of slack may be a counter-incentive to take action at all, by breeding complacency.[19] However, because of its divisional structure, OCM was able to fund and oversee innovation at plant S (an ability that came from the division level) and at the same time maintain a sense of urgency and commitment (which came from plant-level people who feared that they would lose their jobs).

Firms are likely to start their transformation later

One disadvantage of using a market for lean implementation is that a plant can't start implementation until suppliers of lean services exists, for example, people trained at Honda and Toyota leave, or books such as *The Machine that Changed the World* are written to codify the system. Also, when firms are purchasing services on a market, they are more concerned with opportunism than they are when the services are offered in the context of an ongoing relationship (as in the case of a long-term customer). If the service being provided is new, then it may be hard to anticipate all contingencies and establish a price. The incentive contract between OCM and its consultants is now a common practice in process improvement consulting. It effectively aligns incentives, but will be agreed to by both parties only when they have enough experience with a service to specify clearly both the inputs required and the desired outcomes.

Firms are likely to implement lean production in a way that emphasizes short-term results

Since financing is a constant worry, projects may be done slowly and without a larger vision. For example, firms sign up for only a few courses for a few employees at CAMP; the small firms that are CAMP's target audience do not feel they can afford to pay for more. Not having a customer requiring a focus on improving their lines can be a problem. Without strong external pressure, it is easy, particularly in small firms without organizational slack, to fight fires instead of building capability for the long run. For example, one firm did not always stop the line when a defect was found, because they felt they must have the output. Other firms felt they could not afford to pull workers off the line for training.

The most important impact of this financing constraint is that projects emphasize inventory reduction to obtain cash to finance the program. This emphasis often comes at the cost of less emphasis on employee involvement, and finding root causes of defects, or longer term studies of whether process steps are really necessary. Thus, "management by stress" and other forms of cost-shifting are more likely, and the skills necessary for pragmatic collaboration are not developed.[20]

The above list of disadvantages is consistent with Sako's (2002) argument that it is

19 Expenditures on consultants for lean development will be ongoing; OCM's strategic plan requires plants to bring in outsiders to run monthly kaizen events at each plant. (This expenditure also insures that new ideas will continue to flow in, as well.)

20 Similarly, at OCM's S plant, improving quality and finding root causes was almost never discussed. However, there was little shifting of costs to workers, in part due to management's perception that the union was powerful enough to block the change effort if workers bore too much of the cost of change.

difficult to improve supplier capabilities using a market. She quotes Hajime Ohba, director of the Toyota Supplier Support Center in the USA:

> My experience is that much of America's revitalization has been focused on short-term cost reductions to improve profitability. This has resulted in an emphasis on "quick fix" programs and applying technical tools on the shop floor. While these technical tools are part of TPS [Toyota Production System], taken alone they are isolated islands. (Ohba 1997, cited in Sako 2002)

Yet, the experience of OCM (and the other plants in our sample that adopted lean) is that big improvements can be made with market-based resources. In fact, in OCM's case, the consultants succeeded where Honda (in some senses) failed.

A key advantage of using a market compared with being trained by a customer is *that the plant is less dependent on that customer*. In MacDuffie and Helper's (1999) study of Honda's technical assistance to suppliers, dependence was an important issue in two ways. Weaker suppliers lost business with other companies because Honda required them to focus so intently on improving their Honda lines. And stronger suppliers fought with Honda over which techniques were appropriate for their production process. Dyer (2002) found that the technical assistance provided by automakers turned out to be surprisingly customer-specific. For example, Toyota taught its suppliers to transfer materials within the plant in very small batches and to maintain narrow aisles for better visual control. In contrast, the returnable containers that GM insisted its suppliers use were so heavy that forklifts (which need wide aisles) were required. Access to a market for upgrading services also frees a firm from dependence on a customer who may not be competent to teach these topics.

One argument for why consultants are able to successfully implement lean production is that it is now an old technique, one which has been codified. Meanwhile, (as Sako 2002 documents) firms such as Honda, Toyota, and Nissan are working on developing more advanced capabilities with their suppliers, such as product development, training workers to make better suggestions, etc. But consultant-led improvement does not necessarily condemn firms to being only followers and not innovators; it is possible to create competitive advantage while hiring consultants. These consultants combine generic and/or codified techniques with tacit knowledge specific to the firms that hire them. In fact, consultants have implemented all of the Chandlerian innovations of the 20th century this way, as they helped firms combine proprietary knowledge with multidivisionalization, strategic planning, operations research, and use of computers (McKenna 2001).

The experience of northeast Ohio component manufacturers shows the difficulty of wholesale adaptation of models of process improvement from elsewhere; in particular, the diffuse industrial structure (where firms supply many customers spread across the nation, rather than a few dominant nearby OEMs) and weak government capacity for technical assistance make many aspects of the Japanese model hard to apply. These characteristics also make it necessary to modify models developed even in other Midwest states, such as the Wisconsin training consortium described by Whitford and Zeitlin (this issue). We have some evidence that this adaptation is occurring (firms are developing a model of learning based on hiring consultants and experienced managers from other firms)—but slowly.

Many of the reasons for late or non-adoption of systematic production capabilities are due in part to market failures. These failures include the following:

1. Training externalities. As Becker (1975) pointed out, profit-maximizing firms will provide less than the socially optimal amount of general training, because they fear (often correctly, as we have seen), that they will not get the full benefit of their training expenditure because the trained employees will be hired away by other firms.
2. Liquidity constraints. As we have seen, upgrading activities require fairly large up-front expenditures. Since these expenditures do not result in a tangible asset, banks are usually not willing to lend money to pay for them.
3. The need to understand outcomes enough to set prices. This causes adoption to be delayed not only until benefits have been shown, but until procedures have been codified enough so that both buyers and sellers can be confident of a positive outcome.

These reasons suggest a strong case for government intervention in providing upgraded capabilities. Ohio does provide both some direct services (CAMP) and some subsidies for training, which funded a significant part of OCM's (and other firms') upgrading efforts. However, as Honeck (1998) points out, Ohio has lacked an effective "regional productivity coalition" that can lobby for broad-based industrial upgrading. This is a serious problem for Ohio manufacturing. Ohio needs to figure out a system that is viable given its own industrial structure, one which builds on the positive attributes of the existing system (such as the non-customer-specific training and the focus on results provided by the need to pay consultants). A useful first step would be to restore CAMP's ability to provide subsidized training, allowing the program to reach out with an integrated program to small firms that lack the capability to plan a coherent change effort.[21]

However, government intervention is not the only response to market failures. The benefits of supplier upgrading are felt most strongly by manufacturers. Associations of these firms could capture the general interest that manufacturers share in an improved supply chain, and could internalize the training externality. Firms could maximize their collective self-interest by changing existing institutions (for example, by requiring measurable progress at suppliers in order for an OEM to renew its ISO quality certification). However, it may also be necessary for firms that want to compete on efficiency rather than cost-shifting to start a new organization[22] (or transform an organization such as the Association for Manufacturing Excellence). This organization might both provide its own supply chain upgrading services, and lobby against measures that are essentially subsidies for cost-shifting manufacturers, such as low minimum wage, laws weakening workers' compensation in the case of injuries.

21 It would be important to insure that firms that received such aid were otherwise viable, to avoid undercutting firms that are profitable on their own.

22 This idea has been suggested by Daniel Luria and Joel Rogers (personal communication).

REFERENCES

Barker, J.R. 1993: Tightening the iron cage: concertive control in self-managing teams, *Administrative Science Quarterly*, 38: 408–437.

Becker, G.S. 1975: *Human Capital*. New York: National Bureau of Economic Research.

Boyer, R. and Freyssenet, M. 2002: *The Productive Models*. Basingstoke: Palgrave.

Cole, R.E. 1985: The macro-politics of organizational change: small-group activities, *Administrative Science Quarterly*, 30: 560–586.

Cusumano, M. 1985: *The Japanese Automobile Industry*. Cambridge, MA: Harvard University Press.

Cusumano, M. and Takeishi, A. 1991: Supplier relations and supplier management: a survey of Japanese, Japanese-transplant, and U.S. auto plants, *Strategic Management Journal*, 12: 563–588.

Cyert, R.M. and March, J.G. 1992: *A Behavioral Theory of the Firm*, 2nd edition. Malden, MA: Blackwell Publishers.

Dyer, J. 2002: *Collaborative Advantage: Winning Through Extended Enterprise Supplier Networks*. Oxford: Oxford University Press.

Fine, C. 1998: *Clockspeed*. Reading, MA: Perseus Books.

Helper, S. 1991: Strategy and irreversibility in supplier relations: the case of the US automobile industry, *Business History Review*, 65(4): 781–824.

Helper, S. and Levine, D.I. 1992: Long-term supplier relations and product market structure, *Journal of Law, Economics, and Organization*, 8(3): 561–581.

Helper, S., MacDuffie, J.P. and Sabel, C.F. 2000: Pragmatic collaborations: advancing knowledge while controlling opportunism, *Industrial and Corporate Change*, 9(3): 443–483.

Herrigel, G. 2004: Emerging strategies and forms of governance in high-wage component manufacturing regions, *Industry and Innovation* (this issue).

Honeck, J. 1998: Industrial policy for old industrial regions: a comparative study of Ohio and the Basque Country. Unpublished PhD dissertation, University of Wisconsin–Madison.

Kenney, M. and Florida, R. 1993: *Beyond Mass Production*. New York: Oxford University Press.

Kiehl, J.K. 2004: Learning to change: organizational learning and knowledge transfer. Unpublished PhD dissertation, Weatherhead School of Management, Case Western Reserve University.

Luria, D. and Wiarda, E. 1996: Performance benchmarking and measuring program's impacts on customers: lessons from the Michigan Manufacturing Technology Center, *Research Policy*, 25(2): 233–246.

MacDuffie, J.P. 1995: Human resource bundles and manufacturing performance, *Industrial and Labor Relations Review*, 48: 197–221.

MacDuffie, J.P. and Helper, S. 1999: Creating lean suppliers: diffusing lean production through the supply chain, in J.K. Liker, W.M. Fruin and P.S. Adler (eds), *Remade in America: Transplanting and Transforming Japanese Management Systems*. Oxford: Oxford University Press.

Mair, A. 1994: *Honda's Global Local Corporation: Japanization the Honda Way*. New York: St Martin's Press.

McKenna, C. 2001: The world's newest profession: management consulting in the twentieth century, *Enterprise and Society*, 2(4): 673–679.

Nishiguchi, T. 1994: *Strategic Industrial Sourcing: The Japanese Advantage*. New York: Oxford University Press.

Nohria, N. and Gulati, R. 1995: What is the optimum amount of organizational slack? A study of the relationship between slack and innovation in multinational firms, *Academy of Management Journal*, Best Papers: 32–36.

Ohba, H. 1997: TSSC's activities, *IIES Seminar Series 9706*, 58–60.

Parker, M. and Slaughter, J. 1988: *Choosing Sides: Unions and the Team Concept*. Detroit: Labor Education and Research Project.

Sabel, C. and Piore, M. 1984: *The Second Industrial Divide*. New York: Basic Books.

Sako, M. 1999: From individual skills to organizational capability in Japan, *Oxford Review of Economic Policy*, 15(1): 114–126.

Sako, M. 2002: Supplier development at Honda, Nissan, and Toyota, Said Business School, Oxford University, working paper. Available at: http://www.sbs.ox.ac.uk/downloads/Sako4.pdf.

Smitka, M. 1991: *Competitive Ties: Subcontracting in the Japanese Automobile Industry.* New York: Columbia University Press.

Wada, K. 1991: The development of tiered inter-firm relationships in the automobile industry: a case study of the Toyota Motor Company, *Japanese Yearbook on Business History*, 8.

Whitford, J. and Zeitlin, J. 2004: Governing decentralized production: institutions, public policy, and the prospects for inter-firm collaboration in US manufacturing, *Industry and Innovation* (this issue).

Williams, K., Cutler, T., Haslam, C., Williams, J., Adcroft, A. and Johal, S. 1992: Against lean production, *Economy and Society*, 21(3): 321–354.

Womack, J.P., Jones, D.T. and Roos, D. 1990: *The Machine that Changed the World*. New York: Macmillan.