
Creating Lean Suppliers:

DIFFUSING LEAN PRODUCTION THROUGH THE SUPPLY CHAIN

John Paul MacDuffie
Susan Helper

The existence of supplier-customer relationships, particularly among Japanese companies, that fit neither "market" nor "hierarchy" categories has drawn sustained attention in recent years.¹ Such arrangements are integral to the structure of Japanese business networks and they have also been a companion to Japanese direct investment in overseas manufacturing facilities.² In the auto industry, Japanese companies initially used parts from Japan in the new assembly plants built in North America in the 1980s. But since then, they have steadily increased the percentage of parts purchased from U.S.-located suppliers of both U.S. and Japanese ownership.³ In the process, some of these Japanese companies have taken the unusual step of working extensively with their suppliers to teach them "lean production"—often by sending their own employees into supplier plants for weeks or months to redesign work stations, reorganize process flow, modify equipment, and establish problem-solving groups.

This level of involvement with the internal operations of externally owned firms is unprecedented and raises the question: "Why create lean suppliers?" One answer is that Japanese companies have not been able to continue

We are grateful to Honda of American Manufacturing and the Honda suppliers who generously provided time and access to their operations for this project. Thanks also to Paul Adler, Robert Cole, Mark Fruin, Martin Kenney, Ann Marie Knott, David Levine, Charles Sabel, and participants in Wharton's Organizational Learning Seminar for comments on an earlier draft. Funding for this research was provided by the International Motor Vehicle Program at M.I.T., the Jones Center for Management Policy, Strategy, and Organization at Wharton, and the Center for Regional Economic Issues at Case Western Reserve University.

This article is drawn from a chapter in *Remade in America: Transplanting and Transforming Japanese Production Systems*, edited by Jeffrey Liker, Mark Fruin, and Paul Adler and forthcoming from Oxford University Press.

TABLE 1. Characteristics of Supplier Companies

Company	Capitol	Progressive	Tower
Product	Plastic moldings	Stampings	Stampings
Ownership	U.S.	U.S.	U.S.
Plant Location	Ohio	Ohio	Indiana
1992 Annual Sales (In millions)	\$30	\$13	\$84
1995 Annual Sales (In millions)	\$28	\$29	\$222
Total U.S. employees (1992)	300	95	525
Employees at plant (1992)	300	95	145
Year plant opened	1960	1954	1985
Year began sales to Honda	1979	1989	1982
% of total U.S. sales to Honda (1992)	60%	25%	30%
% of total U.S. sales to Honda (1995)	70%	65%	36%
# of significant non-Honda customers (>5% sales) for same product line (1992)	2	6	1
# of significant non-Honda customers (>5% sales) for same product line (1995)	2	5	1

supplying their U.S. assembly plants from Japan-based suppliers because of political pressure to source parts locally (due to Japan's persistent trade surplus with the U.S.) and the strong economic incentive to move production overseas provided by the strength of the yen. Yet this is not sufficient to explain the intensity of the supplier support activities undertaken most extensively by Honda, Toyota, and Nissan.⁴

In this article, we examine Honda's supplier support efforts in particular, drawing upon extensive field work at six Honda suppliers.⁵ Case studies of three of these suppliers are featured here; Table 1 identifies their key characteristics. We spent a total of eight days at Honda, and from one to two days at each of the supplier sites.⁶ We asked respondents (who included purchasing and supplier support staff at Honda as well as managers, shop-floor workers, supervisors, union officials, production engineers, and corporate staff at the suppliers) to tell us about key events in the business relationship with Honda and also about "problems, issues, and opportunities for improvement" that emerged over the course of their relationship with Honda.

Why Create Lean Suppliers?

If one thing is clear from half a century of management research (and the experience of countless companies), it is that organizational change is difficult to bring about and even more difficult to sustain.⁷ Given this, it is by no means

obvious that a company should undertake to bring about organizational change at its suppliers.

Lean production in the auto industry, as described by M.I.T.'s International Motor Vehicle Program (with which the authors are both affiliated), involves far-reaching organizational and technological changes. Within a firm's own manufacturing operation, it involves reducing buffers through Just-in-Time inventory systems, producing only what is needed by downstream "customers," whether internal or external; pushing down responsibilities for quality inspection and the specification of work tasks to motivated, multiskilled workers organized into teams; and eliciting a steady stream of ideas for process improvement (*kaizen*) from employees at all levels.⁸ Added to this, customers are likely to demand that suppliers assume substantial responsibility during product development; accommodate customer requests for engineering changes in their product or manufacturing process; be highly reliable with respect to quality and delivery; and have the ability to respond quickly in case of problems. These requirements are difficult for a supplier to meet unless they have adopted lean production practices themselves. Thus, a lean customer is likely to find it more productive to work with lean suppliers.

However, the adoption process can be risky, since it is common for improvements on one dimension (e.g., reducing inventory levels) to have the *initial* impact of reducing performance on another dimension (e.g., delivery reliability or responsiveness to customer schedule changes). Thus, where an automaker possesses an important capability such as lean production that it wants to establish in its supply base, several alternatives might appear more appealing than trying to develop those capabilities among not-lean suppliers.

Do It Yourself

Vertical integration was once the clear preference when manufacturing firms wanted to insure that they controlled the output of upstream processes. Presumably the firm understands its input requirements better than anyone else, already has manufacturing capabilities, can obtain economies of scale not available to a more decentralized supply base, and can insure through administrative fiat that input prices will not be monopolistic. More recently, vertical integration has fallen out of favor, due in part to the advantages of long-term relationships with separate supplier companies demonstrated by Japanese companies.⁹ If parts are single or dual-sourced, suppliers may be able to achieve substantial economies of scale. The customer can help the supplier with technical assistance, while not bearing full investment costs, and can still benefit from any supplier improvements due to the stipulation that productivity gains will be shared. By focusing on a single product line, suppliers can develop innovations that are beyond the customer's ability to achieve. Extensive tacit knowledge can develop in the supplier-customer relationship, facilitating coordination of the respective expertise of the parties, particularly with respect to complex value-added tasks such as product development.

Switch to a Lean Supplier

If a lean customer can arrange to do business with suppliers who are already lean, what are the advantages of helping existing suppliers learn to be lean? The strongest argument against switching suppliers to get new capabilities is that all the benefits associated with long-term supplier relationships might be lost. As Sako has pointed out, trust between supplier and customer is essential to achieve these benefits, so switching suppliers could hurt not only the relationship with the supplier that lost business, but also with other suppliers observing this event.¹⁰ In addition, the best lean suppliers may have prior commitments to other customers, so they may be less responsive to a newcomer. Finally, the customer has fewer sourcing options if it waits for competitive forces to generate a larger pool of lean suppliers than if it acts to improve the capabilities of its existing suppliers.

Steer Your Supplier to a Good Consultant or Partner

The assumption here is that a customer should encourage a supplier to develop lean capabilities on its own, or to seek help from consultants or partners rather than interfering directly with the supplier's internal operations. Yet the knowledge underlying lean production is not necessarily easy to transfer across organizations. It seems to require a primarily "hands-on" approach in which key principles are taught by observing how certain problems are handled in real-life context.¹¹ Thus a lean customer may conclude that, compared with most alternatives, it has superior knowledge about lean production and a greater ability to motivate suppliers to learn.¹²

Summary

The decision to create lean suppliers is driven by multiple concerns. There can be substantial diseconomies of vertical integration outside of the core business. Switching to lean suppliers may entail considerable costs (economic, political, and reputation). Helping suppliers become lean potentially enlarges the pool available for sourcing choices. Finally, customers may be more effective than outside parties in teaching suppliers to be lean.

Honda's Philosophy of Supplier Relations

History

Honda's approach to supplier relations is rooted not only in the common Japanese practice of long-term supplier relationships, but also in its own history in the auto industry. Unlike Toyota and Nissan, who were building cars before World War II and developed strong and loyal supplier groups in the postwar era,¹³ Honda was founded only in 1948 and began as a motorcycle company. When Soichiro Honda decided to begin building cars in the early 1960s, he had to develop a supply base from scratch, drawing on three sources: suppliers of

motorcycle parts, who were already familiar with Honda but had to learn to make automobile parts; other small suppliers in the surrounding area, who needed to be persuaded to invest in new production capabilities for Honda, based on an implicit promise of future business; and larger companies supplying other auto companies.

Each of these sources of suppliers posed different problems for Honda. The motorcycle suppliers who were already in the Honda "family" were easiest to help, since channels for coordination and technical assistance were already established. The small local suppliers were eager to establish an affiliation with Honda but technologically backward and unfamiliar with the high reliability in quality and delivery required by an export-oriented automaker. The larger suppliers were primarily oriented towards their dominant customer, so Honda had to struggle to get them to be responsive. However, because they had more sophisticated technology and superior production expertise, Honda was forced to go to them for certain parts.¹⁴

There are parallels between these early experiences in Japan and Honda's early years of developing a supply base in the United States. Honda's decision to come to the U.S. reflected a long-term strategy of "make our products where we sell our products" and its corollary for purchasing—"buy our parts where we make our products." When Honda started its U.S. manufacturing operations in 1978 (again with motorcycles), it was initially supported by a core of Japanese suppliers already part of the Honda "family," a number of which established satellite plants near its Ohio manufacturing complex. Honda also began trying to identify small local suppliers in Ohio and surrounding states to take on certain parts. Many of these suppliers were eager to work with Honda but needed considerable assistance to meet Honda's cost, quality, and delivery requirements. Finally, Honda approached some of the larger auto suppliers whose primary customers were the U.S. "Big Three." While these firms had superior capabilities, they were typically not as responsive to Honda's requirements as the smaller suppliers.

Philosophy

This history helps explain key aspects of Honda's philosophy of supplier relations. Honda wants suppliers who can be "self-reliant," with a sufficiently diversified customer base that they will not be at risk if Honda's orders drop due to demand fluctuations. The importance of self-reliance was a lesson learned from painful experience during recessions in Japan, when Honda's commitment to its "child" suppliers (small local companies highly dependent on Honda) became an immense financial strain.

Honda also selects suppliers based on whether their management is willing to be responsive to Honda's needs. These managerial attitudes are more important to Honda than the supplier's technical expertise. Examples of the "right" attitude, from Honda's perspective, include: a willingness to take risks, consistent with the "racing spirit" that Mr. Honda worked hard to maintain in

Honda's culture;¹⁵ investments in new technologies in advance of competitors; investments also in organizational and human resource capabilities (e.g., advanced engineering and production control staff; sophisticated management systems; worker training); and doing all of the above without explicit contractual commitments.

To a self-sufficient supplier willing to offer this kind of responsiveness, Honda offered a great deal in return. A supplier to Honda would have a lifetime relationship—a marriage—in all but the most unusual circumstances. While specific commitments for future business would not be made, suppliers could count on receiving at least as much business as in the past year and possibly much more.

Furthermore, due to Honda's sustained growth, a supplier who was willing to keep up with Honda's strategic direction and production requirements would often be asked to take on new parts they had never made before—and even new production processes. It was clear Honda felt it was easier to teach the technical knowledge associated with a different product or process technology than to find a technically-capable supplier possessing the combination of risk-taking attitude, motivation to improve, responsiveness to future needs, and overall competence that it valued so highly.

Honda's supplier development activities must be understood in the context of this broad vision of mutual responsibility and obligation between supplier and customer. In the words of Rick Mayo, the Honda engineer directing these activities, "We are a philosophy-driven company. We do supplier development as a way to teach our philosophy, to put it into action. It's how we try to help suppliers get past their old way of thinking and understand our way of thinking. It's a mission, not a job."

"BP" at Honda

The core supplier development activity at Honda of America Manufacturing is BP—which stands for Best Practice, Best Process, and Best Performance. Honda of America has a Supplier Development Group that oversees BP and other supplier improvement activities.¹⁶ Once a supplier is chosen for BP, a few staff members from this group along with employees from other Honda departments (e.g., vehicle quality, process engineering) form a BP team with supplier employees to work for several weeks at the supplier's facility. The BP team focuses on improvements in a few specific work areas, and initially avoids projects that would require extensive capital investment or extra personnel. Instead, BP tries to cover all aspects of a narrowly defined project—technology, work organization, problems with second-tier suppliers, or workforce issues such as motivation, training, compensation, and employment security.

The narrow scope allows for quick results and provides motivation for BP participants. BP's deep analysis (only feasible for a narrowly defined project) helps teach systemic thinking, which can then be applied to other areas within

the supplier's plant. For the lines on which the BP team focuses, performance improvements are large: Honda reported productivity increases averaging 50% at the 53 Honda suppliers participating in BP as of 1994, and seven firms interviewed for a report on BP reported productivity gains of 25% and quality gains of 66%.¹⁷

The goals of BP are consistent with Honda's production philosophy for its internal operations:

- Encourage fresh thoughts about production processes.
- Gather better data for more thorough, fact-based problem analysis.
- Seek "common sense," low cost solutions by following the "five whys."
- Know the context by examining the "actual part, actual place, actual situation" (the 3 As).
- Create a smooth flow of production with no waste.

The first BP goal of "encouraging fresh thoughts" acknowledges the need to shake an organization out of its routine ways of looking at its production process or a particular problem. Each BP team contains members from various departments and levels in the supplier's organization to insure varied perspectives. The second goal of gathering extensive data also helps with breaking away from past routines, particularly since Honda has found that many suppliers don't keep records that make it possible to determine if a process change leads to improved performance or not.

The third goal involves "root cause" analysis. Here Honda teaches the process of asking "why" five times, established by Toyota's Taiichi Ohno.¹⁸ To do an effective "root cause" analysis requires considerable contextual knowledge. The fourth goal of BP is to develop that knowledge by going to see the "actual part in the actual place and in the actual situation." Honda's BP representatives try to demonstrate this principle at all times, insisting that BP team members go to the actual spot on the shop floor whenever a problem needs to be explored—not sit in their offices and analyze the problem abstractly.

Finally, the fifth goal of BP is the elimination of "*muda*" or waste wherever possible. Waste is defined as anything that interferes with the smooth flow of production. For example, if tools or components in a given work area don't have a specified storage place, workers may have to hunt for them. Even if this takes only a few seconds, the time wasted can be substantial if multiplied across weeks and months of production activity. The effort to achieve a smooth production flow reveals many upstream and downstream problems, e.g., with other operations in the plant, with suppliers, with the customer order process, or with the distribution system. When each of these is pursued to its "root cause" and remedied, huge amounts of "*muda*" can be eliminated.

Honda required only a few things from the supplier companies participating in BP. A supplier did not have to pay for the time of Honda's BP team members but was responsible for the cost of tools and materials requiring for

improving core production processes. For most BP projects, as noted above, these latter costs were minimal. The supplier also had to agree not to carry out any employee layoffs as a result of BP activities. Finally, Honda required ready access to information about a supplier's cost structure and technology, the ability to move about freely within the supplier's production facility, and the cooperation of management in efforts to involve front-line employees in BP improvement projects.

BP Case Studies

Capitol Plastics

Capitol was one of Honda's earliest U.S.-owned suppliers, going back to the late 1970s.¹⁹ Faced with declining business from the Big Three, Capitol began exploring opportunities to work with Japanese customers. After four years of contacts, Honda made them the second supplier of a small motorcycle fender part in 1978 in order to observe their capabilities. The owner, who was also managing the plant at the time of our 1992 visit, recalled how much information Honda asked for in the early days of their relationship:

Other suppliers thought I was crazy to give them so much. But we found out that the dialogue was genuine. First we got an order, then a purchasing agreement. Then our volume began to expand. All very simple, very little written down."

When Honda began to build cars in 1982, they asked Capitol to take on some important console parts for the Accord. At first, the tooling was supplied from Japan. Honda also arranged for Capitol to establish a "technical collaboration agreement" with their supplier of the same part in Japan. This firm, Morioko, began to send technical personnel to Capitol to help with equipment installation and product launch.

Keeping up with Honda's dramatic growth over the next 5-7 years was like "trying to keep hold of a tiger," according to the owner. "We showed we'd do whatever they wanted." Capitol's overall sales grew from \$7 million in 1979 to \$30 million in 1989. But then, in the industry downturn of the early 90s, Capitol lost a big chunk of business for a Big Three customer due to a design change that eliminated their part. In the resulting crisis, Capitol went to Honda to find out what improvements they would need to make to continue increasing their share of Honda parts. Honda said that Capitol should get involved in BP.

Despite Capitol's willingness to be responsive, Honda was frustrated with Capitol's inability to resolve persistent quality and delivery problems. They sent a team of 4 people from the BP group to "live" at Capitol for 9 months. Two had engineering backgrounds and two were former assembly line workers. This BP team focused first on changes at the management level, recommending changes in reporting relationships and redeployment of certain managers in order to get the more people-oriented managers into shop floor positions. Then

they undertook three BP projects in the plant, each devoted to a single production line and overseen by a task force composed of operators, engineers, and Honda's BP representatives.

The first two projects took 3 months each and the third took 2 months. The emphasis in each project was two-fold: how to evaluate the line and plan improvements, and how to get workers involved in the process. Improvements to the line included the redesign of machine layout to reduce walk time and other unnecessary motion, converting parts racks to a "flow" design (in which gravity pulls a new bin of parts down a slanted shelf with rollers once the old bin is removed), constructing circular fixtures to hold parts (height-adjustable for different workers) that can be loaded on one side, spun around for work to be done, and spun again to be unloaded; improving working conditions (e.g., rubber mats on the floor where people stand, better lighting immediately over the work area), and replacing hand-held tools with fixed-position tools on moveable trollies for better process consistency and less strain on wrists and arms.

During one of the projects, a task force made up of workers from the BP line, organized by Honda's BP staff, uncovered the "root cause" of a mysterious quality problem. On an irregular basis, parts would emerge from the molding machines with "splay" (white spots along the edge of the product) or "short-shots" (a mold not completely filled in). The workers discovered that these conditions resulted from wet, cold particles of plastic resin, which were, in turn, caused by condensation falling into the resin container from an exhaust fan in the roof. Once diagnosed correctly, this was an easy problem to fix. Their success inspired great enthusiasm for BP among the task force members. Honda believed it was crucial to teach supervisors and engineers at their suppliers how to be responsive to operator ideas—a difficult cultural change. As one Capitol employee put it:

Their [Honda's] philosophy is to pull the lower skilled people into the job of redesigning the line. They're willing to lose some on the technical side. They're not just after the best process but getting the people motivated, getting their skills involved."

This employee then expressed reservations about how well this approach was working at Capitol:

"I don't know that Honda's approach is the most cost-effective short-term. At Honda, the processes are already set and pretty good, so when workers make suggestions, the changes are small. Here and at most small American suppliers, the process is *not* well-established. You need to get the process fixed first, and that's a *big* change, which means a lot of fear. 70% of the people would like to participate but 40% are afraid to participate. Sometimes the whole process feels too slow—but I'm not sure management or supervisors could do any better."

The three BP projects brought big improvements in throughput time, inventory levels, scrap, quality defects, cleanliness of the work area, and injuries. For example, the BP project for a part called the Box Instrument Back produced

a 45% increase in productivity and a 67% reduction in the scrap rate. For one BP project, some subcontracted work was brought back to Capitol for more control over quality and to maintain employment levels as the line grew more efficient.

However, after the Honda BP team left, problems crept back in. Delivery problems were particularly severe due to Capitol's lack of expertise in production planning. Capitol also failed to capitalize on the enthusiasm unleashed by the initial implementation of BP. Two examples were cited by both managers and union officials during our visit. In the first case, the BP team for one line suggested covering the areas where workers stood with rubber floor mats. Though they cost only a few hundred dollars, the mats proved effective in reducing operators' fatigue from standing on a cement floor. Other workers saw the mats and asked if they could be installed on their lines too. However, they were told that any changes had to wait until BP came to their line—a time which was subject to many delays. In the second case, workers on another line could not find out how much money their improvement efforts had saved the company. Disclosing this figure (an amount which turned out to be \$250,000) was a standard part of the Honda methodology and a key motivator for participants, who wanted to know that their extra effort had produced something worthwhile. However, the owner did not want to disclose financial information to workers, because he feared that the union would use it to win wage increases.

Capitol's difficulty in keeping the BP process going and the persistence of quality and delivery problems concerned Honda, as well as the firm's owner. Under guidance from Honda's BP advisors, managerial assignments were restructured, new staff were hired, and new intensive projects (e.g., a delivery improvement project with another staff group at Honda) were undertaken. Honda's investment in helping Capitol improve was now quite high; Capitol managers estimated that Honda's technical assistance had cost the automaker over \$1 million. But it remained unclear whether Capitol had the resources for the investments in both physical and human capital that would be necessary to meet Honda's continuously increasing demands. By the time of our visit, Capitol was actively exploring purchase offers and several months later, it was purchased by a large, diversified company making many different kinds of parts.

Tower Automotive

This firm has its roots in Western Michigan, an area which was settled by Dutch immigrants in the early 19th century and has strong religious traditions that are grounded in the Dutch Reform church. The area is known for a strong work ethic and progressive employers. Social ties outside of work are common among managers and employees. Firms have long been innovators in employee involvement and gain-sharing plans and they typically make a strong commitment to avoiding layoffs. Honda purchased parts from several firms in this area; we visited both Tower Automotive²⁰ and Donnelly Corporation.²¹

Honda found Tower congenial from the start. Its older plants were crowded and cozy, reminding some Japanese managers at Honda of their older plants in Japan. The long-serving, loyal workforce was another characteristic Honda hoped to encourage in all its suppliers. Yet despite this comfort level, Honda wanted much that was difficult for Tower and its counterparts to provide. Tower was representative of a group of technically competent, dependable, long-time suppliers to the U.S. Big Three automakers, accustomed to the "boom or bust" cycles of the industry and to keeping costs low to avoid being undercut on price by competitors. Fundamentally mass producers of commodity products, these suppliers exploited economies of scale while also relying on unique technical enhancements to achieve price and performance advantages over competitors. These firms were not, when they began working with Honda, particularly familiar with lean production. Instead, they were successful enough as mass producers to have little reason to change their approach.

Honda learned about Tower Automotive in the late 1970s, when it sent a team to visit over 100 U.S. stamping firms listed in the directory of the Precision Metal Forming Association. For Tower, which was accustomed to seeing a Big Three buyer only once every five years, the fact that they were visited by the president and members of the board of Honda of America made a strong impression. One Tower manager in particular became a strong internal advocate for the advantages of working closely with Honda.

Tower's experience with Honda moved through a set of small, steady steps, each of which impressed Tower's initially skeptical management. First, the tools that Honda provided from Japan worked extremely well from the start. Then Honda provided some steel from a Japanese supplier that proved very easy to work with. Eventually, the steel Tower received from Inland Steel—a major U.S. supplier to Honda—began to show the same attributes as Honda worked with Inland on process improvements. While Honda and Tower had very different attitude towards tool design and maintenance, the two companies were able to work out agreements on acceptable modifications in tooling relatively quickly.

Satisfied by these early experiences, Honda began to give Tower more business. As volume grew, Honda asked Tower to build a dedicated plant for Honda. Tower refused at first, but in 1987 did agree to put Honda production into a plant in Auburn, Indiana, that was initially built for Ford in 1985. Tower then expanded the Auburn plant four times in the next few years to accommodate the higher volume for Honda.

Tower managers were not always comfortable with Honda's policy of having suppliers provide lots of detailed information about their plans and operations.

With BP, at first there was a lot of nervous tension. We didn't want to give away the farm. Eventually we realized that Honda's wish to know everything is not because they are trying to steal our good ideas or because they want to be snoopy. They want a partnership and want to be able to help you find the best way to do things.

Honda's zeal for results, attention to detail, and wish for involvement on the shop floor stood in contrast to Ford, the other primary customer at the Auburn plant. Honda's BP people visited Auburn twice a week. In addition, quality control people came from Honda twice a month and Tower people went to Honda in Ohio twice a month. As one manager told us, with Ford you "never" see the buyer in the plant—just the quality control people once a month. "We go to Ford as little as possible—it is our plant's turn once a quarter."

The flip side of Honda's attention was the strong pressure it applied when problems occurred. Tower (like other Honda suppliers) gets a written report any time there is a quality or delivery problem and has to give a written response detailing what "countermeasures" it will take to remedy the problem. Honda keeps track of the number of parts that are defective or delivered late. If a shipment is one part short, the entire number of parts in that shipment are counted as defective. As one manager explained, Ford, in contrast, is more likely to "call us up" when they see a problem and even then only if it occurs often enough to appear to be a pattern. If a shipment is a few parts short, they'll tell us to "throw a few more" in the next shipment.

Tower managers differed on the merits and shortcomings of Honda's and Ford's approach. One manager preferred Ford:

Ford has focused on systems. They believe that if you have good quality control systems in place, you'll have good parts. After the systems are in place, they leave you alone as long as you're performing. With design, we're more involved at an earlier stage with Ford. They give us CAD (computer-aided design) data as the master specification and then let us work from there. When there are problems, they handle them informally, over the phone. They get a quicker response that way than if they write us up and "ding" us.

This manager also felt that Honda had benefited from Tower's adherence to Ford's SPC system:

Ford really dragged their supplier base up. Ford was the first to teach us SPC. 75% of our salaried people went through their program at the American Supplier Quality Institute. When Honda saw we had Ford's system, they urged us to use it.

Another manager found value in Honda's obsession with eliminating defects:

Honda cares about making the part fit the car, while Ford cares about making the part fit the blueprint. During product launch, Honda takes parts as soon as they are made and runs back to try them on the car. Then they tell us to change this, change that. Ford usually isn't here during our trials. They just want to be sure that we are meeting the spec. If there is a problem, they eventually issue an engineering change. But at Honda, the changes happen in a matter of days. At first we thought they were nuts. But theirs is a great way to do business. You get what you want—a part that works on the vehicle—right away. Everything else—like whether the blueprint is up-to-date—is secondary. Initially, it was incredibly

frustrating because Honda was so detail-oriented and wanted responses from us immediately. But I find they are almost always right.

While we were in the plant, we saw an example of how Tower combined Ford's emphasis on procedures with Honda's focus on an attitude of continuous improvement. We had asked to see a statistical process control chart, a type of documentation required by Ford but not by Honda for this product. The manager accompanying us noticed that the process was heading out of control on a key dimension; he and the operator quickly engaged in a discussion of what might be causing the problem and how to stop it.

BP started at Tower in late 1989 with the arrival of a team of three people from Honda—from welding, quality, and purchasing departments. The team proposed starting with "soft" BP (simple projects with low investment)—organizing all steel blanks in one area, painting floor spaces to indicate where steel coils are to be placed, attaching new bins to stamping machines that are more accessible and can be repositioned.

Next came a project involving "hard" BP (i.e., investment in new equipment)—reengineering the work cell for the center pillar (i.e., a stamped part located between the front and rear passenger doors that connects the roof to the side panels). Initially, Tower's work cell utilized dedicated automation, designed for a given center pillar and able to produce 63 parts per hour. Honda encouraged Tower to invest in robotic technology, but of a particular sort. Rather than having the robots move around the part to apply welds, the welding gun was on a pedestal with a fixed location and welding position. Simple, low-cost, and reliable "pick and place" robots could then be used to move the parts around so each weld could be applied. Automatic sensors were used to check whether all welds were completed successfully. With this new cell design, productivity rose to 125 parts per hour. The life of weld tips was also increased dramatically, from 50,000 welds before tip replacement to 250,000 welds, because the fixed position of the weld gun meant less wear and tear on the tips.

Over time, Tower was able to influence Honda's manufacturing approach. In the words of a manager at another supplier, as Honda came to trust a firm's technical capabilities, a supplier could "earn the right to disagree." For example, when punching holes in a stamping, Tower used a "button" of metal underneath the part that the punch would strike, insuring that the punch would always go to the same depth. Honda was accustomed to doing such a punch without a button underneath—something that increased the risk of splintering around the hole and also required more maintenance for the punch tool. Tower persuaded Honda to install easily changeable buttons and to make them of hardened steel to reduce maintenance.

Despite acknowledging learning a lot from Honda, Tower managers and engineers still resisted Honda's pressure to provide lots of information. When Tower built its Auburn, Indiana plant, the first that Honda heard of the plan was when the supplier presented Honda with blueprints. While Honda was pleased

that Tower was building a new plant, they would have liked more opportunity to comment—a desire that Tower felt was intrusive.

In another case, Tower felt that they had withstood pressure from Honda and had decided to go their own way. At its Greenville, Michigan, plant, Tower hired a consultant to implement a “workplace transformation” program that differed from BP. Whereas Tower managers saw BP as focusing on value analysis and process reengineering, they saw the new program—which, once adopted at Greenville, replaced BP there—as focused on the implementation of independent business units within the plant and “self-directed work teams” on the shop floor. The move to self-directed teams also had an explicit role for the union (the Greenville plant was organized by the UAW, whereas the Auburn plant was nonunion) and emphasized efforts to improve job design. While Tower felt that Honda disapproved of this initiative, Honda disagreed. As one Honda manager explained, “Our first question whenever a supplier proposes something is ‘why?’ We just want to see if it makes sense. We find that if the supplier doesn’t have a good answer, it’s a sign of potential problems. But the supplier reaction is often ‘Honda doesn’t like it.’”

What struck us about this incident was how unfamiliar and uncomfortable the suppliers were with the idea of talking over their internal plans with a key customer. Clearly suppliers are most accustomed to a situation in which a meeting with your customer is a time for receiving orders. Honda has found that to encourage “fresh thoughts” from suppliers, they must be quite flexible about the extent to which improvement activities fall under the BP rubric.

After the workplace transformation program was launched at Greenville, efforts began to bring it to the Auburn plant as well. This took the Auburn plant manager away from the plant in order to help train other managers, right at the time of the 1994 Accord launch. Honda was concerned that its implementation at the same time as a major product launch was drawing attention away from persistent quality problems with 1994 Accord parts.

Tower also asserted its own wishes in some investment decisions. The quality problems alluded to above were concentrated in parts for the Accord station wagon. Because the volume for this product is relatively low, Honda and Tower agreed that investment costs should be kept low and that dedicated welders should not be installed. However, when problems persisted, Honda pressed Tower to invest in automatic sensors that check for missing welds or nuts on subassemblies. Tower refused, insisting on all-manual processes. In another case, Tower insisted on automating processes that were performed manually at suppliers making the same parts for Honda in Japan, despite Honda’s concerns about the impact on overall costs.

One factor affecting Tower’s relationship with Honda in recent years is its acquisition by Hidden Creek Industries and its consolidation with several other medium-sized stamping companies in the area. Tower Automotive, the consolidated firm, has made a determined bid to absorb lots of new business from Ford,

Toyota, and Nissan. With Ford reducing its stamping suppliers from 400 to under 50, Tower was determined to stay in that select group. Ford was also increasingly willing to give Tower major design responsibility. Furthermore, Tower was building a new plant in Kentucky to serve Toyota and Nissan. Thus while the Auburn plant remained dedicated to Honda (as it had been since 1990), managerial time and effort for the newly consolidated firm was pulled in many different directions.

So despite a strong and long-lasting relationship, Tower has struggled with Honda in many ways. Honda continues to press Tower for performance gains and for continued investments in improved capabilities. Faced with pressures from two major customers—Ford and Honda—Tower's senior managers seemed to be finding Ford's more "hands-off" approach more appealing. With Ford's emphasis on getting good systems in place, Tower was able to satisfy Ford's expectations on a regular basis, while Honda's insistence on responsiveness for each new defect or delivery problem was more annoying. (As one manager explained, "Ford's subliminal message is that a few defects are part of life—get your systems right and you'll basically be OK. Honda is after us with their Supplier Performance Report every month.") Also, Ford seemed more likely to make definite commitments of volume to Tower in advance of investment decisions, while Honda continued to insist that their "partners" make ongoing investments so they would be ready for whatever new business might be available.

Thus the Tower case suggests that even where BP efforts succeed in boosting a supplier's technical skills, capabilities for improvement, and overall performance, the stress of responding to two major customers with different priorities can still prevent a supplier from being as responsive as Honda might like.

Progressive Industries

Progressive is a small stamping firm that had a long history of second-tier contracts with the Big Three before it began to work for Honda. It is a family-run business now headed by Ruston Simon, son of the founder.²² His father was an experienced tool-and-die engineer, but Ruston went to college at Northwestern, worked a few years in banking in Boston, then got an MBA before taking over the family business. This combination of education and experience gave him a nontraditional (and more sophisticated) perspective on how a small auto parts firm should be managed.

Progressive was founded 40 years ago as a "die shop" that built tools for bigger stamping companies. To test the tools they were building, they bought an old stamping press. Then a customer asked them to take on the stamping of a small part. They found the steady work associated with an auto contract to be more appealing than the "feast or famine" cycle of the tool and die industry, and they added more and more presses. Many small stampers—tagged by some in the industry as the "smash and ship" bunch—had a similar history. Keeping costs low was paramount, so physical plant was kept small and spartan, wages

were low, presses were old, and high capital utilization was critical. Companies like Progressive that were able to use their tool-and-die skills to keep machines running had some slight advantage over other commodity stampers, but price competition was fierce and customers were willing to switch suppliers with each new low bid.

When Simon took over Progressive in 1984, the company had moved away from the automotive business to avoid its cyclical and price competition but was not particularly profitable. He decided to move back into the auto industry, but discovered Progressive had fallen considerably behind the performance levels needed to win contracts. He began approaching other small stampers in the area who were facing capacity constraints, offering to make their most difficult part for them. In addition, Progressive was able to help these firms improve the performance of their tools.

When Progressive decided to pursue major auto contracts directly, it found the Big Three were shedding suppliers speedily. Then in the fall of 1986, Simon spotted a Honda ad in a metalworking magazine, with the headline "*WANTED: Competitive Stamping Sources*" (see Figure 1). Honda sent an extensive questionnaire asking about the firm's history, equipment, profits, "everything." Then, as it had in the late 1970s (when it found Tower), Honda sent a team of 3-4 American and Japanese purchasing associates to visit 120 stampers in a five-state area. Progressive was one of seven stampers chosen through this process, and the smallest. Honda was impressed with Progressive's quality systems and even more so with the management team's openness to using Japanese tools and learning Honda production methods.

Progressive's experience with Japanese tools is instructive because the design philosophy for dies differs dramatically between the U.S. and Japan. U.S. dies are typically engineered with very hard steel, in anticipation of a long life cycle for a given car model, and hence are both expensive to buy and need a long lead time to build. Japanese dies are typically cheaper, made of softer metal, and require a shorter lead time to develop; however, they also need frequent maintenance. This fits well with the shorter life cycle for most Japanese-designed autos, since extra maintenance costs are easily offset by the quicker development process and cheaper raw materials.

By using Japanese tools, Progressive's tool and die makers gained exposure to this very different philosophy of die design and maintenance. Subsequently, they developed ideas about potential improvements in the Japanese dies and, after producing successfully with these tools for a few years, persuaded Honda to switch to U.S.-designed dies incorporating these ideas. Thus Progressive was able to show that they were receptive to new ideas but also able to contribute their own innovations.

Progressive was particularly innovative in the use of die-sensoring—mechanical and electronic gauges on the surfaces of dies and edges of presses that monitor whether the stamping equipment is operating within certain

FIGURE 1. Honda of America Manufacturing 1986 Advertisement for U.S. Stamping Suppliers

WANTED

COMPETITIVE STAMPING SOURCES

Honda of America Mfg., Inc. is investigating stamping sources to increase domestic content of substructure components.

REQUIREMENTS

LOCATION: OH, IN, KY, MI, PA, WV, WESTERN NY; CAPABILITY TO SUPPLY AUTOMOTIVE PARTS; COMPETITIVE IN INTERNATIONAL MARKETPLACE; EFFICIENT, FLEXIBLE PRODUCTION METHODS; DIE MAKING, DIE MAINTENANCE AND SECONDARY EQUIPMENT MAKING CAPABILITY; HIGH QUALITY, ZERO DEFECT PARTS — CONSISTENTLY; JIT PRODUCTION AND DELIVERY CAPABILITY.

Interested manufacturers should contact the North American Procurement Project in the Purchasing Department for further details no later than October 20, 1986.

HONDA OF AMERICA MFG., INC., MARYSVILLE, OH

513/642-5000

critical parameters. For many traditional stampers, this monitoring process was done by assessing the sound of the machine and the shininess of the areas where die surfaces meet. With Progressive's home-grown sensors (and the accompanying software, developed with outside vendors), presses could be calibrated more precisely, to use the "minimum pressure required," which reduces wear, saves energy, and allows more precise matching of jobs to the tonnage of the equipment. Also, sensors can quickly shut down machines as soon as they detect a problem, similar to the "jidoka" philosophy associated with the Toyota Production System.

The information generated by die sensing became important in one of the BP efforts Honda carried out at Progressive: the development of very detailed technical standards and operating procedures for each press to systematize production processes, limit variance that could lead to defects, and allow the accumulation of process knowledge that could lead to further innovations.

While Honda was relatively satisfied with Progressive's technical capabilities as a stamper, it pushed the firm to move to the next "value-added" step of welding and assembly of stamped parts to produce a finished sub-assembly. Unlike U.S. automakers, who were more likely to build such sub-assemblies in their own plants, Honda has long preferred to give responsibility for sub-assemblies to suppliers. At Honda's small stamping suppliers in Japan, roughly 2/3 of their workforce is devoted to welding and assembly tasks.

These were new areas for Progressive, but adding these capabilities was appealing to Simon, who wanted to move the company away from being viewed as a mere "commodity" producer. "We needed to earn our spurs with them [on welding and assembly]," he admitted, "and we were given more leeway at first than the bigger guys. They started us off on small, simple tasks and we were able to show good results early." Increasingly, Honda is pushing Progressive to take on more complex parts and weld patterns, moving towards multiple welds along multiple axes. Progressive's tool shop heritage has been applied to in-house development of customized welding equipment for the Honda parts they make, including robotic cells.

The BP projects at Progressive unfolded against this backdrop of increasing responsibility, technical challenge, and expansion into new processes. According to one Progressive manager, "There was no single, critical event that was plant-changing. It was a steady learning process. Honda brought us along very slowly." One BP project developed a color-coded priority system for die maintenance. Another BP project took a single press and made a series of small improvements:

- The control panel was moved from the side of the press and put onto a rotating arm, so it could be moved close to the operator while he/she observed press operation.
- Small welded compartments to hold tools during maintenance were attached to the press.
- Oil needed for press maintenance was piped from a central storage location, rather than being hauled in barrels and poured into line-side storage containers.
- A staging area for steel coils was created upstream from the presses, to speed changeovers.
- Simple metal dividers were installed to insure that scrap pieces would fall automatically into scrap containers without having to be handled.

- Three bins for finished parts were put onto a rotating stand, so one bin could be filling while another bin was being unloaded into shipping containers.
- The floor area around the press where incoming materials or outgoing parts are stored was painted to indicate precise placement locations for each item.

Complementing Progressive's BP efforts on the shop floor was a human resource system that was consistent with Honda's values and, in many cases, influenced by Honda's policies. Progressive has had only one layoff in its 40-year history, so the firm had no problem accepting Honda's no-layoff condition for BP. To absorb volume fluctuations, Progressive has established a work schedule of 45 hours (4 10-hour days and 5 hours of scheduled overtime), so that it could cut back to 40 hours when times were lean or add overtime in boom periods. Besides their relatively low base pay (\$8 for operators and \$15 for skilled trades), employees received profit-sharing based on meeting targets in each quarter, plus a discretionary bonus (\$980 in 1993) at year's end. Progressive also provided full reimbursement for outside education and has boosted its training significantly, often using training materials developed by Honda.

Like Capitol, Progressive's early responsiveness to Honda brought a steady growth in orders—sales to Honda that more than doubled from 1992 to 1995 and an increase in first-tier and second-tier parts produced from 10-20 in the late 80s to 125-130 by 1994. Unlike Capitol, Progressive has been able to manage this growth effectively while also taking on additional responsibilities. More money for investments, a more technically sophisticated staff, and more attention to human resource development all appear to be part of Progressive's success. The Progressive case is a good example of Honda's preference to give additional business to suppliers that have demonstrated responsiveness, good performance, and the willingness to take on new challenges.

Analyzing BP's Effectiveness and Supplier Capabilities

Table 2 summarizes the effectiveness of BP at the suppliers. For all three suppliers, the adoption of a *kaizen* philosophy of continuous improvement represented a significant change in their organizational culture. For a small company like Progressive, whose owner became a quick adherent, this culture change occurred relatively quickly. Small size did not help at Capitol, where control-oriented management thinking and limited staff capabilities hindered the prospects for *kaizen*. The move towards *kaizen* was slower at Tower than at Progressive, yet there were more resources to sustain change once it occurred.

Of the three suppliers, both Tower and Progressive were quite effective in meeting Honda's basic cost, quality, and delivery requirements; only Capitol was weak in these areas. In addition, Tower and Progressive had "earned the right to

TABLE 2. BP Effectiveness and Supplier Capabilities (based on 1992-94 plant visits)

	Capitol	Progressive	Tower
Main Product	Plastic molded parts	Small metal stampings	Small metal stampings
Scope of BP's influence	Individual work areas	Entire plant	Entire plant
Sustained after Honda leaves?	No	Yes	Mixed results
Transfer across plants?	N/A; single plant company	N/A; single plant company	Minimal, but other plants don't make Honda products
Kaizen well-established in plant culture?	No	Yes	Varies by product line
Workforce involved in kaizen efforts?	Minimal	Minimal	Minimal
Able to meet cost, quality, delivery goals?	Recurrent problems	Mostly	Mostly, but some problems with low-volume parts
Influencing Honda on production process decisions?	No	Yes, for die hardness and maintenance	Yes, for die hardness and maintenance
Investing in new technological capabilities?	No	No	Yes — transfer presses
Learning new production processes?	No	Yes — doing subassemblies after stamping	No

disagree" with Honda with respect to manufacturing processes, particularly the modification of die design and maintenance practices.

All three suppliers grew dramatically due to Honda's business. But there was more variation in the extent to which these suppliers made major investments in new technologies and new facilities in order to keep up with Honda's future requirements. Tower, a relatively large supplier (and larger now since its consolidation under Hidden Creek), made major investments, while the smaller suppliers did not—primarily a function of the greater ability of a larger firm to gain access to capital. Progressive did add subassembly tasks in order to become a more "full service" provider to Honda.

On balance, the cases support the idea that creating lean suppliers is a viable alternative for a customer that doesn't want to vertically integrate, does not have easy access to a more highly skilled set of suppliers, and wants to maintain commitments to existing suppliers. But the cases also reveal that this approach is not easy.

Lessons For Customers

Structure the learning process so that the knowledge is easier to absorb.

Organizational learning and innovation theorists argue that technical knowledge is particularly difficult to transfer if it possesses the following characteristics: an abstract or complex scientific base; a “fragile” technology that doesn’t work consistently; technology that requires “hand-holding” because of idiosyncrasies that make standardization impossible; or “lumpiness” because knowledge transfer would affect lots of people at the same time;²³ a ‘tacit’ or ‘uncodified’ nature that is difficult to explain explicitly;²⁴ a ‘radical’ or ‘competence-destroying’ nature that makes obsolete some of the recipient’s pre-existing capabilities.²⁵

Honda designed the BP process to avoid most of the characteristics of technical knowledge that make it difficult to transfer. First, the underlying scientific knowledge for the reengineering of production lines was primarily concrete and simple rather than abstract and complex. BP reinforced this by following the principle of “actual part, actual place, actual situation” (the 3As) and by focusing attention on a single problem. Second, the solutions developed through BP were highly reliable. These solutions routinely produced fast, large improvements in suppliers’ operations—reinforcing the incentive to continue with the program. Third, standardization of processes was often achievable and was encouraged as part of a continuous improvement cycle that alternated periods of standardization and periods of experimentation with improved methods. Fourth, by beginning BP on a single “pilot” line and then slowly diffusing the same principles to other redesign efforts, the “lumpiness” of broad, sweeping organizational change—and the potential organizational resistance to such change—was minimized.

Furthermore, BP was well-suited to the tacit nature of the knowledge underlying lean production and continuous improvement. In addition to practical illustrations of how to reengineer a discrete production line, the entire BP process modeled the behaviors that Honda hoped the suppliers would adopt—utilizing the “3 As,” gathering “before and after” data to evaluate countermeasures, emphasizing minimal capital investment until process steps are organized for smooth flow, respecting worker knowledge as a source of ideas for process improvement, and paying attention to (non-wage) factors that could either elevate or dissipate worker motivation.

Though we judge BP to be an effective mechanism for transferring technical (and often tacit) knowledge, it is worth noting two other characteristics of lean production that affect the knowledge transfer process. On the one hand, lean production makes obsolete many of the skills, attitudes, and heuristics developed under mass production (e.g., emphasizing economies of scale and production targets over quality, establishing buffers to keep production running despite defective parts, high turnover, and poorly-motivated employees). It requires alternative perspectives on many dimensions of production (e.g.,

accepting a "quality first" philosophy, understanding the logic of buffer reduction, becoming more open to employee input into production problem-solving) that, taken as a whole, represent a radical shift in managerial mindset. On the other hand, lean production is not entirely "competence-destroying." Indeed, successful implementation of lean production places heavy demands on traditional skills such as production scheduling, workflow planning and data management. Part of the challenge in learning lean production is understanding which aspects of traditional manufacturing practice provide a necessary foundation and which represent barriers to adoption.

Choose the knowledge recipient carefully, keeping in mind how the recipient's "absorptive capacity" and "identity" will affect the knowledge transfer process.

Honda's choice of BP participants was based on a variety of factors, some of which heavily affected the knowledge transfer process. All participants were expected to meet the following criteria: highly motivated to learn, willing to make their operations completely accessible, and willing to commit to the "no layoff" policy that Honda saw as crucial to BP success. Beyond those criteria, there were two predominant paths to being selected for BP. One path (Capitol) was to have performance problems that persisted despite Honda's standard feedback reports and pressures for improvement. Another path (Tower and Progressive) was to demonstrate strong capabilities in *some* areas valued by Honda and an attitude of responsiveness about learning *new* capabilities to meet Honda's current and future needs. Honda's experience with the suppliers selected via these two paths differed considerably.

Two concepts—absorptive capacity and organizational identity—are helpful as a way to characterize what Honda experienced. One key factor in the successful transfer of knowledge, according to Cohen and Levinthal, is the "absorptive capacity" of the recipient.²⁶ The capacity to absorb new knowledge depends critically on the level of related knowledge that already exists in the recipient firm, since prior knowledge facilitates the assimilation and exploitation of new knowledge. While ultimately grounded in individual learning, absorptive capacity at the organizational level requires effective communication mechanisms between members of the firm and sources of knowledge inside and outside the firm.

The absorptive capacity of a firm is also related to its organizational identity. As characterized by Kogut and Zander, the "identity" of the firm is defined by the organizational boundaries which indicate who is (and is not) a member of the organization, by shared goals and values, and by patterns of interaction among individuals that give rise to a common language and common frameworks for action.²⁷ A firm's ability to absorb technical knowledge will be greatest when both the new knowledge and the firm's prior related knowledge are close to the core of the firm's identity. In contrast, a strong identity will create obstacles to the absorption of radical change, because the firm's identity is typically

wrapped up in a stock of previously developed knowledge and organizational routines.

These two factors (absorptive capacity and identity) have different implications for the process of knowledge transfer at large vs. small suppliers. Larger suppliers should have more absorptive capacity than smaller suppliers, both because of more prior related knowledge of the traditional skills on which lean production draws, and because of a stronger identity, based on particular areas of technical expertise, long histories of successful performance, cohesive corporate cultures, and high employee tenure. However, this strong identity might also increase the resistance of larger suppliers to the "competence-destroying" change of mindset associated with adopting lean production. In contrast, smaller suppliers should have less prior related knowledge about lean production, and thus less absorptive capacity. While this might make the knowledge transfer process longer and more time-intensive, a small supplier might be more responsive to the customer's suggestions than larger suppliers.

There can be tremendous appeal for a customer trying to "create lean suppliers" in building up small firms into intensely loyal medium-sized ones. Their motivation is high and they are likely to mold their "identity" very closely upon yours. However, there is a risk in this strategy of too much dependence and too few resources for developing advanced capabilities. This risk is apparent in the Capitol Plastics case. Capitol's strenuous efforts to be responsive to Honda led at first to a larger and larger share of Honda's business. When the limitations of Capitol's management team, production expertise, and technology became clear, Honda used BP to try and bolster the company, at considerable effort and expense, but to little avail.

The alternative strategy of working with already established firms that have a strong customer base but still have ample room for improvement (such as Tower) seems more promising. The early stages can be considerably more complex, since the identity struggles are fierce at the beginning. Picking the right supplier-partner can make a big difference during this stage—e.g., the initial "fit" in company cultures between Honda and Western Michigan suppliers such as Tower, even if far from tight, was sufficient to provide a strong core to their relationship with Honda even during difficult times. Certainly the fact that the fundamental absorptive capacity is present means that the "provider" firm can concentrate energy on motivating the recipient firm and minimizing the "stickiness" of the knowledge transfer process. However, even once the initial struggles are past, the responsiveness of larger firms may be limited by the competing demands they face from different customers, as was the case at Tower vis-à-vis Honda and Ford.

However, the case of Progressive Industries suggests that it is too simple to assume that large suppliers are more capable of learning from a lean customer like Honda. BP was largely successful at Progressive due in part to the "absorptive capacity" of a key individual—the firm's owner—who saw the need to keep expanding the services his firm could provide Honda and in part to the strong

foundation of technical skills developed during its history as a machine shop and provider of advanced controls to other stampers.

Over eight years of experience with BP, Honda has gained a greater appreciation of the demands the BP process places on a supplier's absorptive capacity. Accordingly, they now make sure the supplier is in a position to devote the necessary resources to the improvement process before beginning—no major product launches going on for Honda or another customer; a willingness and ability to devote at least one person full time, and no major problems with its organizational structure, managerial resources, quality and production scheduling systems, or labor relations. According to Rick Mayo, who directs BP for Honda:

There are three things we look at now to evaluate whether BP will work: first, their infrastructure; second, what else is on their plate; and third, who else is in there [other customers]. What we'd do now if a Capitol Plastics arose would be to do an analysis of their overall management structure and resources. We would see that the problem is much bigger than BP. When you realize it's more than BP, don't try to solve it with BP. . . . Before, we tried to make BP an answer for all issues. Now, we realize that a basic precondition of BP is having capable people in place. For example, suppose they fired a quality manager and don't have a replacement. If we go in, we become the quality manager. I might send in a BP guy, but to manage quality, not to do BP. After they've got the basic issues under control (we're getting parts reliably, they change dies when they should, they're not promoting unqualified people), then we can do BP.

Honda also felt that it was very important to encourage suppliers to see continuous improvement as part of their identity, by finding a way to make it fit with their organizational structure, culture, and history and by striving for a consistency of approach across customers. According to Mayo:

We've learned that we've got to get BP into their company so it's *not* seen as a radical change. We used to meet with the top guy and say 'do this project.' Now we realize that the supplier needs to have their own way of doing BP. So we ask "what will fit best with your overall plans?" They don't even need to call it BP. The improvement activities need to be part of their culture, their vision. BP is one club in the golf bag—it's probably the driver, and we hit it hard—but it's not meant to be everything to everyone.

Thus over time, Honda has refined its assessment of which suppliers should participate in BP and, even more importantly, when and how to undertake a BP project at a supplier.

Once suppliers have been selected, manage the relationship in a way that minimizes long-term dependence and speeds the transition to self-sufficiency.

One risk of a "hands-on" knowledge transfer process is that the recipient firm (the supplier) may come to rely on the support services from the provider firm (the customer) and thereby limit its learning.²⁸ The cases offer some sup-

port for the idea that the suppliers might view BP as a service and become dependent on Honda, thereby reducing their incentive to master lean production on their own. Honda associates may have exacerbated the problem by their intensity about fixing problems, which may have encouraged supplier employees to feel "unworthy" and to defer to the BP staff. (A manager at one supplier, not included among the cases in this article, described in vivid detail the combination of relief and anxiety when the "snowflakes"—white-uniformed Honda employees—descended on the production lines at his plant.) When Honda withdrew its BP staff, hoping that the supplier would institutionalize these processes, it was frequently disappointed with the solo initiatives that followed.

This was particularly apparent at Capitol Plastics, where performance gains achieved on certain production lines diminished after the BP team left. At Progressive, performance remained strong, subassembly tasks were successfully added, and technological improvements were effectively implemented. But Honda remained somewhat frustrated with the limited depth of Progressive's management capabilities. According to one Honda manager, "We try to tell them they can't stay as just a mom-and-pop shop and do big business. They can't do it all with 'promote-from-within.' At some point, they'll need more professional management."

In contrast, dependency was less of a concern at Tower. At the beginning of their relationship, Tower was somewhat dependent on Honda's technical assistance to work with unfamiliar Japanese dies and equipment. Yet this dependence was difficult for Tower, whose identity as a capable manufacturer was well-established. The ambivalence about being so dependent on Honda (and about the demands of the BP process) eventually served, we believe, to motivate Tower to become more self-sufficient with respect to lean production capabilities and to synthesize what it was learning from its two major customers. However, as Tower became more self-reliant, it may also have become less receptive to Honda's "hands-on" approach and more favorable towards Ford's "manage-by-the-numbers" approach.

That the relationship between supplier and customer during the "learning" period is often characterized by tension and ambivalence is not necessarily a bad thing. It can motivate the supplier to push through the dependency stage and become self-reliant.²⁹ Honda walked a fine line between making it easy for suppliers *not* to learn and creating an environment that encouraged learning new capabilities. Honda's investment of time and energy in helping suppliers was a visible sign of commitment—something the suppliers could hold on to and use to justify the "leap of faith" required in the absence of contractual commitments. As noted above, BP also demonstrated the behaviors Honda hoped the suppliers would adopt on their own.

In summary, reaching self-sufficiency with respect to newly acquired knowledge is more likely when the supplier has a moderate degree of identification with and dependency on the customer. If these are too high, the supplier

will be tempted to continue to rely on the customer for assistance. If they are too low, the supplier will feel that the customer has nothing to teach. On the basis of the limited evidence from these cases, we conclude that Honda has achieved the most supplier self-reliance with larger companies, who have an identity as strong, competent actors and thus try to reduce their dependence on Honda as quickly as possible.

Balance “learning” and “monitoring” behaviors, while being sure to generate supplier trust.

Customers who want their suppliers to improve must balance the need to monitor the suppliers' existing performance while encouraging them to learn new skills, which in the short term might disrupt that performance.³⁰ Indeed, if supplier capabilities change sufficiently, it could force changes in the monitoring system. While BP was primarily a mechanism for learning, it did allow some monitoring. However, tensions over monitoring at times seemed to threaten learning, as was the case at Tower. For the most part, Honda seemed willing to let BP to stand alone as a learning mechanism and to deal with monitoring as part of routine interactions between Honda purchasing, financial, and quality functions and each supplier.

While some tension between learning and monitoring is inevitable, the more capable suppliers become, the more they can participate in discussions in which both sides benefit, as occurred in the fruitful combination of U.S. and Japanese die practice at Tower and Progressive. Honda appeared to recognize the benefits of such discussions, becoming more flexible in its approach to BP over time, with more willingness to blend a variety of activities together, even those not part of the initial BP plan. Honda also came to realize that suppliers might undertake separate initiatives with other customers or outside consultants, and that these too should be treated as potentially complementary to BP.³¹

Don't worry about knowledge spillover to competitors through a shared supplier. Do worry about impact of multiple customers on a supplier's responsiveness.

Lean production is certainly beneficial in serving other customers besides Honda. Honda managers seemed to take a “rising tide lifts all boats” view of the risk that their rivals might free-ride on their investment in knowledge transfer: “If Ford and GM get better, that's OK. That will push us to get better.”

Also, unlike information about future products or specific technological advances (which Honda certainly did protect), Honda managers seemed to believe that efforts to eliminate the spillover of knowledge about lean production to competitors might run the risk of suppliers gaining only some of the benefits that accrue to systemic implementation. Indeed, helping a supplier achieve consistency across all its operations and all its customers was an important component of Honda's strategy for supplier self-reliance. Mayo told us:

Measurement is one of the biggest things we do—measuring everything in the plant in the same way, gathering real data from physical operations. That's how we end up working on Ford, GM, and Chrysler lines as well as our own. We try to make continuous improvement part of the supplier's culture.

Furthermore, Honda's emphasis on long-term, marriage-like relationships with their key suppliers may also mitigate the risks of knowledge spillover. The loyalty generated by a successful knowledge transfer process can mean that suppliers remain more responsive to their teacher even over many decades.³²

We want to help suppliers solve their biggest problems, but also to think long run and to be self-reliant. We train our BP staff to pay attention to issues of philosophy and commitment. That's the strength of BP—it starts in one place and leads to other things.

Honda seemed more concerned about the issue of supplier responsiveness to its needs in the face of competing customer demands. According to one Honda manager, "Some of these suppliers get pressure from many customers and often say 'yes' to everything. But they have limited managerial resources for dealing with all those demands." BP activities are increasingly postponed for suppliers with "too much on their plate," as noted above, which most commonly occurs when a supplier is launching new products for more than one customer. This concern also seemed to provide the rationale for Honda's extensive supplier development activities at the best smaller suppliers, despite the greater difficulty in helping them achieve self-reliance.

Lessons for Suppliers

Understand what skills will be taught, how long it will take to learn them, and how applicable they will be to other customers.

Should suppliers be willing to get involved with a customer bent on improvement—theirs? Certain advantages of a knowledge transfer process like BP seem clear—the operational improvements from the actual BP projects, the development of internal capabilities for transferring these improvements to other plants and divisions, the strengthened relationship with an important customer. Yet a skeptic might argue that it is a mistake for a supplier to make major investments in building capabilities that suit a customer's requirements in the absence of solid long-term contractual agreements about future business.

If a skill is specific to one customer, then a supplier should make sure in advance that the customer is willing to assure the supplier of a return on its investment in learning—otherwise the supplier is vulnerable to a "hold-up," in which the customer does not allow the firm a return on its investment, knowing that it has no alternative use for the asset.³³ If the skill is general, but requires a long gestation period, then the supplier should ensure that it can weather the

learning period, either due to commitment from the customer or from retained earnings.

BP seems to fall in this second category; it teaches general problem-solving skills helpful to a variety of customers. Even the BP-related investments in capital equipment that we saw were for general-purpose machines. However, in the short term, the intense focus on one line required by Honda can be a distraction from meeting the needs of other customers. This tension was expressed most clearly by Tower, which was cautious about allowing its intensive relationship with Honda to hurt its position with Ford by diverting too much energy away from developing the capability and relationships necessary to obtain a major design role.

Make sure your customer is trustworthy.

Sako distinguishes among three types of trust: competence trust (a belief that the customer is capable of doing what it says it will do); contractual trust (a feeling that the customer will abide by its agreements), and goodwill trust (a belief that the customer will take initiatives for mutual benefit, and refrain from unfair advantage-taking).³⁴ All types of trust are important for the success of an intensive knowledge-transfer project.

First, it is important that the customer be a competent teacher. Even if the customer doesn't charge for instruction, the process of learning a general skill like lean production can still be quite costly in terms of time for supplier managers, engineers, and employees. Regardless of their other reactions to BP, the suppliers were uniform in their respect for Honda's mastery of lean production philosophies and methods—often called the "Honda Way"—particularly as manifested in the skills of the BP coordinators sent to their plants. This sense of Honda's high level of competence was crucial for overcoming the initial skepticism of many suppliers towards the BP process.

Second, contractual trust—which, on the face of it, wouldn't apply to Honda because it rarely provides formal contracts—remains extremely important. Knowing that a customer abides by *unwritten* contracts (e.g., Honda's implicit guarantee of continued annual business for responsive and capable suppliers, at a level that at least matches the previous year's volume) can strengthen a customer-supplier relationship more than seeing an arm's-length customer go "by the book" in observing the terms of a formal contract.

Third, because the knowledge transfer process opens up so many unforeseen avenues for improvement (and potential investment), it is crucial that the supplier believe that its customer is trustworthy in a goodwill sense. The intense amount of information-sharing and coordination between suppliers and a customer like Honda is often resisted at first because of fear that this information will be used opportunistically.³⁵ Yet suppliers often change their views if they see that the customer is merely seeking possible process improvements. Furthermore, as shown in the Tower and Progressive cases, firms can develop goodwill

trust over time, progressively moving towards more and more mutual responsibility, interdependence, and open information exchange over time. A knowledge transfer program like BP can be an important part of the trust-building process, since the customer's investment in teaching a supplier *is* specific to that supplier; if the firm no longer supplies to the customer, the customer loses the benefit of having provided the training.

Provide incentives for all members of the firm to contribute their ideas.

Just as supplier management needs to trust customer management, supplier workers need to trust their managers, on both the competence and the goodwill dimensions. This was a difficult part of the BP process, at least in part because supplier managers underestimated the importance of the changes required in labor-management relations. Capitol unleashed an initial flood of employee enthusiasm, which turned to a trickle when management dragged its feet on the implementation of employee suggestions. In contrast, Progressive's management responded more favorably towards suggestions, particularly from its more skilled employees, and reinforced the emphasis on problem-solving by providing extensive employee training, both on-the-job and at outside educational institutions. Overall, we found that Honda did manage to shift management's mindsets at the suppliers we studied with its emphasis, beginning with the very first BP project, on the importance of shop-floor employee involvement and the requirement that no workers be laid off due to BP-related efficiency gains.

Grow your capabilities as fast as you grow your business—if not faster.

The experience of becoming a supplier-partner for a fast-growing firm like Honda was, for the companies we studied, frustrating and exhausting as well as stimulating and exhilarating. Proving capable of handling Honda's demands was often a ticket to gaining additional business from the other Japanese transplants and the Big Three. In the face of such opportunities for volume, it could be easy for suppliers to defer investments in future capabilities—whether in process technology, information systems, managerial expertise, or production worker skills. However, such a deferral is, from Honda's perspective, the most serious impediment to continuing an effective relationship with a supplier. According to Rick Mayo,

We don't want companies to grow their business faster than they grow their capabilities. We tell suppliers to grow at the right pace to be ready when the time comes for the next phase of work together. For example, when we want to get a supplier involved in the 'guest engineer' program (where the supplier sends engineers to work on 'design for manufacturing' issues with Honda's product designers), they need to have the right kind of engineers already on board and familiar with their operation.

We view self-reliance in suppliers as a means to achieve long-term competitiveness. For most of our competitors, when they do supplier development

activities, it's just about today. We care about today but we also want residual benefit for the future. Some suppliers don't get it, but some get it very well. Those that get it are better suppliers for us and better suppliers for our other customers, which means we know they'll be around.

The larger firms are not necessarily better than the smaller firms at doing this, in Honda's view, but they do possess certain advantages—access to capital, depth of managerial resources, a broader customer base and hence less vulnerability to fluctuations in Honda's volume. The fact that there is widespread consolidation in the automotive parts industry, primarily through merger and acquisition, indicates that many investors, customers, and supplier managers believe that size is a prerequisite to survival in the global sourcing competition of the future. But we would offer a cautionary note about the dangers of suppliers growing too big, too rapidly.³⁶ Size alone will not guarantee the successful development of the many capabilities required by lean customers like Honda; in fact, growth through diversification into new products and processes may deter the development of those capabilities.

Honda certainly wants suppliers to develop their own capabilities because, as the BP experience shows, they are likely to absorb Honda's philosophy and practical lessons most successfully. But another benefit, from Honda's perspective, is that these self-reliant suppliers are speedier about "earning the right to disagree" and thus providing an impetus for Honda's own improvement.

Conclusion

Given the difficulties described above, should a customer still try to create lean suppliers? Should suppliers agree to work with those customers pursuing this goal? Both suppliers and customers can benefit from entering into the kinds of knowledge transfer arrangements described in this study of Honda's BP. However, the specific mechanism chosen by Honda is far from the only way in which such knowledge transfer can take place. We have observed different mechanisms at other companies that are less "hands-on" and time-intensive, and less focused on learning from the "actual part, actual place, actual situation."³⁷ While these mechanisms are arguably less effective at conveying the tacit knowledge associated with lean production, they might also be less costly to the customer and less disruptive in their challenge to the supplier's identity.

Some knowledge transfer arrangements seem clearly *undesirable* in terms of imbalances in the risks and rewards that either customers or suppliers are asked to bear. Where knowledge transfer mechanisms require highly customer-specific investments of time and capital without a long-term commitment from the customer, the risk for suppliers may be unacceptably high. On the other hand, if customers agree to detailed, legally enforceable long-term contracts, they will lose much of their potential leverage with respect to getting suppliers to learn new capabilities.

However, even the best transfer mechanism, applied to a highly absorptive and responsive recipient, is not sufficient to guarantee successful knowledge transfer. The fundamental lesson of Honda's BP experience is that a supplier-customer relationship which generates high motivation for learning and high trust between provider and recipient is a crucial condition for any transfer of a complicated, largely tacit body of knowledge like lean production.

Notes

1. Susan Helper, "Strategy and Irreversibility in Supplier Relations: The Case of the U.S. Automobile Industry," *Business History Review*, 65/4 (Winter 1991): 781-824; Susan Helper, "An Exit/Voice Approach to Supplier Relations," in Gernot Grabher, ed., *The Embedded Firm: On the Socio-Economics of Industrial Networks* (London: Routledge, 1992); Michael Smitka, *Competitive Ties: Subcontracting in the Japanese Automotive Industry* (New York, NY: Columbia University Press, 1991); Toshihiro Nishiguchi, *Strategic Industrial Sourcing: The Japanese Advantage* (New York, NY: Oxford University Press, 1994); Jeffrey Dyer and W. Ouchi, "Japanese-Style Business Partnership: Giving Companies a Competitive Edge," *Sloan Management Review*, 35 (1993): 51-63; Michael Cusumano and Akira Takeishi, "Supplier Relations and Supplier Management: A Survey of Japanese, Japanese-Transplant, and U.S. Auto Plants," *Strategic Management Journal*, 12 (1991): 563-88.
2. Michael Gerlach, *Alliance Capitalism* (Berkeley, CA: University of California Press, 1993).
3. Andrew Mair, *Honda's Global Local Corporation: Japanization the Honda Way* (New York, NY: St. Martin's Press, 1994); Martin Kenney and Richard Florida, *Beyond Mass Production* (New York, NY: Oxford University Press, 1993).
4. James Bennet, "Detroit Struggles to Learn Another Lesson from Japan," *New York Times*, June 19, 1994; Richard Florida and Davis Jenkins, "Transfer and Adoption of Organizational Innovations: Japanese Transplants in the United States," manuscript, Carnegie-Mellon University, 1996.
5. For more detail, see a longer treatment of our research at Honda in Jeffrey Liker, Mark Fruin, and Paul Adler, *Remade in America: Transplanting and Transforming Japanese Production Systems* (New York, NY: Oxford University Press, forthcoming 1998), which includes all six supplier cases and comparisons of Honda's supplier development activities with those of other automotive companies.
6. We provided Honda with the criteria for supplier selection and Honda prepared a list of 15 from which we chose the final set. Honda informed the suppliers that they supported our project, but we made arrangements for the supplier visits ourselves and no Honda employees were present during our visit.
7. Giovanni Dosi and Bruce Kogut, "National Specificities and the Context of Change: The Coevolution of Organization and Technology," in Giovanni Dosi and Bruce Kogut, eds., *Country Competitiveness, Technology, and the Organization of Work* (New York, NY: Oxford University Press, 1992); Richard Nelson and Sidney Winter, *An Evolutionary Theory of Economic Change* (Cambridge, MA: Harvard University Press, 1978); Michael T. Hannan and John Freeman, "Structural Inertia and Organizational Change," *American Sociological Review*, 49 (1984): 149-164.
8. James P. Womack, Daniel Jones, and Daniel Roos, *The Machine That Changed the World* (New York, NY: Rawson Associates/MacMillan, 1990).
9. Nishiguchi, op. cit.; Smitka, op. cit.
10. Mari Sako, *Prices, Quality, and Trust* (Oxford: Oxford University Press, 1992).

11. John Paul MacDuffie, "The Road to 'Root Cause': Shop-Floor Problem-Solving at Three Auto Assembly Plants," *Management Science*, 43/4 (1997): 479-502.
12. Honda does steer its suppliers to good partners, in one sense, by asking their suppliers in Japan to assist the U.S. supplier of the same part. While much of this assistance is technical and product-specific, some involves more general advice about the production system. Yet these Japanese suppliers have a limited interest in developing the capabilities of a U.S. supplier who will be competing with them for business. They are likely to provide some assistance for the sake of goodwill in their relationship with Honda, but not the long, intensive tutoring necessary to incorporate fully the principles of lean production.
13. Nishiguchi, op. cit.; Michael Cusumano, *The Japanese Automobile Industry* (Cambridge, MA: Harvard University Press, 1984).
14. Authors' interviews at Honda in the U.S. and Japan; Mair, op. cit.
15. It is striking how often, in the course of our interviews at Honda, employees (from managers and engineers to purchasing staff) would repeat phrases attributed to Mr. Honda as central to the "Honda Way." Examples include: "Proceed always with ambition and youthfulness. Respect sound theory. Develop fresh ideas and make the most effective use of your time. Enjoy your work and always brighten your working atmosphere. Strive constantly for a harmonious flow of work. Be ever mindful of the value of research and endeavor." Mair, op. cit., p. 45.
16. Celeste and Sabety Ltd., "Honda of America Manufacturing Inc.: An Industrial Model of Technology Transfer—Transforming a Network of Automotive Suppliers," Columbus, Ohio, November 1993.
17. Ibid., p. 34.
18. Taiichi Ono, *Workplace Management* (Cambridge, MA: Productivity Press, 1988). Ono found that experienced employees often provide instant diagnoses of problems in a situation that seems familiar, emphasizing "first-level" causes (e.g., "that machine always breaks down when we run production at this volume") and solutions (e.g., "we need a new machine.") Going further requires probing for why the machine breaks down (e.g., "preventive maintenance not done" (why?); "because maintenance men are busy repairing another machine" (why?); "because the other machine overheats at high volume levels" (why?); "because it is located in a part of the plant with poor ventilation and no air conditioning" (why?); "because it was moved there to make room for a new piece of equipment that never arrived.") The true "root cause" of the observed problem points towards a very different solution (moving the machine or improving ventilation at its location) than the original diagnosis (replace the machine).
19. At the time we visited this single-plant firm, in 1992, it was owned and managed by an entrepreneur who had purchased it nine years earlier. Since that time, the firm has been acquired by a large automotive components company, given a new name, and put under new management. All of the events in this case study preceded the acquisition and did not involve the current management team.
20. At the time of our field research in 1994, the firm was named "R. J. Tower." It was subsequently acquired and merged with several other medium-sized stamping companies in the area to form "Tower Automotive." Everything described in this case precedes the acquisition. For simplicity, we will refer to the company hereafter as "Tower."
21. The case study of Donnelly, which we omit here to meet length requirements, is noteworthy as an example of Honda's willingness to help a capable supplier learn an entirely new and unfamiliar production process, in order to build on an existing supplier relationship rather than seeking a new supplier with that expertise.

Donnelly initially made unpainted door mirrors for Honda. When Honda decided to offer painted mirrors on its new models, it encouraged Donnelly to equip its new plant for painting, a process Donnelly had never done. The initial paint process, mostly manual, had major quality problems so Honda urged Donnelly to invest in a fully automated, sophisticated paint line. Despite having no explicit contract or commitments to purchase in hand, Donnelly's board did approve the \$5 million investment. Even with the new paint line, intensive BP activities with Honda were needed due to initial quality problems. Eventually, Donnelly overcame most of these early problems and began to win painted mirror business from other car companies, boosting its corporate sales from \$20 million in 1990 to \$30 million in 1992.

22. In 1996, Ruston Simon sold Progressive to another investor, although he remains as president.
23. J.D. Eveland and Louis Tornatzky, "The Deployment of Technology," in L. Tornatzky and M. Fleischer, eds., *The Processes of Technological Innovation* (Lexington, MA: Lexington Books, 1980).
24. Nelson and Winter, op. cit.
25. William Abernathy, Kim Clark, and Alan Kantrow, *Industrial Renaissance* (New York, NY: Basic Books, 1983).
26. Wesley M. Cohen and Daniel A. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Sciences Quarterly*, 35/1 (1990): 128-152.
27. Bruce Kogut and Udo Zander, "What Firms Do? Coordination, Identity, and Learning," *Organization Science*, 7/5 (1996): 502-518.
28. Paul Attewell, "Technological Diffusion and Organizational Learning," *Organization Science*, 3/1 (1992): 1-19.
29. Even once achieved, self-reliance could have different meanings. For Honda, self-reliance did not mean substantially less of the intense interactions between customer and supplier. For U.S. suppliers, in contrast, the idea of self-reliance might be best expressed as "now leave me alone."
30. Charles Sabel, "Learning by Monitoring: The Institutions of Economic Development," in Neil Smelser and Richard Swedberg, eds., *Handbook of Economic Sociology* (Princeton, NJ: Princeton University Press, 1994).
31. In fact, Honda has recently trained a team of engineers at the Cleveland Advanced Manufacturing Program, a technical assistance agency, in BP techniques so that they can help Honda meet the demand for the process among suppliers to Honda and to other firms.
32. For examples of long-term loyalty to Toyota in Japan generated in part by the automakers' technical assistance programs, see K. Odaka, K. Ono, and F. Adachi, *The Automobile Industry in Japan: A Study of Ancillary Firm Development* (Oxford: Oxford University Press, 1988).
33. Benjamin Klein, R. Crawford, and Armen Alchian, "Vertical Integration, Appropriate Quasi-Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21 (October 1978): 297-326.
34. Sako, op. cit.
35. Gabriel Szulanski, "Appropriating Rents from Existing Knowledge: Intra-Firm Transfer of Best Practice," Ph.D. Thesis, INSEAD, Fontainebleau, France, 1995. Szulanski argues that trust between the knowledge provider and the recipient is a key factor in motivating the recipient to learn what is being taught; this motivation is as important a factor in successful learning as is a more technical factor like the amount of prior related knowledge a recipient has.

36. A similar sentiment has been sounded, of late, by Big Three executives such as Chrysler's Executive Vice President for Supply Tom Stallkamp: "There is some danger that suppliers are getting overly integrated. We weren't very good when we were vertically integrated. You should stick to what you do best." *Cleveland Plain Dealer*, August 18, 1996.
37. MacDuffie and Helper, in Liker, Frui, and Adler, op. cit.