

Manufacturing in India – The End of an Era or Just the Beginning?

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Introduction

Since the liberalization reforms of 1991, India has found its manufacturing industry in a precarious position. Prior to 1991, Indian firms relied upon the license raj. Under this system, the Indian government licensed firms for production in their particular industry. This system provided strong barriers to entry and promoted a sellers' market and complacency among Indian firms. What these companies offered in terms of quality, cost, and delivery did not matter, because they were armed with licenses. Companies developed enormous capabilities to work with an internal focus and considerable energy and innovative thinking was spent on handling the bureaucrats – not the customers. The 1991 reforms have allowed for the establishment of fully owned subsidiaries of transnational corporations in India. This has prompted the market to slowly begin to slip away from the sellers and begin to be controlled by the buyers. Competition has exposed Indian manufacturers' lack of competitiveness, substandard quality, time-to-market shortcomings, productivity weaknesses, and lack of global vision.

While this may paint a rather bleak picture for Indian manufacturers, it also presents opportunities for firms that are willing to engage in a process of conversion and understand how to reinvent themselves. And there is an increasing number of companies that are embracing change. Indian firms are beginning to restructure by benchmarking themselves against manufacturing standards set by global players.

As the world moves into an "Information Age" – one where ideas are more important than assets and telecommunications is making geographic location irrelevant, India is on the threshold of triumph. India's has a wealth of manpower that is skilled in knowledge-intensive services (the fastest growing sectors of the world's economy) and a population with a natural affinity for mathematics and sciences. If these strengths can be harnessed in manufacturing sectors, and India's illiteracy, infrastructure, and political barriers can be surmounted, then India could become a global manufacturing player to be reckoned with.

Current State

WEF Report

The Geneva-based World Economic Forum's Report on Global Competitiveness reveals that India has been losing the competitiveness battle for the past decade. Of the 48 nations considered for the study in 1995, India ranked 39th (a drop of five places from the 34th position in 1994). It dropped six more positions in the next two years to settle at the 45th position in 1997. In 1998, India's competitiveness ranked 50th out of the 53 nations considered⁴.

The same report puts India near the bottom of the list in time-to-market and price & cost control. Indian corporations' long lead times force firms to carry large inventories or produce to a plan that is different than what the market demands. This results in high costs; large, non-moving inventories; poor delivery reliability; and eroded market share. The report also provides interesting insight into Indian labor issues. India is ranked 3rd in abundance of labor. However, India occupies the 46th position in employee training⁴. Many Indian organizations acknowledge that getting the best out of the work force and motivating employees are serious problems facing manufacturing managers.

The numbers presented in the global competitiveness report demonstrate how the 1991 liberalizations reforms have not just opened the doors to opportunity, but also facilitated the associated threats. At no point in the history of independent India has there been such an important need to examine the management of Indian manufacturers. Any error in judgment could prove to be fatal. But better understanding of market realities and suitable restructuring of operations will certainly improve India's manufacturing prospects.

Cost-Plus Mindset

Of the liberalization reforms of the 1990's, some of the most significant were those proposed by the Chelliah Committee. Among these was the recommendation for a basic shift in the mindset of manufacturers, namely calling for the end of cost plus margin operations². In its place, the industry was asked to reconcile with the reality that the price dictated by market forces (i.e., global market forces) minus the overhead margin was the cost at which goods and services needed to be delivered to the customer. This is a

fundamental change for manufacturing organizations that requires them to acquaint themselves with waging fierce wars in the market on the basis of quality, cost, and service.

Domestic Focus

One of the weaknesses of manufacturing organizations operating in a controlled economy is the predominant domestic focus in their approach to business. For a country such as India, a large domestic market, the role of the state in industry, and the philosophy of a planned economy were some of the reasons for this inward focus. Organizations with a domestic focus suffer from a “frog-in-the-well” syndrome. This, along with the influx of foreign capital, goods, and production processes themselves, have many Indian firms wondering how they can compete with the foreign juggernaut and whether or not the government has shortchanged Indian industry by changing the political environment so quickly.

Adjunct View of Manufacturing

A 1997 study by Pankaj Chandra and Trilochan Sastry (Indian Institute of Management, Ahmedabad) examined the competitiveness of Indian manufacturing and presented comparisons based on a similar study in the United States¹. The study revealed that the average firm is still very far from becoming world class. They surmised that the heart of the problem lies in views of manufacturing. They hold that in India, there is a traditional view of manufacturing as an adjunct or support activity for marketing and finance and therefore needs little top management. They believe that this philosophy still exists in subtle ways. That is, top managers often want to invest in one large effort to improve manufacturing. After that, they want to go back to their traditional concerns. Internationally, competitors view manufacturing and R&D as their competitive advantage and are continuously working on improving manufacturing by making it more flexible and responsive. That, they claim, is where Indian firms suffer.

Factory Layout

Many Indian manufacturers believe laying out machines on the shop floor is an exercise done once in the lifetime of the machines. Later, when additional machines are procured, they are simply placed wherever space is available⁶. However, it is hard to imagine that

organizations will continue to produce the same products year after year. Improved technologies, product life cycles, and new product lines make a strong case that firms will need to alter their manufacturing needs. Therefore, it is surprising that Indian managers often do not change the layout of their machinery as they change the scope of their business. This lack of foresight can result in confusion on shop floors and long cycle times. Unfortunately, a bad floor plan blunts the competitiveness of the products and services offered by organizations and cuts deep into their market share in several ways. Some of these are:

- In a poor functional setup, the customer is not central to the design. The internal conveniences have taken priority over customers.
- There are many Indian companies where products travel several hundred miles before getting dispatched to the customer.
- Information flow of paper work, authorizations, and documentations at offices can contribute to the confusion.
- More travel across the shop floor means more material handling, more material handlers, more material handling equipment, and more time for processing.
- More authorizations and paper work leads to changing of hands across functional departments in the offices and excessive delays, potential loss of information, and very little ownership.

Are Current Investments Targeted?

Indian manufacturing perspectives are obviously in sharp contrast to those in the United States, where innovation, R&D, and structural change have priority. However, Indian firms have invested in a variety of improvement programs. But some crucial elements are missing; for example, while firms are focusing on employee training, worker training is accorded the lowest importance. Firms are also investing in information technology, but what is not clear is how they plan to use this information for better decision-making. A few firms have been able to progress by leaps and bounds, but a large number of firms are struggling with housekeeping, monitoring quality problems, and training issues.

Case Study: A Firm “Under the Gun”

As an example of the threats to Indian manufacturers, consider Tisco, a steel manufacturer and icon of Indian manufacturing. In the two decades between 1973 and 1993, the manufacturing costs of saleable steel at Tisco, the most efficient integrated steel plant in India, has increased continuously, rising by a factor of 10.73. In contrast, the nominal cost of major overseas steel producers, which had risen for a decade since 1973, experienced a decline after 1983. Manufacturing costs in Indian steel plants increased in real terms; the annual average rate of increase between 1982-83 and 1992-93 has been significantly higher than the average rate of inflation as represented by the movement of the GDP deflator². The Indian steel industry has yet to achieve the standard quality parameters that characterize the international steel industry. This is directly attributable to the fact that before liberalization, protection made the market a seller’s paradise. The regime of protection turned steel producers into high-cost producers and contributed to the present inability of the producers to meet international standards in product quality, packaging, and customer service.

Case Study: Firms “On the Right Track”

Some Indian manufacturing firms are successfully navigating the traumas of change. These firms, of various sizes and product lines, are restructuring by benchmarking against quality standards set by global players. Sundaram Fasteners and Sundaram Clayton are two companies of the Sundaram Group that are clearly becoming world-class companies. Sundaram Fasteners has managed to introduce impressive changes; machine breakdowns, for example, have come down from 65 per month to 11 per month; tool change time has fallen from 210 minutes to 30 minutes. They have been awarded the best supplier award by global auto manufacturers, while Clayton has been awarded the prestigious Deming Prize for its brakes division¹.

Bharat Forge is another example of an older enterprise gearing up to meet the challenges of global competition. Today, the company has done better than its competitors in the face of a demand slump. This is attributable to the integrated forging shop, excellent machining capabilities, and control over input costs. In 1998, the forge plant capacity was forecasted to increase from 70000 to 110000 tons per year¹.

Ensuing Problems

Quality Problems

The World Economic Forum's Report on Global Competitiveness has brought to the limelight India's dismal performance with respect to customer satisfaction and quality. Increasingly, Indian organizations seemed to have missed out on both the Customer Orientation and the Total Quality Management drives that manufacturers in other countries have embraced. Interestingly, the 1996 global competitiveness rankings put China at 16 when it came to customer orientation compared to India's 43rd ranking⁴.

Supply Chain – Distribution Problems

The WEF report puts India almost at the bottom of the list with respect to time to market and price & cost control. Accordingly, Chandra and Sastry paint a bleak picture of Indian distribution tactics. The fact that the licensing raj has vanished has only exposed the structural weaknesses that Indian firms operated under (and continue to operate under). Management of inventories across the supply chain is weak; inventories remain high, with working capital tied up for long periods of time; there are delays in delivery; and the overall cost across the chain remains high. And, as stated, firms invest very little in meaningful R&D.

Organizational Structure Problems

Typically, Indian manufacturing firms have designed their organizational structures with sub-optimal results. These firms do not know much about what the customer feels about getting the products from them or whether the customer has any problems in using the product. They do not even know what the customer wants. Simply put, these firms organize themselves by bringing groups together on the basis of similar skills, with one group that looks at the market and customer problems. That relieves all other groups of customer-oriented thinking. This causes people in the organization to be preoccupied with things that are purely internal and inward-focused on their small area of operation without any reference to the customer or product⁴.

The ultimate representation of a customer in a manufacturing organization is the work order and the product as it gets manufactured, assembled, and tested. Unfortunately, in these functionally focused firms, the information and material flows related to the

execution of a customer order get tossed from pillar to post. Every functional group builds castles around themselves and begins to operate like isolated islands. Protecting the self interest of the group becomes more important than satisfying the customer. All this leads to a complicated material and information flow. When material and paper (documentation, authorizations, etc.) flow a horizontal direction, the information flow alternates between the vertical and horizontal directions. Within each department, the flow is horizontal. However, each time the material and the paper change hands from one group to the other, the direction of flow changes from horizontal to vertical. The extent of the vertical flow of information is directly related to the procedural aspects related to the process. For example, if a process requires the authorization of the department head, the vertical flow of information is longer. Often, such a flow mechanism promotes excessive delay and loss of ownership. The longer the vertical flow, the greater the delay. Moreover, vital information gets lost. Customer instincts and preferences become inaccessible to the shop floor, where these preferences are ultimately fulfilled.

These organizational structures can also result in serious conflicts of priority and confusion in the minds of managers at various positions. Consider a manufacturing manager. He and his subordinates have the responsibility of pushing the components that go into all their product families. A problem arises when the fabrication and assembly shops of the product families get stuck for lack of components from feeder shops. This situation is very common in organizations with a functionally laid out structure⁴. Similar problems exist in production control, design, and other manufacturing support functions. Conflict resolution and prioritization of the jobs is not always successful. Tactics used include simple rules such as “do the job of the person who makes the most noise,” handing out personal favors, or returning such favors received some time earlier. Thus, the system quickly degenerates into a personal one. It appears that nobody in the system is responsible for a given product except the Product Manager and his subordinates.

To Manufacture or Not?

The plight of Indian manufactures suggests that even established companies should learn to play the new ball game. Consequent to the changes brought about by the reforms, a few concerns assume paramount importance.

It appears that Indian corporate entities engaged in manufacturing are at a crossroads. They can choose between two operations, either to manufacture and sell products of world-class quality, or to become traders of such products. The current market realities and the nature of changes taking place across the globe suggest that India firms may question the basic premise of whether to manufacture at all. For the purposes of this paper, it is assumed that Indian firms *will* take the manufacturing route.

Unless these firms develop world-class standards and competence in manufacturing, their desire to compete as global manufacturers will remain a pipe dream and the dreaming organizations will quickly vanish into thin air. The next section addresses the solutions necessary to creating successful manufacturing organizations. It involves questioning the Indian mindset with respect to designing and managing a manufacturing enterprise.

Solutions

Innovation in Supply Chain Management

In summarizing their findings, Chandra and Sastry conclude that innovation and supply chain management are the key factors for the robust growth of any global enterprise, and that the failure of Indian firms to account for them in their scheme of things could be disastrous as international competition heats up. What Indian organizations need to learn is that in their pursuit of delivering value, they need to look at the entire value chain. Trying to keep the suppliers outside the purview of the overall improvement of competitiveness amounts to not attaining the desired results and business gains in the market place. Such organizations will severely blunt their competitive edge at the market place and will eventually fade into oblivion.

Until recently, getting suppliers to deliver quality material in time was the predominant activity of the buyers in an organization. This consumed almost all the time spent by the buyers. However, the role of suppliers in the organization of the 21st century is much more than providing timely supplies of quality material. That becomes just a routine aspect of the relationship. Suppliers should be expected to play a key role in developing new generations of products, providing better technology for existing products, taking part in aggressive cost reduction to targeted levels, and improving the delivery performance by cutting down lead time. Every organization needs to engage itself in a

variety of initiatives under the umbrella of developing supplier relationships. Among these are³:

- A continuous process of screening and capability assessment of potential sources.
- Provide a host of technical, infrastructural, and financial assistance for quality improvement, lead time, and cost reduction projects undertaken by suppliers.
- Continuous training and skill enhancement of the engineers at vendor organizations to bring them in sync with the manufacturer on manufacturing management matters.
- Provide the know-how and initial hand-holding for the implementation of JIT and other lean manufacturing practices and planning & control systems that the manufacturer wishes to percolate down the supply chain.
- Continuously address the changes required in the suppliers business system consequent to changes in the manufacturer. Such initiatives arise out of the implementation of email, Electronic Data Interchange (EDI), and Enterprise Resource Planning (ERP) systems that the manufacturer implements.
- Provide emergency support to suppliers during their periods of distress.

These initiatives would call for a battery of cross-functional engineers and managers representing purchasing, quality, design, process planning, costing, and information technology working full time on these issues. This would require the creation of a centralized structure that works closely with the layer of innovation in an organization. Suppliers would have to be part of this team on a full time basis. The benefits of such an arrangement appear to be enormous.

Supplier Partnerships

When an organization develops suppliers with an underlying philosophy of a long-term relationship based on mutual trust and cooperation, half the job of integrating the supplier with other groups internal to the organization is already done. However, some more mechanisms need to be created to sustain this relationship on an ongoing basis and reap mutual business gains. Recent advances in communication using computer networking technology offer considerable help in this area. Moreover, changes in the manner purchasers, suppliers, and designers relate and work with each other can make a difference. In addition, new performance measures, use of novel communication

channels, and new supply practices are the areas to look towards for help in these processes.

Allowing suppliers on to the shop floor of manufacturing organizations was an alien practice for many Indian organizations until recently. However, when suppliers are allowed on to the shop floor, the communication process between the ultimate user and the supplier greatly improves, leading to potential improvements in quality and delivery schedule.

Organizations can formalize this process by bringing in a system of direct online supply of items. Under this arrangement, input material is identified with certain suppliers. The suppliers are then requested to deliver in a certain pre-determined quantity at the place marked for the specific item in the respective area. Such a system offers several advantages. Salient among them are³:

- Simple documentation and control for the flow of materials into the work cells replaces elaborate paperwork at the stores.
- The direct online supply provides a sound basis for building a good communication channel between the supplier and the user.
- The system results in real time exposure of the various materials related problems on the shop floor.
- Above all, instituting direct online supply will help organizations achieve several benefits arising from ownership of production materials, machines, and the processes. The only way to cut down investment inventory is to eliminate the stores and keep the production material where it belongs.

Competition in the future is going to be between one value stream and another. Suppliers are likely to play a key role in this process. The individual identities of the buyer and the supplier have to co-exist in an overall framework of a single value stream. Organizations need to know the art of collapsing the supplier layer and merging it with other layers internal to the organization. Only when this process is completed can there be hope for Indian firms competing on a global scale.

Develop Performance Measures that Promote Co-Partnership

Existing supplier performance measures in most Indian organizations have very little to say about suppliers and their roles in the manufacturing organizations. Currently, there

are two measures directly relating to suppliers. The first is accounts payable. Accounting is usually happy to delay payments due to suppliers as much as possible. This allows them to achieve a better operating cash cycle. The other related measure is purchase price variance. Essentially, a favorable variance indicates purchases at prices more efficient than what was budgeted⁶.

Both of these measures have hampered the improvement of the materials management systems and the relationship between the buyer and supplier. They have also contributed substantially to inventory increases and quality deterioration. There seems to be an unwritten mandate that all other issues come after price. Such a narrow view is undesirable because a lower price can still lead to a higher cost of ownership of an item. The immediate requirement is getting away from price being the sole basis for taking on suppliers. Organizations should consider other factors such as quality, delivery reliability, and emergency responsiveness to special contingencies.

Indian organizations need measures that indicate fairly and clearly the extent to which co-partnership initiatives are going on within the organization. Moreover, they should also indicate the pace at which these take place. The procurement team members should be measured on the extent to which they have been successful in developing these partnerships.

IT Solutions

Physical distance between the buyer and supplier is one area of concern when it comes to merging the supplier with other areas of an organization. One way to solve the problem is to co-locate the suppliers near the buyers. Automobile and component manufacturers have resorted to this practice. However, in other situations, it is possible to reap further gains by employing information technology solutions.

With the arrival of email, the internet, and document management systems, organizations are able to freely exchange data between the supplier and the buyer in real time. For example, it is possible to send a purchase order and drawings related to an item of purchase electronically. Additionally, with the proper choice of user rights and control, organizations can allow the suppliers to view relevant screens. This allows production plan information to be used by suppliers to schedule deliveries. Electronic Fund Transfer

has become a key enabler of electronic commerce. Payments can be made without any paper transactions between the sender and the receiver.

Another application of IT in the area of purchasing is the recently introduced concept of procurement cards. Procurement cards are cost effective methods for making small purchases for maintenance, repairs, and operating supplies. Put into operation, a procurement card would replace enormous paperwork and accounting transactions involved in buying such items in an organization with a simple month-end transaction processing system. Buyers in an organization would use the cards for making the required purchases and the card provider would pay the supplier.

JIT

JIT is a Japanese management philosophy which has been applied in practice since the early 1970's in many Japanese manufacturing organizations. It was first developed and perfected within the Toyota manufacturing plants by Taiichi Ohno as a means of meeting consumer demands with minimum delays. Taiichi Ohno is frequently referred to as the father of JIT³.

Just in Time manufacturing is a systems approach to developing and operating a manufacturing system. It is based on the total elimination of waste. It requires that equipment, resources, and labor are made available only in the amount required and at the time required to do the job. It is based on producing only the necessary units in the necessary quantities at the necessary time by bringing production rates exactly in line with market demand. In short, JIT means making what the market wants, when it wants it. JIT has been found to be so effective that it increases productivity, worker performance, and product quality, while reducing costs.

Kanban

Also developed by Toyota, the kanban system efficiently controls repetitive manufacturing environments in order to minimize the inventory needed to allow a JIT delivery of parts and supplies. The people who manage this system must understand some basic concepts of linear functions to make good decisions for their company. Kanban uses the levels of buffer inventories in the system to regulate production. When a buffer reaches its present maximum level, the upstream machine is told to stop

producing that part type. This is often implemented by circulating cards (kanbans) between a machine and the downstream buffer. The machine must have a card before it can start an operation. It can then pick raw materials out of its upstream (or input) buffer, perform the operation, attach the card to the finished part, and put it in the downstream (or output) buffer. The number of cards circulating determines the buffer size, since once all cards are attached to parts in the buffer, no more parts can be made. When the machine picks up raw material to perform an operation, it also detaches the card that was attached to the material. The card is then circulated back upstream to signal the next upstream machine to do another operation. This way, a demand for a unit of finished goods percolates up the supply chain.

Six Sigma

Six Sigma is a quality improvement and business strategy that began in the 1980's at Motorola. Emphasis is on reducing defects to less than 4 per million (sigma is a statistical term that measures how much a process varies from perfection, based on the number of defects per million units), reducing cycle time with aggressive goals such as 30-50% reduction per year, and reducing costs to dramatically impact the bottom line. The statistical and problem solving tools are similar to other modern-day quality improvement strategies. However, Six Sigma stresses the application of these tools in a methodical and systematic fashion to gain knowledge that leads to breakthrough improvements with dramatic, measurable impact on the bottom line.

The Six Sigma DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new processes or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement. This Six Sigma process is executed by Six Sigma Green Belts and Six Sigma Black Belts, and are overseen by Six Sigma Master Black Belts. According to the Six Sigma Academy, Black Belts save companies approximately \$230,000 per project and can complete four to six projects per year. General Electric, one of the most successful companies implementing Six Sigma, has estimated benefits on the order of \$10 billion during the first five years of implementation⁵.

Implementing Change

Change Dynamics

Any change in the status quo of managers, line supervisors, the work force, and unions is generally unwelcome. They are gripped by fear of the unknown. Changes that alter the existing layout on the shop floor will evoke significant resistance from the work force because such changes alter the social structure existing on the shop floor. Groups get disbanded and new groups are expected to be carved out of the new architecture. The power structure within each group is apt to be realigned. Moreover, workers tend to imagine that the new mechanism worked out to change the manufacturing architecture is yet another method to get more work out of them at no extra cost.

Transferring to the new manufacturing architecture from design to reality is an art. The extent to which organizations actually realize the benefits claimed due to the changes is directly related to how well the transition is managed. The implementation of the new changes requires careful thought and consideration. Top management needs to understand the role they should play in this process. The middle level managers, the union, and the workforce need to be convinced of the validity of the change. Only out of such conviction comes the emotional attachment, support, and cooperation in changing the organization.

Top Management's Role

Nothing is taken seriously when the employees in an organization come to know that the changes have neither the top management's blessing nor their involvement and commitment. This is a significant aspect of management of change. Top management can do several things to ensure the smooth and successful implementation of change. Playing the role of a mute spectator can take away the spirit of the whole exercise and cause significant damage to not only the change program, but also to the morale of the work force.

The success of change implementation heavily hinges on two issues. The first is the issue of utilization. One of the guiding principles of the new manufacturing architecture is the dedication of resources. Operationalizing this idea has never been easy for organizations. Dedication of resources may call for a higher level of capacity build-up than what the firm

is accustomed to. The capacity could be in terms of additional machines, additional process and logistical resources, and additional manpower. Managers tend to downplay this dedication issue. Part of the solution to this problem is changing the performance measurement and reward systems. Unless top management gets involved in this process and provides clear directives with respect to the extent of dedication, implementation of the new architecture will not deliver the promised benefits.

The second issue that seems to play a significant role is the existing incentive schemes. The improvements in processes due to the changes in manufacturing will often result in reduction in the earning potential of the workforce if the incentive schemes are not redesigned. This is due to the fact that the standard man hours required will come down and as a result of the improvements. Top management should ensure that the earning potential of the workforce is preserved in the short term and the incentive scheme is made consistent with the new arrangements in the long run.

Top management also needs to play a vital role in communication. They should not miss a single opportunity that helps them demonstrate their support and involvement in the implementation process. Talking about the changes and the role played by employees should be their subject matter when addressing employees at company functions. The next section further addresses communication issues.

Communication

Initiating large-scale manufacturing changes and seeing them through to conclusion demands courage on the part of managers who act as change agents. Courage comes out of conviction and competence, which is derived from internalization of the need for change, the nature of the changes, and the potential benefits. One of the key processes in any management of change is communication.

Successful change programs demand substantial investment in communication. Top management should first be educated on the need, the required changes, and the potential benefits. The process then continues until the lowest level in the organizational hierarchy is reached. Changing a manufacturing architecture is no different in the required level of investment in communication and training.

Informing employees about the need for change and their role in the process is one kind of communication. However, there are many more varieties of communication channels

available to organizations that allow them to continuously interact with employees at different stages of change:

- Organizations can utilize their internal communication mechanisms such as newsletters and intranets to continuously report the process of the changes.
- Top management should not miss any opportunity to demonstrate their commitment to change. This include special review of progress at periodic intervals and frequent visits to where the changes are being carried out.
- Leading by example whenever possible is another communication channel that is quite powerful. Managers can undertake menial tasks and report their experiences back to the employees.
- Personal communication from managers to employees (i.e., hand delivered letters) assures employees of the roles they are expected to play and clarifies that it is not wrong to make mistakes in the new setup.

Quantify!

Changing over to a new manufacturing architecture can result in numerous benefits. A cursory look at these benefits suggests that many of the benefits fall under three categories – obvious, intangible, and difficult to quantify. To complicate things further, the benefits are often a combination of the three.

Benefits such as better worker morale, better team work, better sense of ownership, and better accountability are intangible. Improved production planning & control, reduction in WIP, and lead time are obvious. There are other categories of benefits such as a better customer focus that are hard to grasp. However, it is difficult to estimate the extent to which these benefit an organization until implementation is complete. A detailed simulation exercise can help to estimate these benefits. Nothing excites employees more than hard numbers and some tangible results. Management must be aware of this and endeavor to generate as much information as possible to catch the attention of the other employees. Suggestions for this include:

- Calculate the savings in the costs of reducing total distances traveled of supplies under the new architecture. Allow employees to participate in these calculations.

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- Detailed simulation studies can help estimate “difficult to measure” categories. The potential reduction in WIP, lead time, and increase in output can be estimated with some accuracy if management can model the new process for employees.
 - Generating statistics that appear to have mind-boggling efficiencies serve to bring a sense of excitement to change. Such statistics highlight the problems of existing processes.
 - Using graphical displays can impress the value of change upon the employees. By merely looking at the display, employees, over a period of time, will begin to think about the merits of the new design.

Conclusion – The Future

While the evidence so far is scattered in terms of the magnitude of changes that are taking place in Indian manufacturing, one thing seems pretty clear: *the paradigm is shifting*.

The old premises of Indian manufacturing will simply not work. This is a fact that firms across the industrial landscape are recognizing. Against this background, one can say with reasonable confidence that the Indian economy is witnessing the end of manufacturing as it was practiced before the reforms of 1991. In its place, India is moving to manufacturing that has been benchmarked to global standards. But overall, the attempts have been patchy and not universally spread. So, clearly, Indian manufacturing is going through a transition. The ethos that manufacturing is an operation best left to trade school graduates with more brawn than brain is being laid to rest because the rest of the world does not view it that way. This means that the job requirements for the shop floor and related manufacturing systems have to be upgraded, as they have been over the past 20 years in the United States and Japan. The functions must become white collar functions with higher job requirements, for which firms should be willing to pay higher salaries.

The difficult part of this story is, of course, finding a way to provide the necessary resources to allow India to successfully implement change. For Indian manufacturers to achieve and sustain globalization, the kind of capital made available to India will have to be drastically overhauled in terms of its duration and cost. At the end of the day, the story of Indian manufacturing is the story of Indian capital; one era of the former is dead, the other is waiting to mature into vigorous youth. If India’s political climate and

economic health can continue on a path of reform, then innovative manufacturing firms can leverage lessons learned by lean manufacturing pioneers. Only then can India capitalize on the potential that exists within its borders and become a global manufacturing player.

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