Competitiveness of Indian Manufacturing

Findings of the 2001 National Manufacturing Survey

Pankaj Chandra

Trilochan Sastry

Indian Institute of Management

Vastrapur, Ahmedabad 380015

chandra@iimahd.ernet.in

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Abstract

In this paper we present findings of the second national survey on the competitiveness of Indian manufacturing. The paper develops hypotheses on the competitiveness of firms in the manufacturing sector and addresses some key questions on the characteristics of world class firms in India. We analyze the processes and practices that such firms have adopted to become world class. More important, we highlight firm level practices that are preventing Indian firms from becoming globally competitive.

The findings point towards three distinct aspects of manufacturing management that define the capabilities of the firm, i.e., strategies related to dynamic control of shop floors, network linkages and innovation. It is found that firms that build distinctive technological and managerial capabilities in these domains are able to compete globally. The paper provides a comparison with manufacturing capabilities of competitors in China and draws lessons for organizing large scale manufacturing. It also provides an assessment of the changes that have happened in manufacturing priorities and strategies in India since our last survey that was conducted in 1997 and highlights the implications of these changes.

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1. Introduction

Manufacturing in India is being written off by the popular business press. There are more business pundits who seem to be itching to write its epitaph than there are analysts who have provided any serious perspective on its performance or have given suggestions for its improvement. Its has not been established if the current downtrend is an implication of a larger international phenomenon or if it is due to a restructuring of the Indian manufacturing environment in the face of new competition or is it reflective of any declining competitiveness. The question that every one wants an answer to is, how competitive are manufacturing firms in India?

To answer the above questions and to find meaningful solutions, we need to understand the environment under which firms have been operating and the issues that leaders of Indian manufacturing are grappling with. Whether these firms are fundamentally changing the way their manufacturing operations and supply chains are organized needs to be examined. Moreover, the perception of the leaders of firms about their own operation needs to be evaluated vis-a-vis the perception of external commentators. In essence, we need to examine the process of change in these manufacturing firms and their impact on manufacturing competitiveness in order to comment on the health of this sector. This has been the focus of the second national survey of competitiveness of Indian manufacturing firms undertaken by us at the Indian Institute of Management, Ahmedabad in the year 2001. The findings of the survey presents an aggregate picture of trends in manufacturing management as well capabilities that have been developed by Indian manufacturing firms. Appendix 1 gives the details of the survey. We also provide an assessment of the changes that have happened in manufacturing priorities and strategies since our last survey that was conducted in 1997.

2. Some Features of the Changing Manufacturing Environment

The organized manufacturing sector that we consider in this study comprises 0.8 per cent of a total of 14,618,623 firms in India. The remaining constitute the unorganized sector as classified by the National Sample Survey (i.e., the directory firms, non-directory firms and the own account firms). This organized sector employs 19.1 per cent of industrial workers in the country and contributes to

74.6% of gross value added in the economy (Kundu and Lalitha, 1998, ASI, 1995-1995). The manufacturing environment of this organized sector can be characterized as follows:

- Increased competition and entry of competitive firms. Several MNCs that are entering the Indian market are bringing in better practices, new technologies and are introducing products of superior quality.
- Large scale product substitution and increased variety. In almost all product segments, the consumer has seen a greater choice in terms of product features and has also led to increased demand for better quality products.
- High cost of capital and infrastructure/tightening of working capital (though there have been one of kind schemes like Technology Upgradation Fund for the textiles sector which provides a subsidy of 5 per cent on the interest rate for capital purchases).
- Diversified manufacturing. Indian manufacturing base is diversified though there is little coordination between various levels of a sector's value chain.
- Negative effects of location policies of the past. Policies of the past that provided incentives to locate in under-developed regions of the country made firms locate plants in very distinct locations. Many multi-plant firms now find it difficult to contain the cost of distribution from these plants and are unable to simultaneously roll out various improvement programs or vendor development strategies effectively.
- Lack of focus on equipment/labour standards. Use of non-standard tools and methods of production have locked a large number of firms in a low-level quality equilibrium. For instance, the "adda" (or locally made machine tools which are origami in metal) of Rajkot and Batala are still used by a large number of SMEs despite its poor precision and short life. Extent of mechanization is still very low even when it promises improved quality and short process times. Policy makers and industry associations have failed to ensure usage of state-of-art tools of production and safety. Reforms in labour laws are still pending.
- Changing tax regulations. Firms need to have stable regulations or need advance notice of change to order and make rational investments. Frequent changes in the tax regime has introduced uncertainty in operational planning. Octroi, excise, customs, central sales tax etc. have yet to be rationalized and their collection is not automated.
- Emergence of SMEs as drivers of growth in employment . Despite difficulties that SMEs face in procuring credit or harassment that they face from various government sources like

customs/central excise/local municipalities etc. for obtaining permissions to operate or to access markets, they have become the key source of employment generation and innovative activity in the country.

- A new retail environment. Big format retailing in the consumer goods segment is posing new requirements for operations management.
- Diminishing labour pressure. The labour union movement has also changed considerably over the last decade and militancy is on the decline. A new mindset is emerging amongst younger and skilled workers.

These pose new managerial challenges to the management of manufacturing enterprises India.

3. New Competitive Challenges

In our last survey (Chandra and Sastry, 1998), we had noticed that firms were facing competition predominantly from MNCs and some imports. While the new competition was in terms of low costs, improved quality and products with high performance, intense competition was seen in high end products and large ticket projects. However, the slowdown in global economy and adverse political events have since then subdued the market further – investments have come down, buying has slowly dried up and consumers & industries are looking to stretch their rupee as far as possible. In other words, the market for products seems to have shifted towards price sensitivity and has rewarded process improving strategies. Firms are conserving resources and delaying investments in technology.

China, on the other hand, has aggressively consolidated its position as one of the leading manufacturing locations in the world. (Some researchers are already starting to talk of three key hubs around the world – the knowledge hub of North America, Europe and Japan; the manufacturing hub of China, Korea and Vietnam and the data hub of India, Ireland, Israel etc.) It has graduated from being a global supplier of plastic molded US$ 1.00 toys to white goods and bicycles and sophisticated electronic gadgets. Its foray into semiconductor manufacturing almost two years ago is late by world standards but is strategic from long term perspective. Significantly, low cost Chinese goods (e.g., CFC bulbs from China sell for Rs 55 in the Indian market vis-à-vis a Phillips (India) model sells for Rs 235) have entered the Indian market in a big way. More importantly, whether it is bulk drugs or watches, Chinese products are selling at much lower prices in global markets. While there are complaints (mostly anecdotal) about the quality of Chinese

products in the Indian markets, these same products or their improved versions are winning larger market share as compared to Indian exports. Are there mis-perceptions of Chinese quality or are the Chinese firms playing a price-quality tradeoff very effectively in different markets? More fundamentally, why are Chinese firms able to compete globally while Indian firms do not? Is doing manufacturing in India more difficult and expensive than doing it in other countries? Or is there a capability and competence issue lurking somewhere behind the scene? These are some of the many questions that need to be answered in order to understand the state of manufacturing competitiveness in India.

4. Manufacturing Strategies

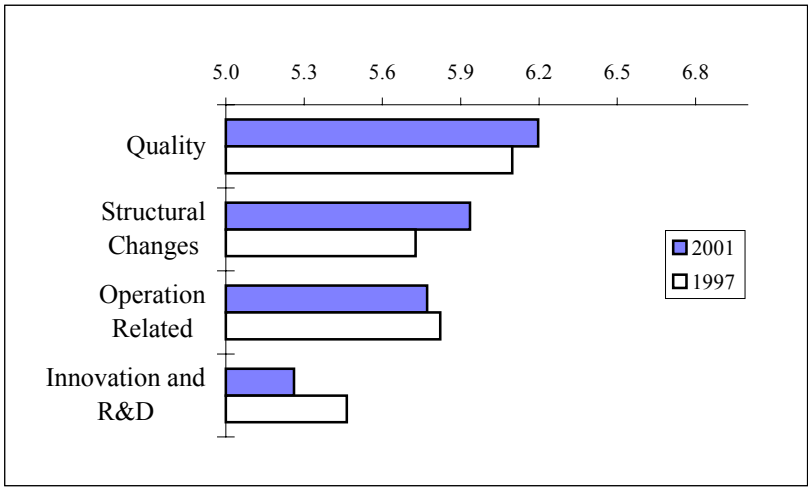
The 2001 Survey highlights the strategies adopted by Indian firms to improve their competitiveness. These strategies are viewed in two parts: the priorities of firms and the programs implemented to achieve these priorities. These priorities and programmes have been evaluated on a scale of 1 to 7 where 1 represents the lowest value in terms of importance or strengths or payoffs etc. and 7 represents the highest value (e.g., most important in case of degree of importance or much stronger in terms of degree of strength).

4.1 Priorities & Strengths

Figure 1 shows the relative importance given to four sets of issues by Indian firms over the two surveys (1997 and 2001). Quality remains the number one competitive priority of Indian firms. The priority for Quality and Structural Changes (which includes ability to change product mix, fast delivery capabilities & low price capabilities), has gone up since 1997. This is good news and indicates that the industry is recognizing the importance of bringing about basic changes in manufacturing systems, processes and practices. The priority for invention and R&D has gone down since 1997. This is not a good news. This has implications for long term competitiveness since manufacturing needs to be backed up by new product introduction and new processes to sustain itself both domestically and in exports. Same is true for operations related changes.

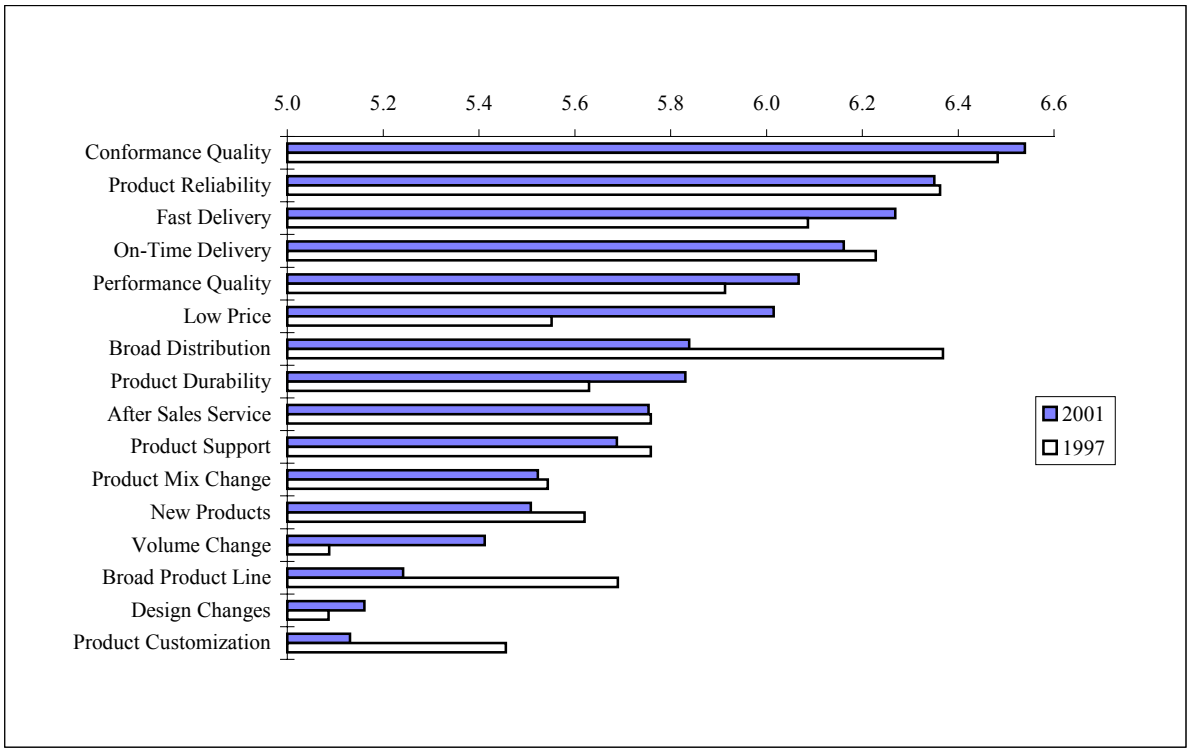
Figure 2 gives the details of various manufacturing priorities of Indian firms. The top three priorities for 2001 have been improving conformance quality, improving product reliability and fast delivery (as opposed to conformance quality, broad distribution and product reliability in the 1997 survey). The replacement of broad distribution with fast delivery reflects a shrinking of distribution network perhaps as a measure of cost control (more on this later). This may be

Figure 1: Competitive Priorities of Firms: Group Averages



supported by a greater emphasis on "low price" by firms in 2001 – perhaps an outcome of increase in competition from China etc. Product customization has lost its importance in 2001. Another strategy with similar effect has been the reduced emphasis on variety as seen by low importance of broad product line.

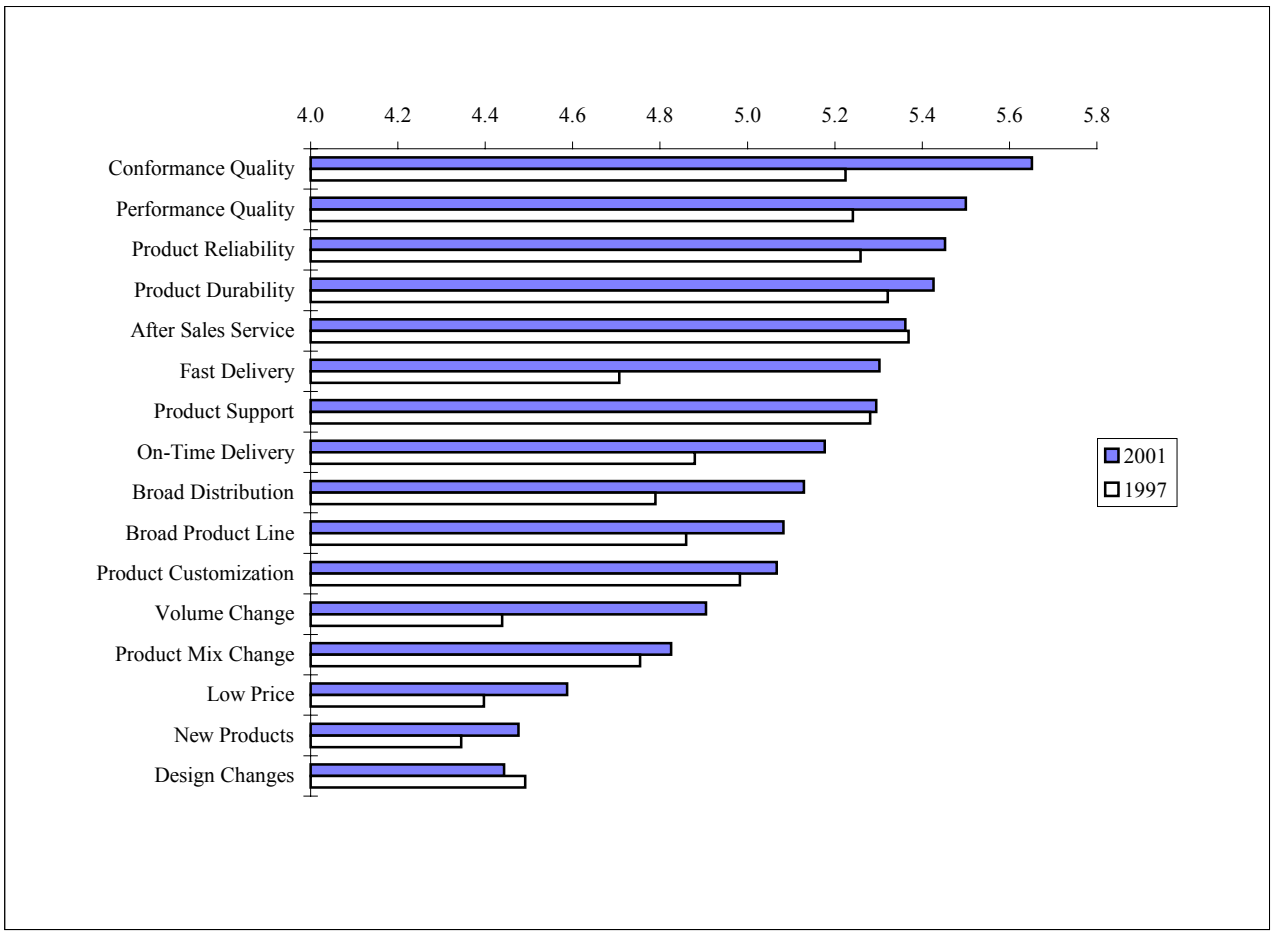
Figure 2: Competitive Priorities of Firms: Degree of Importance over the Next Five years



If we look at perceived strengths (Figure 3) the picture is similar to importance though it is

disturbing that despite a low perceived strength in innovation and R&D, firms are not paying adequate importance to this factor. Compared to 1997, perceived strengths on most factors like product reliability, performance quality, conformance quality, fast delivery, on-time delivery,

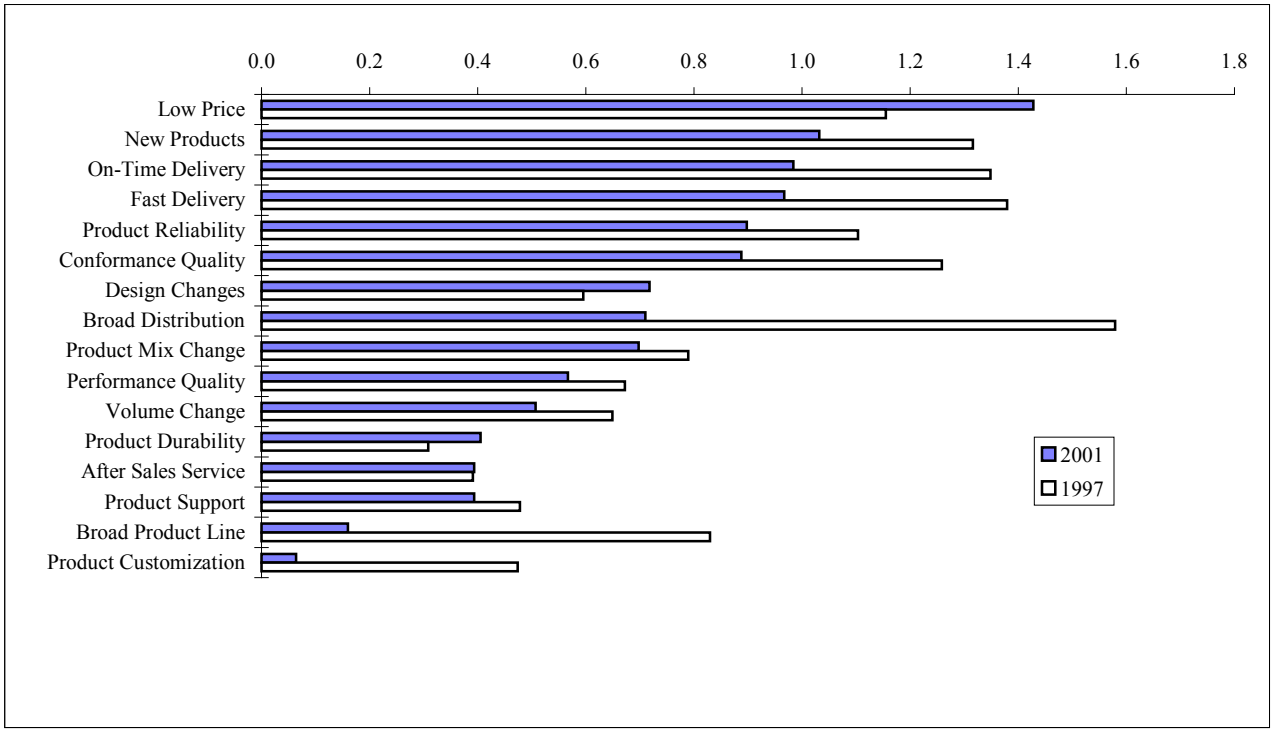
Figure 3: Perceived Strengths of Firms: Degree of Stregth Relative to Indian Competitors



volume change etc. have gone up. This may suggest that manufacturing in fact might have improved. However, more data and research is needed to establish this. The competitive gap between perceived importance and strength was higher in 2001 for factors like low price, design changes, product durability, and after sales service (Figure 4). Perhaps this is another indication of a shift in competition, maybe due to low priced imports from overseas.

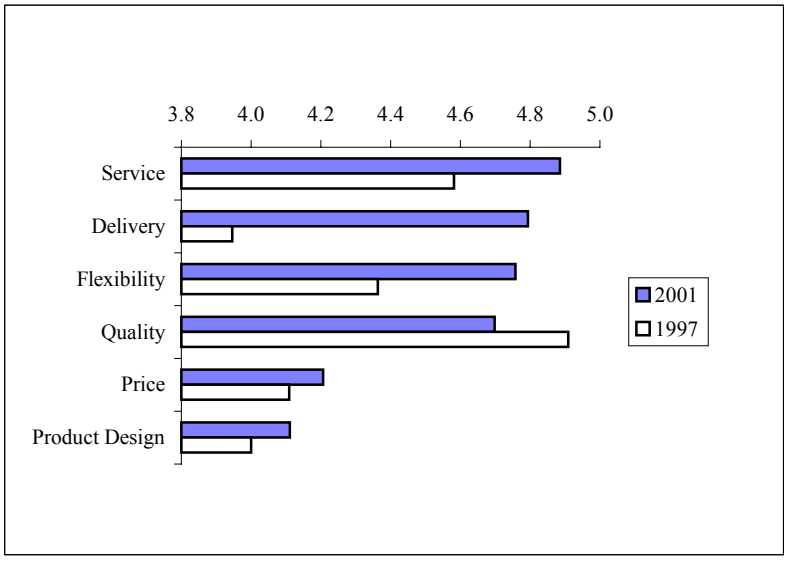
In Figure 5 we present perceptions of top management about their own operations vis-à-vis their foreign competitors. Interestingly, the sample firms rate their operations, on the average, "about equal" or "even slightly better" than their competitors outside India. The average score (on a scale of 1 to 7) is 4.9 on Service dimension, 4.8 on Delivery, 4.7 on Flexibility, about 4.7 on Quality, 4.2 on Price , and 4.1 on Product Design Capability. Note that on a scale of 1 to 7, firms

Figure 4: Competitive Gap: Difference between Future Priorities and Current Strength)



report 1 if their operations are "much weaker" than the competitors outside India, 4 if they are "about equal" and 7 if their operations are "much stronger" than their competitors outside India. About 11 per cent of sample firms have reported that they are much stronger than their overseas competitors on the dimension of flexibility while 6 per cent, 6 per cent, 5 per cent, 5 per cent and 6 per cent of sample firms claim the same on dimensions of price, quality, delivery, service and

Figure 5: Comparison of Performance with Foreign Firms



product design capability respectively. There are two possible interpretations of this reaction – (a) a large number of firms in the sample are the ones that are doing well (after any restructuring that may have happened in their industry) and hence are more competitive globally; (b) while firms may have a good perception of their own capabilities, they have a poor assessment of the capabilities and strengths of firms outside the country.

In summary, manufacturing strategy of most firms is still not addressing certain fundamental issues of competition: need to change product mix rapidly, need to introduce new products based on indigenous R&D, need to use process innovation and quality improvement process to reduce cost of operations and consequently price of product. One wonders if the industry has a good control of the causal factors that define competitiveness in a low margin environment.

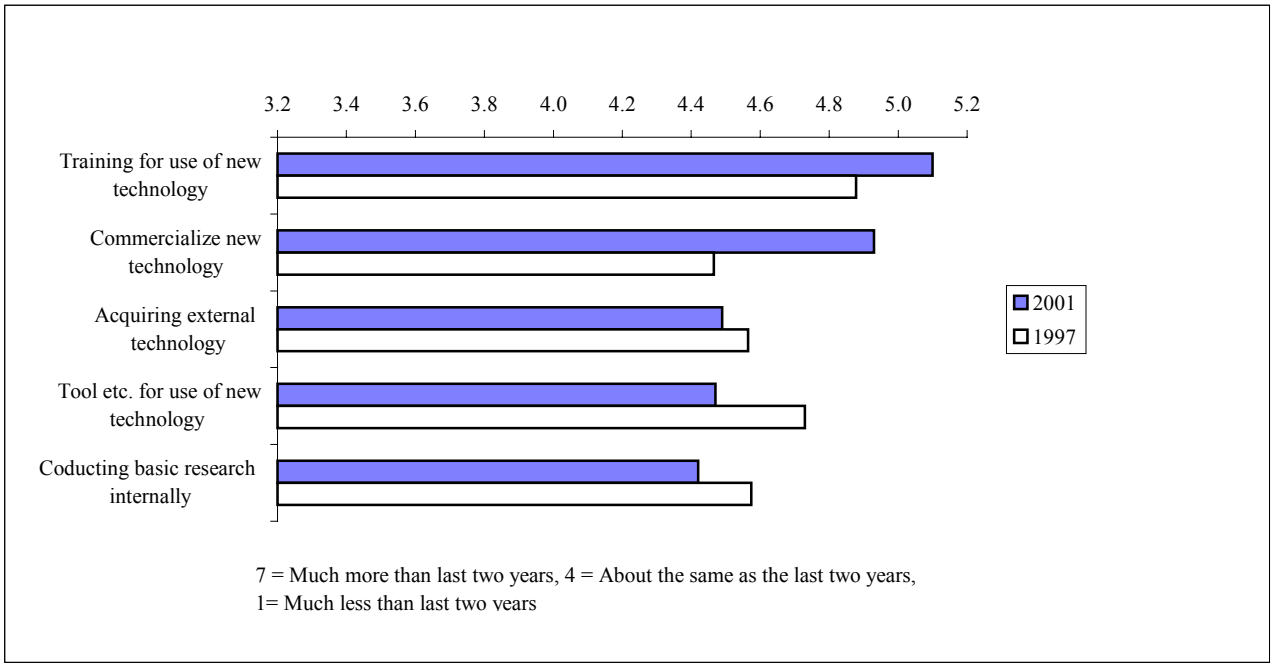
(Misplaced) Priorities & (Lost) Opportunities

Based on data from sample firms, cost of manufacturing still constitutes about 70 per cent of sales while physical distribution costs account for about 10 per cent of sales. If we look at the manufacturing costs further, an interesting structure emerges (based on data from our sample firms) – material cost comprises about 65 per cent of the total cost, direct labour accounts for about 9 per cent and other costs (i.e., overheads etc.) account for the remaining 26 per cent. This picture has changed just a bit from our last survey. This implies that efforts to reduce manufacturing costs need to be targeted on reduction in material related costs as well as overheads. The same figures for US (from 1997) were 55 per cent, 31 per cent and 14 per cent respectively. Investment in material costs would get reduced by looking at long term contracts with vendors, reducing rejects & reworks dramatically (currently, even the cost of warranty/returns is around 1 per cent of sales, on the average, which is quite high), developing alternative materials etc. By reducing investments in inventory across the supply chain (through implementation of pull-based material procurement), even the overhead costs can be reduced further. The debate on labour, on the other hand, is not so much about containing cost but points towards the fact that we have not been able to develop management systems to take care of large workforce. More on these issues later.

Absence of serious innovation from the agenda of most firms exhibits an incomplete assessment of the drivers of competitiveness. Figure 6 presents evidence to this effect. While investment in tools for the use of new technology, conducting basic research internally and rate of acquisition of technology from external sources was low in 1997, it has further deteriorated in 2001.

It should be pointed that these three actions are key triggers for achieving gains through innovation in any firm. What is most puzzling is that while industry recognizes the benefits of innovations (see Figures 7&8) yet its actions are not commensurate with their belief. Stringent government regulations (e.g., new environment pollution norms in the auto sector) and new standards (e.g., QC1400/ISO9000 series) have also helped firms bring new technology (i.e., products, processes and practices), and consequently improve their competitive positions. Similarly, most firms feel that downturn in the global economy will not support any efforts to expand markets – domestic as well

Figure 6: Projected Levels of Investment in the Future for Innovation Related Activities



as overseas. Two questions follow from this observation that industry must answer for itself: how do firms in China or Vietnam or Thailand, for example, continue to raise market shares globally? And, how are domestic firms preparing for the moment when the global economy starts to come out of its current low? Industry also appears to have given up on lowering labor costs as seen in Figure 8. Though one would think that the downtrend in economy would be a strong motivation to find newer ways to enhance labor effectiveness. Equally surprising is the fact that most firms no longer consider efforts for shortening production cycle times as yielding benefits (Figure 8). The gap in this area is also the highest amongst factors under study (Figure 9). Improvements in cycle times are stagnating at many firms that have been quite active in the past.

Figure 7: Past Benefits of Innovation over the Last Two years

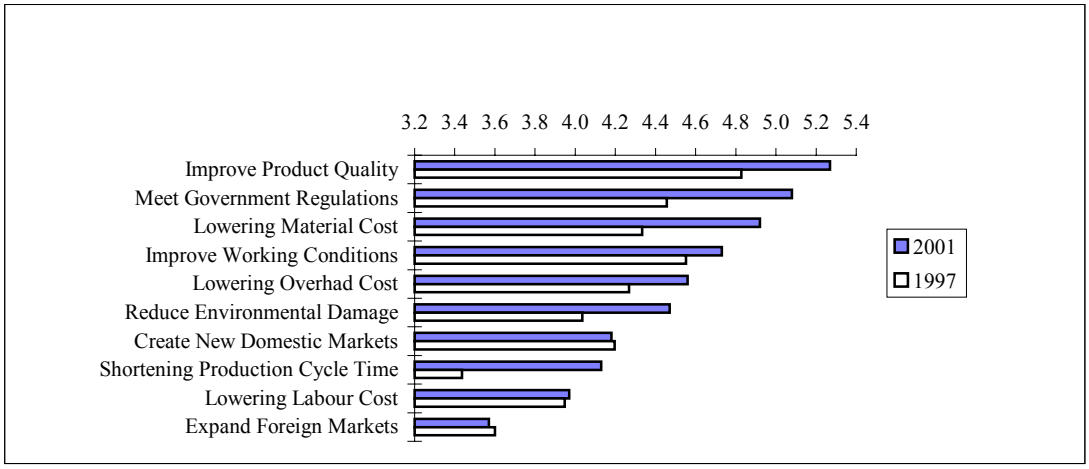


Figure 8: Potential Benefits from Innovation in the Future

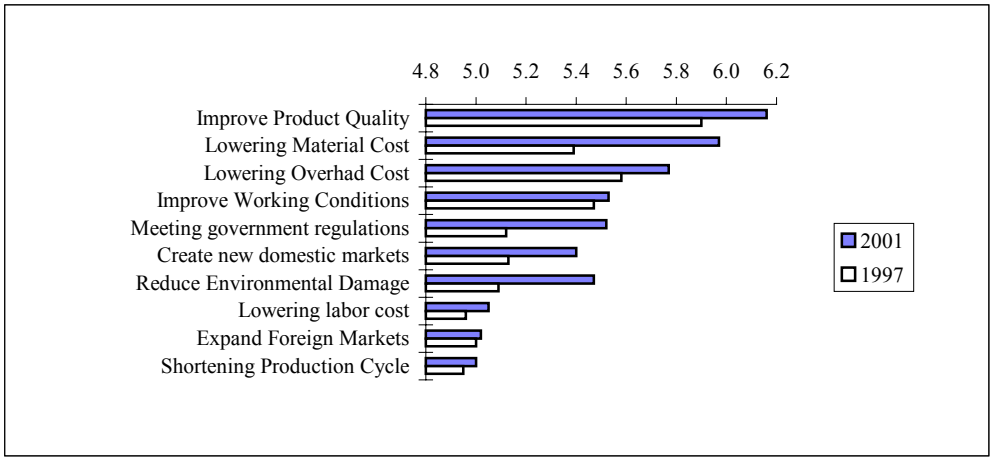
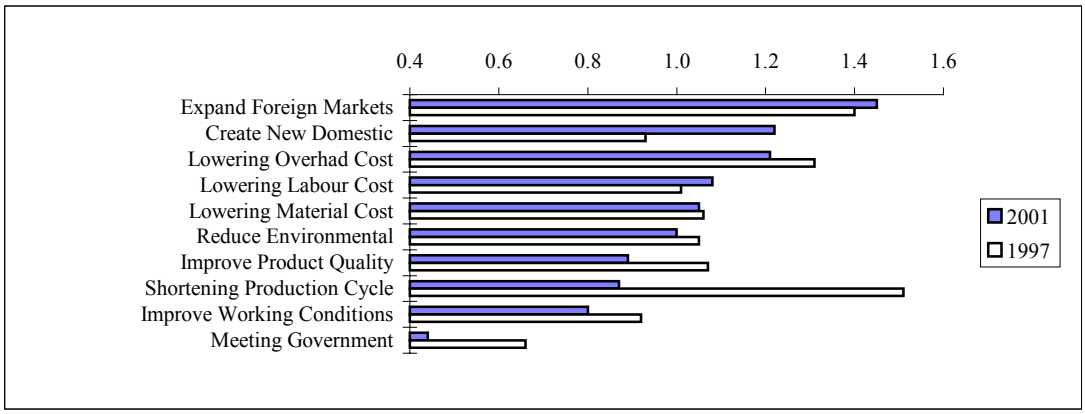


Figure 9: Gap between Past Benefits and Potential Future Benefits of Innovation



If we look into the process drivers of innovation, we can get a few clues to explain this lack of innovative ability in our firms: on an average, sample firms have fewer people with advanced degrees in their organization (i.e., on an average, firms have about 7 Ph.Ds and 43 with Masters degree while several firms did not have any employee with PhD or Masters in their organization), they invest about 3 per cent of sales on conducting research & development, spend about 1.5 per cent of sales in training for implementation of new technology, spend about 1.7 per cent of sales in coordinating various functions to commercialize new technology, have introduced, on an average, 42 new products during the last two years of which about half are close variants of existing products (e.g., a pharmaceutical firm claimed to have introduced two hundred new products in the last two years which also included strips of twenty tablets as opposed to the old packaging carrying ten tablets !) etc. While most (about 95 per cent of sample firms) have invested in new equipment in the last two years, half of this was imported. What was encouraging, however, was the high incidence of process related improvement in the firms. One could postulate that while a number of Indian firms are making significant process related improvements on the shop floor, product improvements or designs changes & significant practice related changes are lagging behind. Developing an ability to innovate is an opportunity that competitive firms can barely afford to give up. Not investing resources in "mind time" as well as in innovative activities is bound to reduce the competitive stretch of any firm.

4.2 Programmes & Execution

Manufacturing firms have been investing resources in a variety of improvement programmes aimed at enhancing their productivity and effectiveness of decision making. Table 1 gives a comparison of changes in emphasis on various manufacturing programmes. It lists the top ten initiatives that Indian managers have adopted in the last two years and compares them with a list of top ten programmes that they plan to implement in the next two years. Past initiatives have focused on training of workers, supervisors and managers. Perhaps that has prepared these organizations for bringing about different kinds of changes that they want to implement in their firms in the future. Moreover, absence of common information network across the firm has also led to sub-optimal decision making. It appears that firms would like to integrate information systems with manufacturing in the future – whether this means integrating machines on a computer network so that data streams can be monitored automatically for real time control or for making

planning & scheduling decisions through computer based decision support systems or is it simply for collating information for making reports, is not very clear. Neverthless, it is a good signal for Indian manufacturing. In addition to poor appreciation, it is lack of availability of application software at reasonable price that has also prevented the usage of IT for value adding work. Another item that has entered into the list of future initiatives is the focus on improving the quality of work life. This has been one of the most neglected areas in most manufacturing firms in India – many a shop floors have poor working environment in terms of temperature control, housekeeping, clean eating areas, modern meeting places, use of safety equipment etc. A healthy workplace creates a highly motivating environment. A case in point is the factory of the Orchid Chemicals & Pharmaceuticals which has a very green and clean work environment and pleasant work places for engineers and supervisors.

Table 1: Changes in Emphasis: Top Ten Manufacturing Initiatives of the Past and the Future

Initiatives in the Past	Initiatives in the Future
1. Continuous Improvement of Current Manufacturing Practices	1. Integrating Information Systems across Functions within Business Units
2. Management Training	2. Continuous Improvement of Current Manufacturing Processes
3. Supervisor Training	3. Management Training
4. Cross Functional teams	4. Developing Manufacturing Strategy to support Business Strategy
5. Worker Training	5. Integrating Information Systems within Manufacturing
6. ISO 9000	6. Benchmarking
7. Improving Manufacturing Processes to protect the Enviornment	7. Supervisor Training
8. Functional Teamwork	8. Cross functional Teams
9. Developing Manufacturing Strategy to support Business Strategy	9. Total Quality management
10. Integrating Information Systems across Functions within Business Units	10. Improving the quality of Work life.

Noticeable by their absence in the list of top initiatives for future are workers' training, TPM, JIT/Pull implementation on shop floors & material management, functional teamwork (i.e., production cells), supplier partnerships, statistical process control (SPC), outsourcing

manufacturing and ISO 9000. All these are common characteristics of managerial systems at world class plants (Industry Week, 1999, 2000, 2001). Pull production systems and SPC are the new tools of manufacturing. They are necessary to reduce inventory not only on the shop floor but across the entire supply chain. The issue is not whether we should or should not hold inventory but to determine the right levels of inventory and then continuously reduce these levels by implementing programmes that will reduce variability in operations. Continuous improvement programmes and Six Sigma initiative help in reducing variability in materials, processes & outputs. Firms that do not train their people in statistics will not able to take advantage of many shop floor improvement programmes like Six Sigma. It is truly amazing that while the Japanese implemented their version of pull systems (e.g., JIT) in late seventies and early eighties and the North Americans and the Europeans did the same in late eighties and early nineties and the Taiwanese and the Koreans did the same in mid nineties , yet Indian firms have not found merit in this strong practice! What is equally disappointing is that if one asks an average Indian engineer or a manager about statistics, the understanding barely rises above mean, median and mode. Even notions of variation are not well understood. One wonders as to how and when would our workers learn about sampling and orthogonal arrays?

Initiatives that have been ranked as the "bottom ten" in terms of the emphasis that firms will put in the future are: compuer-aided manufacturing (CAM), computer aided design (CAD), computer integrated manufacturing (CIM), design for manufacture (DFM), computer aided engineering (CAE), flexible manufacturing cells (FMC), closing or relocating plants, taking back products from customers to recycle or restore, simple pick & place robots and complex robotic systems. It is worth noting that most world class manufacturing systems around the world have implemented many of these programmes/technologies that are listed at the bottom of the emphasis list in India. This could also reflect the low extent of hi-tech manufacturing in the country in terms of hi-tech products and the usage of hi-tech processes. Another interesting observation is that all these technologies & initiatives require sophisticated information processing capabilities yet none of the large or small IT firms in the country have developed killer applications for these domains!

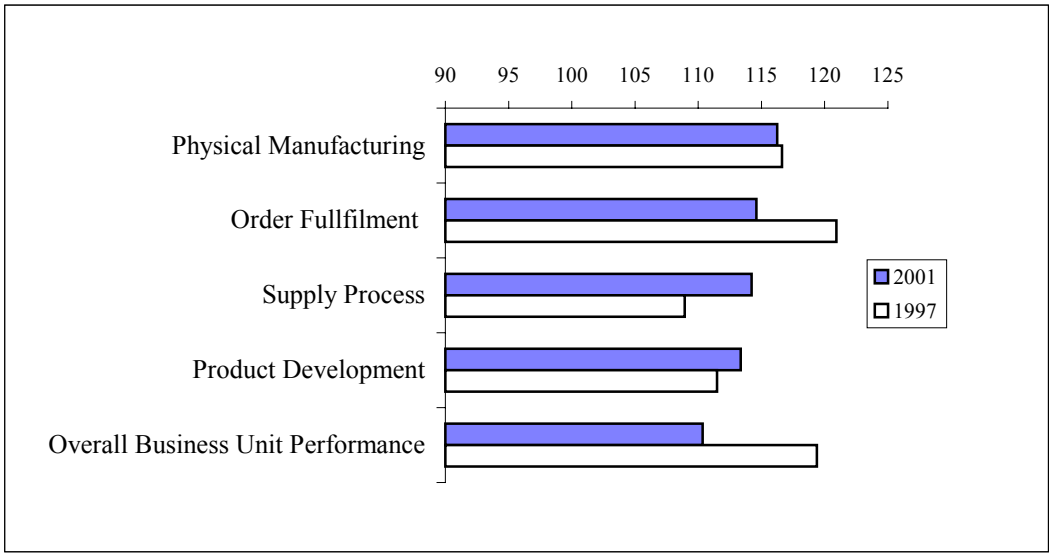
Another area worth mentioning is the "execution" skills of Indian manufacturing firms. There are four elements of "execution" related problems that firms do not pay enough attention to. These are: errors in following instructions, inaccurate record keeping, misplaced tools and material, and weak operational coordination (or strict scheduling) between groups involved in

execution of any programme. As a result, there is no neatness (i.e., absence of firefighting) in most operations projects. This results in higher operations cost though most of it may be hidden.

5. Manufacturing Performance

In order to determine if the manufacturing strategies and various managerial programmes that firms have implemented have indeed led to improvement in performance, we look at various performance measures as reported by the sample firms. The 2001 survey points to some interesting findings. Figure 10 shows the per cent increase in performance in five broad areas. It can be seen that the average rate of increase in performance in areas of manufacturing and order fulfillment

Figure 10: Average Performance Indicator

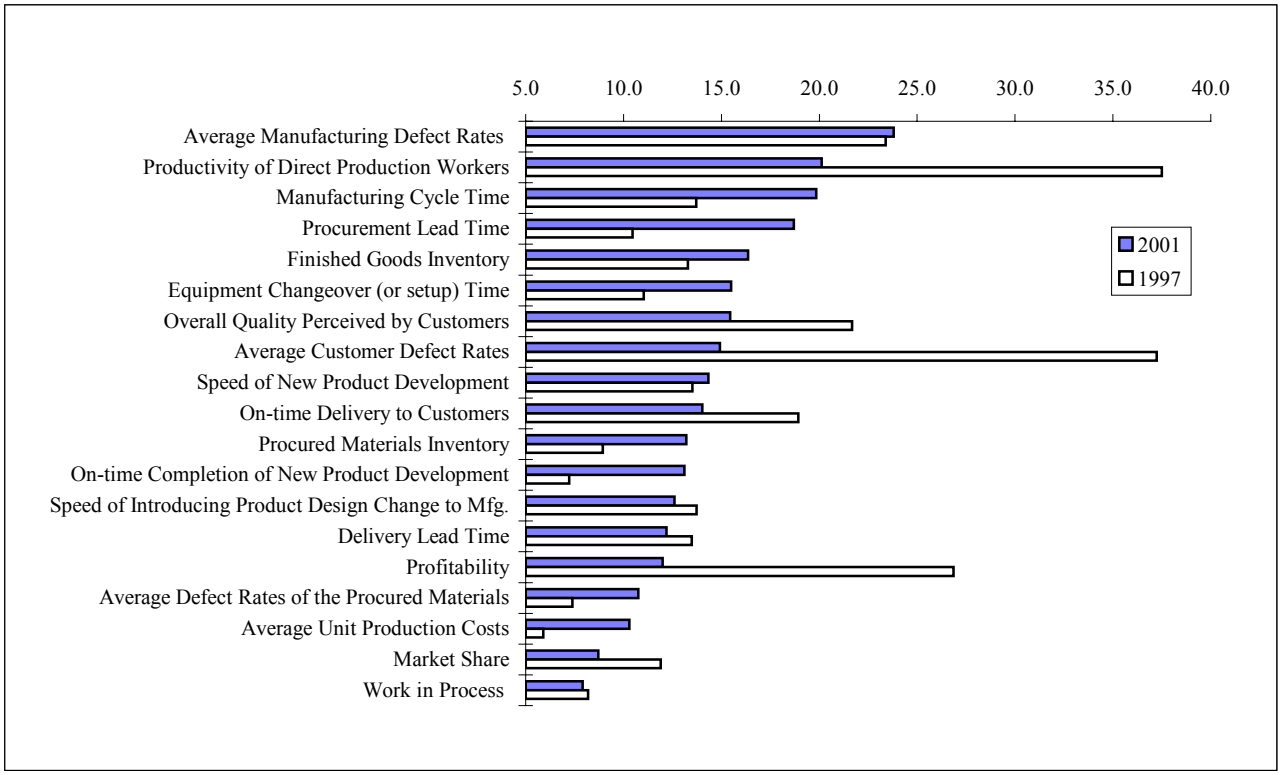


have been lower in year 2000-2001 as compared to the last survey period of 1996-1997. However, improvements in supply processes and product development processes have been more this time around as compared to the last survey period. The rate of increase of overall business unit performance in the current survey period is also lower than that in the last survey period. Lets explore these domains and performance therein.

Figure 11 shows the percent improvement on various manufacturing performance indicators over the last two years (Figure 10 is an aggregation of these indicators into five categories). The top five areas that have seen maximum improvements are "average manufacturing defect rates (an average of 24 per cent improvement over the last two years),"productivity of direct production workers (about 20 per cent)", "manufacturing cycle time (about 20 per cent)", "procurement lead time (about 19 per cent)" and "finished goods inventory

(about 16 per cent)". (Please note that the top five improvement areas in the 1997 Survey were productivity of direct production workers, average customer defect rates, profitability, average manufacturing defect rates and overall quality perceived by customers !) In some ways this is good omen for manufacturing as improvements on cycle times and inventory reflects a success of various operational improvement programmes especially those that are tactical in nature. Four key trends can be observed from this figure: First, the emphasis on supply management programmes have resulted in improvements in related outcomes (i.e., procurement lead times, procured material inventory, and average defect rates of procured materials) and these improvements are better than those in the last survey. Second, some shop floor programmes have led to

Figure 11: Percent Improvement on Various Manufacturing Performance Indicators over the Last Two years



improvements in areas like manufacturing defect rates, manufacturing cycle times, setup times, and unit production costs. However, there has been less success in reducing WIP on shop floors. Third, the customer interface, on the average, has not seen substantive improvements (the rate of increase has been less than what it was two years ago). This includes perception of quality by customers, average customer defect rates, on time delivery to customers, and delivery lead time. Fourth, the rate of growth in profitability and market share, on the average, has come down

significantly. This could be due to the downturn in the economy and the consequent drying up of the domestic and export markets and due to intense competition from firms within the country and outside.

Unlike the last survey, several firms in the 2001 survey have reported deterioration in their performance. 38 per cent of sample firms have seen an increase in WIP over the last two years. On-time completion of new product development has declined for 27 per cent of firms. 17 per cent of sample firms have seen an increase in manufacturing cycle times and procurement lead times. Market share of 16 per cent of firms and profitability of 14 per cent of firms has come down in the last two years. Overall perceived quality by customers, average customer defect rates, delivery lead times and average unit production costs has come down for about 12 per cent of firms. Some deterioration has also been observed in other performance parameters as well. Of all the instances of decline in performance (across all parameters), maximum instance of decline has been found in firms in the process industry, followed by those in the automotive sector, engineering & machinery sector, textiles, consumer goods and electronics (in descending order). Deterioration in operational performance is a sure sign of loss of competitiveness of these firms. It reflects poor control of operations and should be a cause of concern.

Table 2 gives a summary of sector-wise manufacturing performance of the sample firms in the 2001 survey. It provides a comparison of various performance measures across industry sectors like automotive, consumer goods, electronics, engineering & machinery, textiles and process industry. The numbers give average values on a certain performance parameter (while standard deviations are given in parenthesis). We also present averages (and standard deviations) on these indicators for the entire sample as a whole. Some of this data can be benchmarked against the overall industry averages from a survey done in the US in 1994 (Kim and Frohlich, 1994). It can be seen that performance varies by the sector. The high standard deviations point to a large variability in performance within each sector with the worst for firms in the process industry (with a coefficient of variation of about 2). While the growth in unit sales has been high, profitability has been low (firms in the textile sector seem to have done well on this count). This could be seen in the context of low capacity utilization for all sectors other than textiles and process. In terms of operational performance, the automotive sector leads all others. This sector has also seen strong linkages with global customers who have stringent requirements of both quality and price. Globally, this sector has been at the forefront of operations related innovation. High lead times still

Table 2 Mean (Standard Deviation) Values of Manufacturing Business Unit Performance by Industry

Indicators	Automotive	Consumer Goods	Electronics	Engineering & Machinery	Textile	Process	Overall (India) Mean	Overall (USA) Mean*
Annual sales revenues (RS. crores)	2307.4 (3799.9)	302.1 (219.7)	428.3 (488.6)	84.3 (29.8)	108.1 (96.3)	765.5 (1528.1)	789.7 (1951.3)	4327.5
Net pretax profit ratio (profit/sales) * 100	4.8 (4.4)	-0.4 (26.0)	2.5 (11.1)	5.7 (4.1)	10.1 (7.8)	6.4 (8.2)	5.0 (12.2)	11.8
Growth rate in unit sales (%)	20.9 (19.8)	24.8 (41.2)	25.6 (17.8)	10.4 (9.07)	24.3 (15.5)	13.1 (12.6)	17.9 (19.4)	7.7
Growth rate in rupee sales (%)	21.3 (13.9)	26.5 (25.5)	25.7 (8.2)	4.78 (7.12)	34.9 (23)	11.2 (12.3)	18.5 (17.6)	6.4**
Market share of primary product (%)	31.0 (23.4)	29.2 (20.0)	35.9 (22.5)	34.9 (22.6)	33.2 (21.9)	29.3 (26.9)	32.7 (24.8)	34.1
Capacity utilization	73.8 (12.7)	77.0 (10.7)	66.3 (23.3)	66.1 (9.6)	94.0 (10.7)	93.3 (23.9)	82.1 (22.1)	73.7
On-time deliveries (%)	92.8 (5.4)	94.4 (3.8)	86.0 (14.8)	86.0 (12.8)	80.0 (14.7)	88.5 (5.9)	88.6 (9.7)	88.9
Average manufacturing lead time (days)	11.6 (6.6	26.6 (31.9)	22.4 (28.0)	30.6 (28.5)	32.3 (12.12)	33.7 (44.9)	27.8 (33.0)	-
Annual inventory turns per year	10.6 (3.3)	7.4 (6.6)	8.3 (8.5)	11.9 (6.8)	9.9 (6.6)	13.7 (12.3)	10.9 (8.9)	11.2
First pass yield (%)	86.94 (22.9)	92.8 (10.9)	87.4 (6.1)	87.1 (9.8)	94.5 (5.7)	85.1 (25.2)	90.3 (12.3)	-
Sales from new products (% of annual sales)	38.6 (23.6)	42.3 (29.2)	40.0 (36.7)	19.2 (14.6)	55.2 (23.0)	17.2 (16.1)	33.9 (26.2)	-
Cash-to-cash cycle (days)	36.2 (52.9)	71.2 (33.9)	78.8 (56.6)	89.0 (51.1)	56.7 (20.2)	61.2 (44.2)	64.1 (45.4)	-
Value of existing backorders (% of annual sales)	6.0 (5.4)	1.8 (2.3)	15.0 (7.1)	52.3 (65.9)	4.5 (0.5)	22.8 (21.6)	21.4 (35.1)	-
Value of outstanding accounts receivable (% of annual sales)	12.6 (5.8)	11.6 (5.3)	18.0 (8.4)	25.7 (13.2)	5.0 (5.0)	18.2 (8.2)	16.5 (9.4)	-

* Overall mean values for US industry is given for the year 1994; ** reflects growth rate in dollar sales; 1 US$ = 47.5 Rupees; 1 crore = 10^7

plague other sectors in the sample and inventory turns continues to be to quite low by global standards. In particular, the engineering & machinery sector suffers from poor cash-to-cash cycles, high outstanding orders as well as account receivables, low performance on innovation etc.

Interestingly, the overall performance measures for 2001 on many dimensions appear to be similar to those in the US for 1994.

In Table 3 we compare the average performance of different sectors on some dimensions over the two survey period, i.e., 1997 and 2001 on some dimensions. For example, the average annual sales revenue of an automotive firm in the sample has gone up from Rs 292.7 crores in 1997 to Rs 2307.4 in 2001 (this may be due to sampling differences within the two surveys as well as higher investments in the recent survey period). Similarly, the average revenue of sample firms in the electronic sector has more than doubled between 1997 and 2001 while that for engineering & machinery, textiles and process industry has reduced. The sharp decline in average sales of firms in the textile sector (a decrease by about 84 per cent) could be reflective of loss in competitiveness and

Table 3: Mean Values of Manufacturing Business Unit Performance by Industry in 2000 (1997)

Indicators	**Automotive**	**Consumer Goods**	**Electronics**	**Engineering & Machinery**	**Textile**	**Process**	**Overall (India) Mean**	**Overall (USA) Mean***
Annual sales revenues (Rupees crores)	2307.4 (292.7)	302.1 (248.0)	428.3 (160.9)	84.3 (162.8)	108.1 (601.1)	765.5 (1096.6)	851.9 (384.4)	4327.5
Net pretax profit ratio (profit/sales) * 100	4.8 (9.6)	-0.4 (7.5)	2.5 (9.8)	5.7 (11.6)	10.1 (5.1)	6.4 (12.0)	5.3 (9.9)	11.8
Capacity utilization	73.8 (80.0)	77.0 (70.3)	66.3 (69.6)	66.1 (64.2)	94.0 (90.6)	93.3 (91.7)	74.6 (76.1)	73.7
On-time deliveries (%)	92.8 (80.8)	94.4 (84.8)	86.0 (75.0)	86.0 (80.2)	80.0 (93.0)	88.5 (92.9)	80.5 (83.7)	88.9
Average manufacturing lead time (days)	11.6 (19.2)	26.6 (21.3)	22.4 (13.3)	30.6 (74.7)	32.3 (19.2)	33.7 (30.0)	25.9 (39.5)	-
Annual inventory turns per year	10.6 (8.0)	7.4 (6.6)	8.3 (5.3)	11.9 (6.4)	9.9 (8.1)	13.7 (6.4)	10.5 (6.6)	11.2
First pass yield (%)	86.9 (74.4)	92.8 (75.4)	87.4 (82.3)	87.1 (91.0)	94.5 (96.0)	85.1 (92.8)	80.8 (85.6)	-
Sales from new products (% of annual sales)	38.6 (22.7)	42.3 (24.3)	40.0 (44.5)	19.2 (12.8)	55.2 (52.8)	17.2 (16.1)	32.4 (25.4)	-
Cash-to-cash cycle (days)	36.2 (50.3)	71.2 (41.3)	78.8 (61.0)	89.0 (116.5)	56.7 (76.6)	62.9 (72.0)	63.5 (75.0)	-
Value of existing backorders (% of annual sales)	6.0 (10.4)	1.8 (17.5)	15.0 (10.1)	52.3 (62.9)	4.5 (26.0)	22.8 (9.6)	21.6 (30.1)	-

* Overall mean values for US industry is given for the year 1994; ** reflects growth rate in dollar sales; 1 US$ = 47.5 Rupees; 1 crore = 10^7

hence a large scale restructuring of the sector. (Higher capacity utilization and lower sales imply higher inventories.) Consequently, those that have remained are performing well (as reflected by higher profitability of remaining firms). What is also obvious is that firms seem to be working hard (as seen by growth in unit sales), however, pressure on margins is high. Profitability of firms across sectors (except textiles where restructuring is evident) has declined over the two survey periods. The good news is that performance on operational parameters like on time deliveries, inventory turns, first pass yield etc. has improved. The not-so-good news is that their global competitors have also improved on these parameters in the same period and sometimes by higher percentages.

In the following paragraphs we discuss findings from the exercise to determine significant correlations between performance and several practices. These relationships that we describe below are found to be significant across all the six sectors of industry that we have studied. Analysis of firms in the survey shows that firms that have high sales revenue also have high investments (as a per cent of sales revenue) in conducting basic research and development internally, and in training for implementation of new technology and also have higher per cent of employees with advanced educational degrees (i.e., a Masters or a PhD degree). Similarly, those firms that have higher number of employees with advanced degrees and those that invest more in training on new technology are more likely to carry out basic R&D in house and are more likely to invest in advanced technologies for manufacturing and R&D purposes. Interestingly, manufacturing costs are also found to be negatively correlated with investments in internal R&D and training on new technologies. As a result, it is no surprise that firms that show higher profitability are also those that make higher investments in basic R&D, show higher percentage of perfect orders delivered to customers, and have lower value of backorders as percent of annual sales.

When we look at operational performance, we find that percentage of perfect orders delivered to customers and first pass yield on shop floors are positively correlated with percentage of perfect orders received from suppliers. This highlights the need to control quality and costs across the entire supply chain in order to remain competitive. Moreover, as first pass yield increases, effective capacity utilization also increases (as there is less need to re-work on or do replacement work for defective parts) and hence return on assets also increases. This is borne by high positive correlation between these three variables. Firms that have higher first pass yield also have lower average manufacturing lead times. These correlations point towards practices and performance measures that go together in delivering competitiveness to firms.

Table 4 provides a comprehensive list of performance measures tracked by firms in different sectors. A single firm may be following a few of them, however.

6. Extent of Supply Chain Coordination

Coordination is the essence of supply chain management (SCM) which deals with the process of synchronizing the flow of information and goods to customers across a network of suppliers, manufacturers and distributors. While all the sample firms appear to have implemented some form of a SCM programme, the need to change the decision making process in organizations has not been well understood. IT departments have, once again, undermined the supply chain agenda of firms by over-emphasising the transaction aspect of supply chain systems (i.e., selling SCM as a IT solution) while ignoring the changes required in decision hierarchy and processes. Two factors quietly affect the performance of firms significantly – long lead times and uncertainty in external environment (i.e., in demand or supply situation) & uncertainty in internal processes (i.e, absenteeism, variable processing rates, machine breakdowns, transport delays, uneven production schedules etc). This is often not well understood in industry. It has been seen that by ensuring flow of information across the entire supply chain and by shortening lead times, firms are able to reduce the impact of uncertainty. Any holding back on efforts to reduce lead times will result in high inventories or lost sales. Coordination across supply chains in most firms is weak, at best, and performed, if at all, informally. Supply chain management is about recognizing interdependencies between functions and between members of the chain and developing effective strategies to synchronize decisions. This objective is amiss with most firms even today.

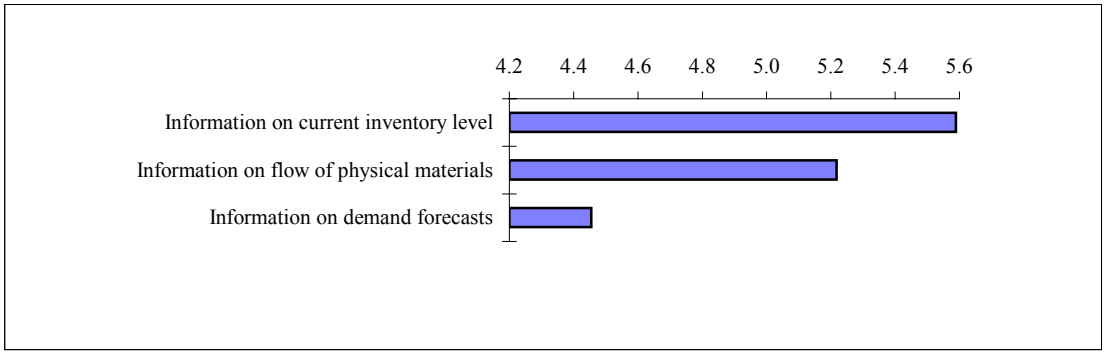
One of the difficulties that we notice in a firm's ability to coordinate their supply chain is poor collection and usage of meaningful information. Despite investments in ERP systems most firm`s barely share relevant information to all members of the supply chain. (see Figure 12). Without smooth flow of information, decisions are inaccurate and delayed – both leading to higher costs of operations. Moreover, it leads to the well know bullwhip effect and consequently to a build up of inventory across the chain. This issue of lack of visibility of information needs to be looked in the context of forecasting practices, inventory practices, supplier relationship, transportation planning and location policies of the firm.

Table 4: A List of some Key Performance Measures Tracked by Manufacturing Firms

Automobiles	Consumer Goods	Electronics	Engineering & Machinery	Textiles	Process
• Asset utlilization & efficiency • Scrap generation • Power & fuel costs • Plan cost reduction • Productivity (direct & indirect) • Internal & external rejects • On time delivery • Raw material yield • Vehicle indent fulfillment • Warranty of pre-delivery contents • Variable cost erosion • Supply chain cost • Personnel cost • In-house quality • Manufacturing overheads	• Raw material cost • First pass yield • Fuel & power costs • Reject rates • Productivity • Per capita output • Aligment to market need • Velocity ratio • Actual inventory & throughput speed • Hitting ratio • Efficiency • Wastage of resources • Product quality • Product delivery • Employee welfare • Manufacturing costs • Plant utilization • Costs • Defects per million	• Capacity utilization • Plant yields & wastages • Warranty (per cent evoked) • Compliance to regulations • Material costs • Overhead control • On time delivery • Process rejections • Inventory levels • Cost of manufacturing • Manufacturing cycle times • Material availability to meet monthly production schedule • Value addition per	• Order lead time • Customer yield • Downtime • Defect rates • First pass yield • Plan versus dispatch • Cost of production • Working capital required • On time delivery • Warranty failure per unit manufactured • Value of returns • Resource usage variances • Value addition per employee • Srap generated • WIP • Inventory levels	• On line quality • Off line rejects • Afterwash quality • Per cent defectives • Lead time • WIP • Labour & machine productivity • RM costs • On time delivery • Waste loss • Overdues to debtors • Labour costs • Downtime	• Total cost of manufacturing plus distribution • RM cost as per cent of sales • Total inventory • Working capital required • Yield & rework • Power & fuel costs per unit • Utilization • Inventory turns • Fixed overheads • Customer complaints • Total production • Raw material availability & costs • On time despatch • ROCE,PBDIT/sales • Delivery compliance • Wages as per cent of

• Rejection & rework costs • EVA, ROS, ROCE, ROI • Downtime • WIP • Compliance with sales need • Product quality on various dimensions • Inventory turns • Material cost reduction	• On time delivery • Organization climate • Regulatory compliances • New product development support • Inventory turns • Service call rate analysis • Raw material usage per unit product • Savings per unit product	employee • Filed rejections • Labour cost as per cent of sales	• Orders in hand for next three months • Cash to Cash cycle • EVA • Vendor defects		value addition • Cost of quality • Sales volume with negative contribution • Plant uptime • Input/output rations of key material • Machine efficiency • Resource usage variances • Acceptance rate • Value of non-moving materials • Tonnage delivery • Stock movement • Cost of Utilities as per cent of manufacturing • Overdues • Maintenance time for critical equipments • Quality index • Maximum output • Application performance in field • Idle capacities

Figure 12: Extent of Availability of Information to all Functions in the Business



More than half of the sample firms do not use any analytical process for forecasting demand (most simply project sales data from the past to get estimates of budgeted sales and do not have a framework to link the drivers of demand with a forecast). Worst still, a large number of firms (41 per cent) do not track forecasting errors – consequently, the sales forecasting exercise carries errors over the years and this results in wasted resources in the form of excess inventory/shortages, excess manpower/shortages etc. Those firms that track errors, find that the distribution of errors to be as follows (Table 5):

Table 5: Distribution of Forecasting Errors

Range of Forecasting Errors	Per cent of Samples Firms Reporting Error
0 – 5 per cent	22
5 – 25 per cent	58
25 – 50 per cent	14
50 – 75 per cent	3
75 – 100 per cent	3

About 20 per cent of sample firms have forecasting errors greater than 25 per cent. This should also give a sense of the magnitude of resources/opportunity loss at these firms. The loss to the entire supply chain, however, would be exponentially higher as the impact of forecast error is to increase the variability across the chain. Firms that significantly improve the decision making processes are the ones that can take advantage of improved forecasting ability.

A similar story emerges when one looks at inventory levels across the chain. Only 61 per cent of sample firms track inventory across the supply chain. Of the firms that do, 59 per cent of inventory by value is kept at the manufacturing facilities, 21 per cent by value with the distributors,

9 per cent by value with the wholesalers and 11 per cent by value with the retailers. It could be lack of market related information at the manufacturing level, long manufacturing/order lead times, uncertainty in transportation lead times, and uncertain (and/or long) procurement time that may be leading to high levels of inventory at the manufacturers. Unfortunately, 80 per cent of the sample firms expect their suppliers to hold inventory to meet their requirements. What these firms forget is that, in the supply chain context, this additional cost of holding inventory at the suppliers actually affects their own competitiveness as it would increase the cost of material/subassembly procured (any rational supplier will include this cost in the product cost).

Modern supply chain practices require a tight linkage between suppliers and manufacturers both in terms of providing support to the supplier in developing its capabilities as well as developing long term contracts with them (as this encourages the supplier to invest in new technology, practices and people). Figures 13 and 14 show an improvement in capabilities on most supply chain objectives both at the supplier and as well as at the distributor's end respectively. The

Figure 13: Current Supply Chain Capabilities of Upstream Suppliers

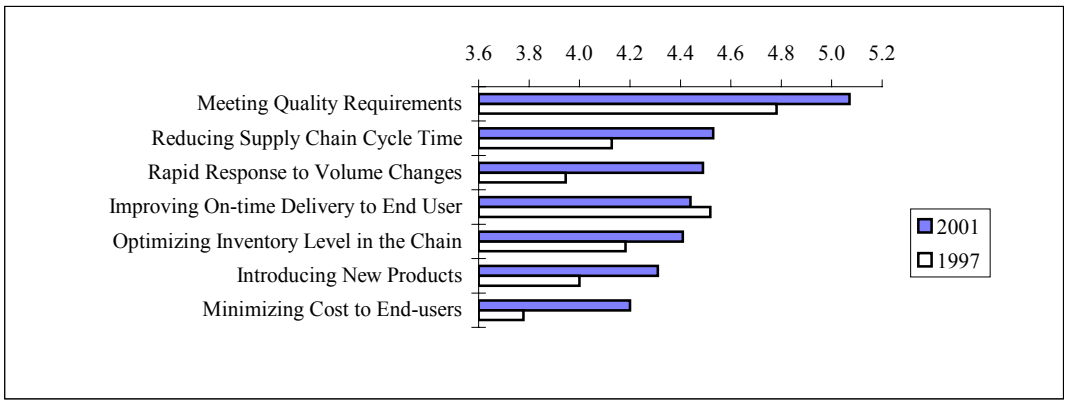
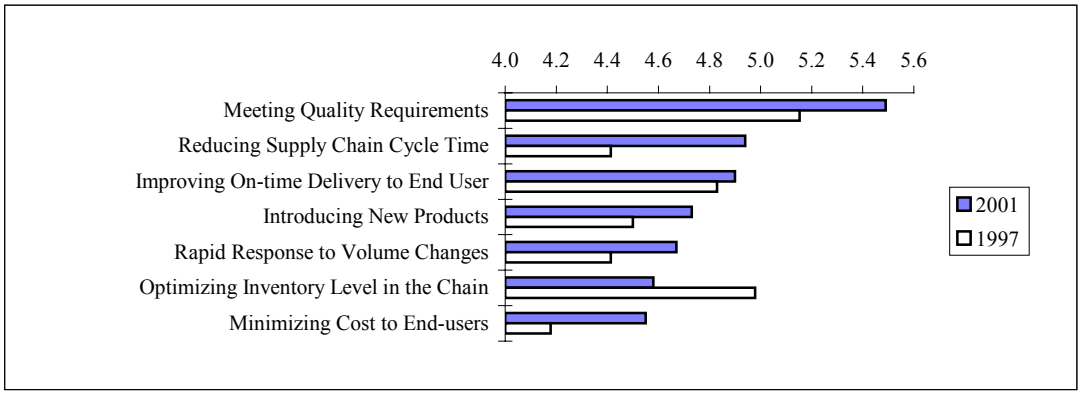


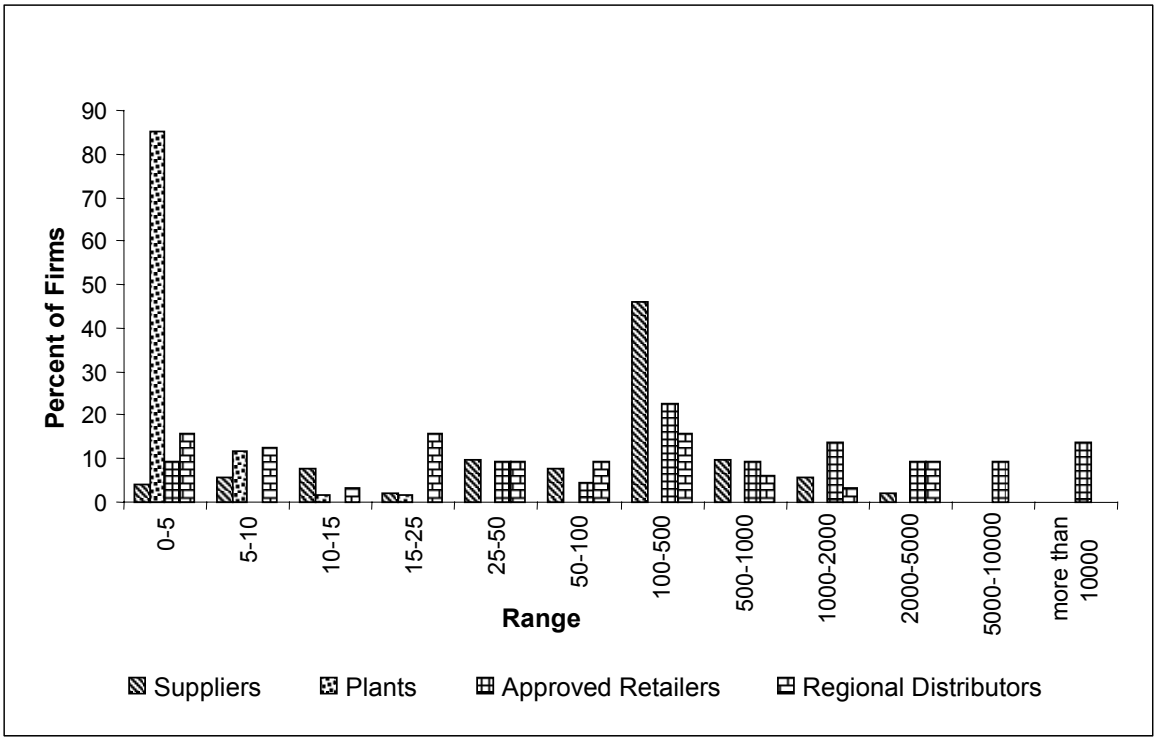
Figure 14: Current Supply Chain Capabilities of Downstream Distributors



noticeable exception is "optimizing inventory levels in the chain" – both the suppliers and distributors of Indian manufacturers seem to have done poorly since the last survey in 1997. Firms still rate the capabilities of their distributors better than those of their suppliers. What is disturbing is that this gap has increased on factors like "meeting quality requirements", "improving on-time delivery to end user" and "reducing supply chain cycle time". One wonders whether this gap is due to poor capabilities or a problem of perception. Lets look at the extent of support provided by firms to their suppliers. Only 28 per cent of the sample firms have a long term contract with their suppliers. Barely 12 per cent of firms have any kind of association (this has become very common in Japan and Korea) for its suppliers through which it can transfer common skills and technology to its suppliers. In Japan, supplier associations emerge out of firms located in a supplier park owned by a large firm. Fifty per cent of sample firms share their manufacturing experience with their suppliers or provide training to them (while about twenty per cent of the firms depute their own technical personnel to help the suppliers). There is very little evidence of equity holding in suppliers (about 4 per cent of firms) or the distributors (about 3 per cent). Before we make some more observations, lets look at the structure of the supply chains of these firms.

Figure 15 shows the structure of the supply chain of the sample firms. If we look at the first block of histograms in this figure, it says that about 4 per cent of firms have less than five suppliers, about 85 per cent of firms have less than five plants, about 14 per cent of firms have less than five regional distributors, and about 9 per cent of firms have less than five retailers. A similar statistics is obtained for other ranges of suppliers, plants, distributors, and retailers. What is worth noting is that 63 per cent of firms have more than 100 suppliers, about 39 per cent of firms have more than hundred distributors, and 77 per cent of firms have more than hundred retailers. In addition, about 17 per cent of firms claim to have more than 500 suppliers. The same for distributors and retailers is 22 and 54 per cent respectively. This is perhaps where the bottleneck to competitiveness also lies. Larger the number of suppliers, higher is the cost of coordination, higher is the level of inventory required, more difficult would it be to implement new managerial practices across all suppliers, higher would be the cost of providing technical intervention at the supplier's plants etc. When we look at the spatial distribution of both plants and suppliers, the above statement becomes even stronger. Of the sample firms that operate more than one plant, 48 per cent of these plants are located more than 100 kilometers away from each other, 33 per cent of these plants are located more than 500 kilometers away from each other and 18 per cent of these plants are located more

Figure 15: Structure of the Supply Chain of Sample Firms



than 1000 kilometers from each other. Similarly, on an average, only 4 per cent of suppliers are located within 5 kilometers of the manufacturing plant, about 13 per cent are located within 5-25 kilometers of the plant, 16 per cent are located within 25-100 kilometers of the plant and about 67 per cent of suppliers have facilities that are more than 100 kilometers away from the plants. Location policies of the past may have forced some firms to locate plants away from each other. However, this my be coming to haunt today as the cost of coordination increases and so does the ability to roll out managerial programmes across locations. This problem gets exacerbated with suppliers. Manufacturers have to either develop suppliers separately for each location (thereby increasing the number and affecting consistency in quality, price & delivery times) else material has to travel longer distances if there is a common supplier to all plants. The trend worldwide is to develop vendors close to the manufacturer (and have manufacturing facilities as close as possible to each other unless the distribution costs to the customer becomes prohibitive). This facilitates pull based material control, improved interaction between the suppliers and manufacturers, and provides some form of economies of procurement or dispatch. As can be seen from the data presented above, a large majority of Indian firms lose out on this advantage. Of course, the often made assertion that Indian suppliers are not reliable hence the need to have more of them is also reflective of the old manufacturing mindset. While many firms will talk of co-production and

partnership with suppliers, only a few are willing to travel the extra mile and take the pain of setting these relationships right.

Another neglected area in supply chain management is transport & dispatch planning. Ninety eight per cent of sample firms have a contract with trucking companies for making dispatches and only 11 per cent own their own fleet of trucks. While 36 per cent of these firms use third party (3P) logistics service providers for making dispatches, about 30 per cent use 3P service providers for procuring their material from their suppliers. While industry magazines have written a lot about the critical role that Dynamic Logistics plays in procurement and kitting of parts for TELCO's Indica operations, Indian firms do not seem to be taking lesson from such examples. Somehow, transport planning has remained a unglamorous area within Operations despite the fact that about 10 per cent of the cost of sales comes through physical distribution. Transport planning (e.g., optimal dispatch quantities & frequency of dispatch, vehicle routing, loading pattern in the trucks etc.) does not appear to have received the required attention. For example, barely 21 per cent of sample firms report the use of any software for scheduling dispatches. Understanding the linkage between inventory and transport planning is a key to reducing operational cost of distribution.

Only a small fraction of the firms use computer based decision support systems for helping their managers make effective decisions. About 13 per cent of firms use some kind of computer based system that will help them make supply chain decisions, 43 per cent have implemented an ERP or a comprehensive in-house information system, and only 37 per cent of firms use any software for scheduling on shop floors. These are relatively weak indicators of a modern manufacturing environment. When it comes to web-enabled manufacturing, the situation is no better (though we must mention that the general usage of internet based systems is better today than it was during the last survey). Most of the usage is of the email variety which includes interaction both with the suppliers (47 per cent of firms) and the customers (about 48 per cent of firms). However, only 23 per cent of firms use the web for placing orders with the suppliers. The per cent of firms who sell online to the customers is even lower (about 11 per cent). Firms will have to distinguish between the use of email for following up on transactions & professional/personal exchange versus using the web for enhancing decision making (as in use of auction sites or online CAD systems or CAM system monitoring or accessing application software etc.). It may be noted

that a large majority of firms do not even use email to interact either with their suppliers of their customers.

While a number of firms claim to have implemented supply chain management programmes, many have failed to understand that coordination across functions and across supply chain structures (i.e., retailer, wholesaler, plants, suppliers) forms the key to implementing these practices successfully. Consequently, they have neither changed the decision making processes nor have they changed the structure of the supply chains to ensure that decisions are synchronized. Moreover, the use of modern tools of decision making like web enabled systems or decision support systems or statistical analysis of information is still very low. In addition, while most firms claim to have initiated SCM projects, only 8 per cent of the firms have changed their organization structure to create a separate functional entity that will manage supply chain operations. In the remaining firms, the departments that are responsible for managing the supply chain activities are mostly purchase and materials and in a small fraction of firms, logistics. As a result the real benefits of supply chain coordination eludes them.

6. Some Conclusions

There is one key message that comes out from the current survey (may not be the greatest surprise either!) – a single minded focus on productivity is the only solution out of the current manufacturing crisis that firms in India find themselves in. A large number of firms have embarked on a productivity improvement exercise (but a much larger number is still using clever accounting practices to survive). However, only a small per cent of this group is investing resources to improve productivity continuously. Gains are often lost due to an on-off approach to productivity improvement. At many places you get an impression that the firm was waiting for new production systems/manufacturing practices to get evolved elsewhere before they could them adopt at their own plants. Operations at many firms are opportunity driven rather than strategy driven. It is not uncommon to find firms that serve large volume orders and customized orders from the same shop floor thereby affecting negatively the economics of production. Large volume production requires a certain type of layout, planning regime and performance measures that are very different from those for a customized production environment. It is not surprising that Indian managers rate their plants low on flexibility as that also requires specialized layouts (e.g., mixed-mode layouts/cellular structures) that will deliver large variety at high throughput rates. In terms of shop floor

performance, firms are found to be wanting on providing high quality at low price. High quality can come through better control of process variability, control of material and improvement in design. The manufacturing infrastructure of a number of Indian plants, i.e., physical ambience (that affects the quality of work life and safety), technology on the shop floor, (e.g., process control devices, computers and data streaming systems, bar coding equipment, sensors, latest tools of production, safety devices etc.), housekeeping, etc is far from what you would find at world-class plants. Similarly, current procurement practices do not permit vendors as well as shop floor managers from implementing vendor-managed-inventory systems on shop floors. Another global practice that has failed to find roots in Indian plants is the "pull production system". Production czars must understand that pull manufacturing or pull replenishment system is the missing link between higher productivity and low inventory levels. Another casualty of economic slowdown has been efforts to reduce cycle times. This is the only mantra that will deliver higher quality at lower costs as this is directly correlated with first pass yields, absenteeism, setup time reduction, reduction in waiting times etc.

The second finding relates to issues of innovation in manufacturing facilities. Firms that invest in innovation have seen higher sales revenue and are more likely to find overseas customers. Indian firms are low on new product introduction, are unable to (or not caring to) successfully ride on the "imitation to improvement" cycle (e.g., copies of Symphony air coolers by small producers especially in Delhi lacked the technical capability as well as the finish of the original; same can be said of imitation toys currently available in the Indian market). The story of Japan in 1960s and in today's China is one of imitating existing products and then improving them (often significantly) to provide a better value proposition to the customers (both domestically and overseas). One can derive lessons from the Chinese toy industry – continuous improvements in plastic molding technology allowed them to leave traditional North American & European producers behind both in cost and quality. R&D investment in Indian firms is not at par with global standards (barring a few firms in the pharmaceutical and auto sectors; the worst culprit being textiles). While many Indian firms provide some managerial training to its managers, very few have continuous advance technical training programmes for production/engineering employees. In addition, Indian plants do little to reward and retain employees with advanced technical degrees. Globally, leading manufacturing firms hire a large number of people with masters or doctoral degrees in technical disciplines to advance the state of technology both in the

product as well in process domains. This is the big difference between above average firms abroad and those within the country and perhaps is an important reason for low improvement gains in Indian firms.

The third finding relates to issues of practices in and rationalization of supply chain network of Indian firms. Supply Chain of firms is fragmented, complex and lacks discipline. Firms still source from large number of vendors and supply to large number of distributors. As a result, vendors & distributors look for other partners due to absence of large volumes from a single producer and become myopic in making investments to improve their own processes. This has also resulted in reduced product and process innovation at these ends. Indian manufacturing continues to lag in adoption of efficiency-enhancing-technologies in warehousing and transportation sectors. Most Indian products and dispatches are still not bar coded. Distributors, perhaps, remain the worst adopters of efficiency enhancing technologies. This is despite the fact that most firms appreciate the role of inventories and lead times in reducing costs. So where does the implementation fail? Partly, it is lack of easy availability of these technologies and consultants who would implement (especially in small industrial centers), partly it is government regulations like excise and octroi (which forces irrational location of warehouses and leads expenditure of "evasion energy" by vendors & distributors), partly due lack of promotion of these technologies by industry associations and the government, and partly due to deployment of low cost manual labour in most of these operations. Indian firms are also found to segregate domestic and export markets on quality and price. This has three major disadvantages: one, it does not allow firms to get the advantage of economies of scale if the same product was produced for the domestic and the export market (thereby making it more expensive for both the markets); second, this strategy requires higher investments in plant and equipment as many a times firms establish separate plants or lines for different markets which makes coordination more complex; and third, it slows down the integration of domestic supply chain into global ones thereby retarding the spillover advantages of best-practices. Another related issue is the extent of information across the supply chain. Indian firms are woefully inadequate in this regard though ERP systems have helped collation of information. Unfortunately, dissemination of information or its accessibility by the distribution channel and suppliers has been restricted to relatively fewer firms like HLL, Asian Paints, etc who have also invested in V-Sat technology for this purpose. Visibility of information across the chain is extremely essential for making accurate decisions and reducing inventories. Only a handful of

these so called "information collectors" use decision support systems or analytics on this collected data for making better decisions. Lastly, none of the firms surveyed had any "supplier association" - of the type made popular by Japanese firms for coordinating flow of material and innovations across their suppliers. Japanese manufacturers use their supplier association to provide common inputs on management & technical practices in order to increase efficiency or for deployment of new technology or for initiating dialogues for reduction of input costs etc. While some Indian firms regularly send their engineers to support their supplier's operations, few made investments in technology for their supplier.

The fourth and the last general finding relates to customer service. Indian firms rate themselves highly on on-time delivery, after-sales service and product support. They also rate their performance, on the customer service dimension, at par with their foreign competitors. However, the role of customers in design of new products and services is almost missing. In terms of access, Indian firms normally service customers through larger number of retailers as compared to their counterparts abroad. In terms of customer responsiveness, firms are found to be all over the chart. While this cannot be generalized for all firms, an experience by an international customer of a leading textile mills is instructive: a customer in Sri Lanka faced a situation whereby he had called its Indian textile supplier to report a major deviation in the quality of cotton cloth received from the Indian producer; at the first contact, the customer was asked to send the complaint by fax; when several days passed by and he received no response, the customer called again to enquire the status of the request – he was told that the fax had not been received; the customer contacted the marketing head who disputed the claim of the customer, cited his pre-shipment quality statements, and promised to send his marketing manager to investigate; after a few more telephone calls, the marketing manager arrived at the customer's location only to find that the customer's assessment was correct. By this time, three weeks had passed by from the date of first contact and the customer had to pay a penalty for delays to his customers in Europe. This was the last that this customer ordered from India. This customer cited how a supplier from a neighbouring country had responded in a similar situation – at the receipt of the complaint, the supplier had instantly shipped a replacement lot so that the customer's production would not get stalled and had subsequently investigated the complaint. Interestingly, the supplier had managed to convince the customer that his complaint was not justified and even sold the replacement lot to the customer!

7. Lessons from China

A study by Roland Berger & Partners (1998) found that the three key reasons for MNCs to setup business in China were to get a "foothold for a Asian strategy" (65 per cent of firms), "market development" (62 per cent of firms) and "low labour and production costs" (28 per cent of firms). They also found that MNCs (either through their subsidiaries or joint ventures) and the diaspora firms (firms owned by people of Chinese origin) were leaders in changing business practices in China. But most interestingly, they report that successful firms breakeven in about 18.4 months. What lessons do the success of firms in China hold for addressing the needs of global markets?

There have been several major shifts in industrial axes in China - firms are slowly moving from manual to automated manufacturing environment; firms are moving from large size manual casting and finishing type production to more complex small size precision casting and assembly; firms are moving from old industries like heavy machinery etc. to newer sectors of manufacturing (especially consumer electronics); and firms are moving away from old work relationships and the "iron rice bowl" mindset to newer and more dynamic work conditions.

Due credit goes to Chinese industrial policy that saw manufacturing as a source of comparative advantage. It also saw manufacturing as a pathway to make new products, advanced tools and processes available to domestic firms in order to enhance their productivity. For example, Chinese policy makers realized that the widespread communication revolution in mobile technology and its advantages could become possible only if low cost pagers/telephones were available to the consumers and for that it ensured that big telecom firms like Motorola etc. setup manufacturing facilities in China. They appreciated that to provide better services, firms would have to make new technology available to the large population. This could happen only if low cost technology was available and hence the role of domestic manufacturing. Contrast this with India where despite the fact that manufacturing of equipment was included in the National Telecom Policy, to this date, all mobile sets are imported (or smuggled) from outside thereby delaying its widespread implementation in the country and the benefits thereof. China also used its non-WTO status to attract large scale manufacturing investments by providing tax breaks, subsidies on infrastructure development, secure industrial parks, low fluctuation in industrial policy, active participation of local governments and single window clearance for setting up a new enterprise. As an example, while Indian policy makers were turning down suggestions to develop a semiconductor manufacturing industry in India as being too late to enter, China was attracting

Motorola to invest about US$4 billion in setting up a modern semiconductor plant in China. It saw semiconductor manufacturing as integral to the development of its manufacturing sector in the future (e.g. development of new versions of intelligent consumer goods that employ chips for logic and control). Chinese government has also employed the successful global practice of using experts for designing and implementing industrial policies.

At the firm level, three key features of Chinese manufacturing emerge - contract manufacturing, large scale manufacturing, and creative imitation (see Box 1). The story of Chinese manufacturing is a story of strategies to become contract manufacturers for producers overseas. During the early years of reform, a large domestic market, tax benefits and low production costs attracted overseas firms to China. USA, perhaps, also saw Chinese manufacturing as a right tool to open up the Japanese market! Though, interestingly, Japanese firms started to develop third party suppliers in China which led to a methods & systems revolution in Chinese manufacturing. This gave China access to state-of-art processes, global practices and much needed volumes. In addition, joint ventures also found it easy to increase the local-content share in the products over a period of time as their contract manufacturers had developed robust manufacturing capabilities. This helped reduce prices of these products in global markets which further increased sales volumes for the Chinese producers.

Chinese manufacturing is also about scale. Chinese firms have developed an expertise in large-scale production – skilled & disciplined workers, methods improvement, standardization of processes, large-scale procurement systems and large volume production capacities. They compete through low margins and large volumes to increase their top line. China has a large pool of technically educated workers and a sizeable number of them hold advanced degrees. Manufacturing firms hire them and also provide extensive training on modern production systems. Dormitories near place of work have helped attract talented workers from different parts of China. They also provide for social interaction and support in a new location. Over the years, export zones have grown considerably and local municipalities have developed modern shopping malls, entertainment centres, night schools etc. that have helped raise the quality of life of these factory workers and provided an opportunity for upward mobility in the society. Once again, we must

BOX 1: Three Cases from China

Case I: Beijing Shirt Factory, Beijing

The Beijing Shirt Factory (BSF), a state owned enterprise, is one of the leading cotton and blended shirts producer in Beijing. It is a supplier to ten global brands (e.g., YSL, Arrow etc.) and also sells in China under a local brand called 'Temple'. BSF produces all its shirts at a single plant. Annual turnover of the firm is Rs. 125 crores. The firm employs 1100 workers and produces 4.0 million pieces of which 80 percent is exported is a state owned company.

BSF has a long-term relationship with Beijing's No. 1 and No.2 fabric units for supply of fabric. The order processing lead-time at BSF is seven days, on the average (or twenty days if raw material, i.e., fabric, has to be constructed).. The plant is laid out over eight floors of a building in Central Beijing and it operates on a single shift. For example, one floor is devoted to production for YSL. The YSL shop floor is about 50m in length, employes 200 workers, is divided into three sections and each section has a Quality Control monitor and an overall supervisor. Each section has a cellular layout and all work is done at few parallel stations. The plant is ISO 9000 certified and has sophisticated Statistical Quality Control implementation with QC-charts displayed at each station. One saw very little WIP on the shopfloor, excellent housekeeping (i.e., 5S programme), raw material release that was synchronized with shop loading, and a the shop floor that is well heated given Beijing's sub-zero winters. Operators wear lab coats, cap and gloves (the latter was meant to prevent spoilage of light shirting fabric) . In general, the shop floor had a pleasant working environment.

Interestingly, the shop also has state-of-art equipment especially on the fabric cutting process and packaging. Packaging is done with specific country labels and prices so that it could be shipped directly to retail stores around the world. The cost structure was as follows:

material cost = 50-60%
utilities and manpower = 20%
others (managerial OH, pension etc) = 30-20%

BSF has a long-term arrangement with JUKI (the sewing machine firm) to provide new technology to the firm. It has allowed JUKI to open a showroom/office in its 8 floor building – a strategic move that gives access to maintenance staff of Juki at close proximity and allowes trials of new equipments in its plant. BSF also has a large showroom where the same YSL shirt would retail under the Temple brand for local consumers at Rs. 250.00 per piece!

Case II: KAIDI Silk Screen Printing, Hangzhou

KAIDI Silk Screen Printing (KSSP) company is a leading firm from Hangzhou (a pretty South eastern city of China close to Shanghai) that is involved in dyeing, printing and finishing of silk. It also owns a small garment facility. The firm is about a decade old. KSSP is a public company, is listed on the stock exchange, and the state ownership is limited to 30 percent. The turnover of the firm is Rs. 1250 crores and employs 1000 people at its three plants (two silk printing and dyeing facilities and one garment plant).

The interesting story is how KSSP used their first order to acquire state-of-art technology. The first order for the firm came from a German buyer. The firm negotiated a creative arrangement where the buyer purchased the latest equipment for KSSP and offset the investment against future payments. In return, KSSP promised a sweet deal on pricing. The firm has never looked back since then. It turns around its technology more rapidly than its competitors (often by borrowing from commercial banks at a rate of 8-10 per cent). KSSP's strength is its state-of-art design house. The design house comprises about 30 designers, preparation personnel and 40 CAD stations for screen design. Interestingly, the design houses of some of the leading firms in India have a couple of CAD stations and, perhaps, a designer to help it compete with the likes of KSSP.

Case III: HiSense Group Corporation, Qingdao

Hisense Group Corporation is a large high-tech enterprise specializing in consumer electronics (e.g, televisions, computers, DVDs, CDMA mobile phones), household appliances (i.e., air conditioners & refrigerators) and information technology (i..e., software & network equipments).. Hisense had an annual sales of USD 1.95 billion in the year 2000, a 26% increase over the previous year when sales for many of the competitor's products were in decline. It sells to over 50 countries and regions, has subsidiaries in USA, Japan, Brazil, Indonesia and Hong Kong, has another production base in South Africa, and a trading office in Italy.

The company has origins in the state owned Number Two Radio Factory of Qingdao which was founded in 1969. It had a staff of 30 and a facility covering an area of 1000 square meters. Its "Red Lantern" brand of receivers was an instant success. After some development work, the firm started producing vacuum tube television sets with a 14-inch screen as and later graduated to transistor TV receivers. By late 70's four firms, supported by the Qingdao City government including the Number Two Radio Factory, were merged to form the Qingdao Television Factory. Mid-eighties saw collaboration with Matsushita of Japan to manufacture colour television at Qindao. By late eighties, Quigdao was the leading television brand in China and the factory became one of the Top-100 Large Electronic Enterprises. It is the only Chinese enterprise in electronics to win the National Quality Award for four consecutive years and the first Chinese electronics enterprise receive the ISO9001 certification. In addition, it has also received ISO9000, ISO14000, EU CE, GE certifications and follows other standards like UL, CUL, FDA, FCC etc. In 1997, the firm went publicfor an IPO and was amongst the top ten electronics companies in China.

Today, Hisense operates three advanced manufacturing and R&D centers. *Hisense IT Industrial Park*, situated in the national-level Qingdao Economic and Technological Development Zone in Huangdao District, (southeast of Qingdao), covers an area of 80 hectare at an investment of US$ 242 million. Being the largest e-center of the group, this park has design and manufacture facilities for electronics, telecom and IT products with an annual production capacity of 3 million color TV sets, 500 thousand PCs and one million CDMA mobile phones. Situated in Nancun Town, Pingdu, (a satellite city in northern Qingdao), the 50-hectare *Hisense Household Appliances Industrial Park* has an investment of over US$ 60 million. This park has an annual production capacity of 1.5 million inverter air conditioners. It has become an important export base for Hisense as well as the largest production base of its kind in China. *Hisense High-tech Development Park* lies in downtown Qingdao. With an investment of about US$ 37 million, it has a 50,000 sq m building space and an additional 42,000 sq m land area. The park consists of 11 research institutes for household appliance, refrigeration, mobile communication, IT, network technology, intelligent control and optical communication. More than 1,500 professionals and experts work at these institutes. It is the R & D center of the group as well as a Nation-Class Technology Center and a Post-Doctoral Research Station. It is also the National Experimental Unit for Intellectual Property Protection

Hisense invests 4 percent of its annual sales revenue in the development of new technology and products. More than 30 per cent of its turnover comes from new products. Of the 10, 000 employees at Hisense, 42 hold doctoral degrees, 380 hold master's degrees and over 4000 hold bachelor's degrees, many of whom are involved in various R&D areas. As a National-Class Technology Center and Post-Doctoral Scientific Research Station, Hisense annually undertakes more than 10 state-level research projects as a part of the state's "863 Plan" of technology innovation. Hisense has established long-term cooperative technological linkages with Chinese Academy of Science and prestigious universities like Tsinghua University, Beijing University, Beijing Aeronautical Engineering University, Xi'an University of Communications, Shandong University, Qingdao Oceanography University and Qingdao University. It has close economic and technological relations with companies such as AT&T, INTEL, IBM, PANASONIC, TOSHIBA, SANYO, HP and SIEMENS. Its key research areas lie in the application of digital and Internet technologies, intelligent technology, chip development, and designs for ventilation and air conditioners.

contrast this with new semi-urban industrial centers in India (e.g., Silvassa) where good technical people still do not want to go due to absence of common civic facilities. Bangalore and Pune are exceptions, however. This educated and disciplined workforce in China has played an important role in absorption of good manufacturing practices in plants. For instance, garment workers have easily adopted practices of 5S on shop floors along with adoption of strong industrial engineering methods. Chinese workers are also slowly emerging as capable handlers of miniature assembly processes, perhaps drawing upon their traditional strengths in aesthetics and meticulous detailing. A number of plants have also implemented large volume production systems like flow manufacturing system, efficient assembly lines, stringent supervision (which increases the first pass yield), standardization of process, globally acceptable tools/equipments of production and safety etc. though computers are not commonly found on shop floors. Many Chinese firms procure through common agents thereby allowing for volume purchase and consequently volume discounts. The Canton Engineering fair is a testimony to the success of large volume manufacturing. Another area where Chinese firms have developed expertise over the years is in creative imitation. One must recall that this strategy was successfully used by Japanese producers after the second world war. Chinese firms have staged their innovation strategy effectively – start with imitation of packaging, move to copying of external features especially styling, modify styling, imitate functionality, improve upon functionality – all at a low cost. Of course the choice of products for entry in global markets has also been strategic - low value items like toys that require high labour content (i.e., stuffed toys, low cost apparels etc), to products that need skilled assembly (i.e., multi-part plastic toys to begin with and then graduating to complex assembly of consumer electronics) and products that have a mass market (eg. consumer goods, bulk drugs, bicycles etc). And lately, firms are graduating towards manufacture of technologically sophisticated products like plane engines. This is reflective of improving technological capabilities, learning on complex equipments & machines and exposure to sophisticated precision products & processes. Another factor that has helped innovation at Chinese firms is the role of technology research centres associated with each large enterprise (in addition to industry wide centres that receive public funds). For example, prior to 1984 Yachai Diesel Engine Company was a small producer of low power diesel engine for agricultural machinery (ranked 173rd among China's IC engine producers). After a series of strategic choices and smart implementation, it became China's largest diesel engine manufacturer. Its share of China's medium-duty truck market climbed from zero in early

1980s to about 49 per cent in 1995. One of the key strategic initiative was investment in training and R&D. In 1990, Yuchai spent 5 per cent of its total wage bill in training. From 1980 it had setup its own technical training programme to upgrade technical skills of workers, especially in computing and IC engine technology. By 1995 it had more than 275 engineers working in R&D, product enhancement and new design of engines. Its brightest employees were in the technology and engineering department and had strong links with the Shanghai Internal Combustion Engine Research Institute to help upgrade its engines continuously (Nolan, 2000). Chinese firms have also been playing the "setting of standards" game which has given major impetus to manufacturing of proprietary technology. 4G technologies in telecom is a good example of how Chinese R&D agencies have rasied the bar and if the world starts to adopt this standard, there would be a windfall for Chinese telecom manufacturers. In essence, firms have started to benefit from a strong interplay of focused R&D and effective manufacturing to produce new products and processes.

One must also mention that China's area of concern is reforms (or lack of) in the State Owned Enterprises (SOEs). While many SOEs have done extremely well post-reforms and are quite competitive globally (as can be seen from the case studies in Box 1), critics claim that that a large majority are saddled with in-efficient technology, a large labour pool, and a high wage bill. It is said that while the Chinese government is reducing subsidies to these units, they are forcing state banks to give loans, in order to support these units, at very low or no interest which in many cases is being written off. Consequently, a large number of banks may be ready to collapse and create massive macro-economic imbalance. It is also alleged that many of these SOEs are over-producing to keep their plants busy and it is this excess production that is flooding global markets at less than marginal costs. Distribution has been one of the weaknesses of Chinese manufacturing and with the gradual removal of government canalization of SOE exports post-WTO, this area has become quite vulnerable. These policies provide ample lessons for Indian manufacturers and policy makers.

8. Becoming World Class Competitors

Firms all over the world have some inherent advantages and some hard-wired disadvantages. Some have higher per unit labour costs (as in the US) while others face higher consumption of utilities to overcome natural challenges like extreme temperatures (e.g., petroleum companies in Prudhoe Bay or mining firms in Canada or manufacturing firms in Northern Europe) and some

others face small labour force for the size of their economy (i.e., Singapore and Tiawan) or small domestic markets (as in Japan). However, successful firms in these environments press hard to develop other competitive advantages to overcome their inherent disadvantages. They design technological and managerial interventions to overcome their disadvantages. Same must become true for firms in India. While Indian firms do suffer from higher utility rates and its poor quality, uncertain policy regimes, high internal taxes, some labour rigidities, infrastructure glitches etc., it must ask itself some tough questions: has it utilized existing resources effectively; has it developed new processes and practices that overcome the inherent disadvantages; has it resisted policy-related-competitiveness and sought competence-related-competitiveness for itself etc. More important, would Indian manufacturing become globally competitive if one fine day all the policy impediments are removed by the government? This is not to say that government should not act rapidly to remove these impediments. Indian firms must ask themselves about the kind of distinct competencies that they may have developed in comparison to their global competitors.

One of the first requirements of becoming world class is to create and interact within a world class environment, i.e., use global standards in work practices, equipments & toolings, quality & safety etc. Firms have opportunities to learn about best practices from global suppliers, consultants, customers and even competitors. Competing with global competitors helps in establishing contemporary technical and managerial benchmarks and practices. It is not uncommon for world class firms to track progress, investments, strategies and practices of their competitors with care. One clear way of interacting with world class firms is to focus on "contract manufacturing" – this is a strong way to learn and develop capabilities. This is perhaps the best way for medium scale firms to move up the volume ladder.

Indian firms need to invest in generation of intellectual property, be it in product, process or practice domain. Hiring people with advanced degrees (which also means ensuring that technical expertise is financially rewarded at par with managerial expertise in the organization), providing intense technical training on advanced disciplines, focusing on process R&D on the shop floor (as this is less easy for a competitor to copy), improving imitation capabilities, and including number of patents filed as an important performance measure for the plants will help in this direction. Once such a regime sets in, implementing programmes on innovation and productivity improvement will become easy.

Global firms focus intensely on their suppliers. This is where new models exist in integrating small and medium suppliers successfully in a firm's operations. Whether it is intervention in shop floor practices or investment in technology or early discussions during product development, any support to suppliers yields compounded returns to the manufacturer in terms of reduced variability in quality and delivery, higher precision, lower costs etc. But one killer practice that prevents building trust in most firms in India is the long delay in reimbursing suppliers. This one weak practice, often, negates all the good efforts of the manufacturer towards the supplier. Once the supplier side intervention is linked with good decision support systems (i.e., computer based models to help make decisions) within the plant and in managing distribution network, a firm can be on it way to becoming world class.

And above all, world class competitors have a Strategy-Practice-Execution Plan (SPEP) that helps dynamically plan manufacturing strategies, design managerial practices to achieve performance targets, and finally execute them effectively. Absence of SPEP means less than optimal returns. Becoming a world class competitor is as much about planning to become one as it is about making it happen.

Appendix 1: Survey Methodology

This is the second national that we have undertaken to understand the competitiveness of manufacturing firms in India. The questionnaire for the survey comprised five sections, namely, Business Unit Profile, Manufacturing Strategy, Competitive Health Check for Manufacturing, Managing Innovation for Competitive Advantage, and Supply Chain Management. There were three types of questions in the survey instrument - those which required firms to rate various aspects of their operations vis-à-vis their competitors (on a scale of 1 to 7); those that required firms to rate the nature of past & future interventions in manufacturing in order to improve the competitiveness of their units; and some that required firms to give information on various performance parameters.

The questionnaire was mailed to managing directors of 1000 select medium and large firms in the India. These firms were represented a cross-section of size, industry type, and performance. The response, however, was extremely poor. Follow-up letters were sent to all and phone calls made to many in order to remind them of the questionnaire. Duplicate copies of the questionnaire

were mailed to many firms. Finally, the number of valid questionnaires that we used for analysis was 83. This number itself provides a lot of information on Indian firms! Interestingly, our sample consisted of firms that have been generally performing well according to many published sources.

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