A technology management perspective on collaborations in the Indian automobile industry: a case study

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Abstract

A study was conducted to analyze technology management practices of firms in the automobile industry in India. The case studies of three firms which collaborated in post Indian independence (i.e. after 1947) period and after the economic reforms began (i.e. after 1985) have been presented. The cases were prepared using interviewing and observation techniques. Profitability, liquidity, and turnover ratio analyses have been carried out to assess the firms' financial health. Input from the questionnaire survey has been presented to compare the perception of the firm's performance compared to industry on select variables. The situation-actor-process-learning-action-performance (SAP-LAP) paradigm was used to analyze the cases. Learning issues have been synthesized.

Keywords: **Collaboration; Transfer of technology; Technology strategy; Technology absorption; Automobile industry**

1. Introduction

The Asia-Pacific region is considered by many scholars, practitioners, and investors to be one of dynamic and rapidly growing economic regions in the world. Countries included in this region are Japan, China, Taiwan, South Korea, North Korea, Hong Kong, Thailand, Malaysia, Indonesia, Singapore, Philippines, Vietnam and India. The region is a voracious importer of new technologies and an innovative user of existing technologies. Many of

these countries have undergone major economic reforms to be able to facilitate the domestic firms to compete in the global market. Many strategic alliances, joint ventures (JVs), and collaborations came into existence. Lately, many of these firms expanded their operations in other countries to evolve into multinational companies.

In India, the process of economic reforms started in 1983, which was followed by fierce liberalization in 1991. Indian market was opened up for foreign firms and Indian organizations were allowed to compete in the overseas markets with local and multinational organizations. In the wake of globalization of trade, commerce and industry, and liberalization of economies of the various countries of the world, it has become mandatory for all the players to have a sound technology base, without which accomplishing operational and strategic goals would become not only uneconomical but almost impossible. The increasingly demanding global business environment calls for a separate management function which looks after corporate interests on the technology front.

Many strategic alliances came into existence across a variety of industries to make Indian firms compete not only in domestic but also in international market. The industries which could attract direct foreign investments and maximum number of JVs include electronics, communication, information technology, and automobile. Several Indian organizations have acquired state-of-art technology from their foreign collaborators and JV partners. Though technology has been the basis for such emerging collaborations and JVs, the technology management function does not de-emphasize finance, marketing, personnel and other traditional functions of an organization.

At the global level, there are perceived advantages of technological collaborations that are taking place all over the world. Developed and developing countries stand to gain from legislative and economic reforms. Technology transfer is now taking place in India with organizations from many developed countries like US, Japan, UK, Germany, etc. Our discussion of a global scenario does not mean that India is only at the receiving end and technology has to flow only in one direction. There can be a market for the technologies which India has developed in many core areas in recent years.

Competitiveness of an organization can be assessed from various parameters, the most important of them being technological innovations and breakthroughs which the organizations realizes or has the potential to realize over a period of time. It may be difficult to measure the impact of adopting an innovation or rejecting the same, but over a period of time overall financial and marketing results can definitely help in drawing conclusions regarding technology-based decisions. Technological changes and decisions to adapt to changes in the environment can make or break an organization. Examples of the significant impact of commercializing a technology on the overall performance of the organization are numerous, from the invention of the steam engine to intelligent cars.

In the changing global scenario, those organizations that integrate technology related decisions into business strategies have considerably improved their chances of reaping benefits from technological innovations. There is always an element of risk associated with adoption of a new technology. This indicates that technological innovations cannot be adopted without prior analysis in context to a particular organization. Technology involves moderate to high investments, and it also has an effective lifetime, after which the same technology may not remain commercially viable and hence, needs either upgrading or total replacement. Under the circumstances, where total replacement is

called for, the previous technology which was in use must generate enough revenues so that the investment for the new one may be either totally or partly funded from operations.

New organizations must consider all these factors quite carefully, and the choice of technology becomes an extremely crucial decision for them. For existing organizations, a watchful approach will help not only in survival and growth but also in taking and maintaining technological leadership in their respective industries. For those organizations that are already technology leaders of their respective industries, technology management strategy becomes a more crucial weapon by which they can sustain their positions in their existing businesses and also explore new markets, thereby restricting the entry of competitors and exit of customers in different parts of the world. By evolving suitable technology strategy leading firms can identify and cultivate core competencies (Prahalad and Hamel, 1990) in the businesses they are in.

The study reported in this article covers three cases of Indian automobile firms which involved themselves in collaborations for technology acquisition in the late 1950s, 1960s, and early 1980s and addresses the issues related to strategic management of technology in developing countries in general, and within Indian industry, in particular. The objective of the study was to assess technology management practices in the Indian automobile industry with special emphasis on clarity in technology acquisition, developing capabilities to adopt, adapt, and implement new technologies, indigenization, competitiveness, and effectiveness of technology alliances. The study also examines the nature and impact of flexibility in technology management decisions. During the course of study the following issues were also addressed:

- technology strategy of the firm,
- technology transfer model followed,
- technology as a powerful tool for competitive advantage,
- innovation culture in the organization,
- technology development,
- vendor development,
- research productivity,
- building core competencies,
- technology strategy framework being evolved and followed.

The study also aims at ascertaining the perception of the corporate world about the strategic management of technology. What do the top and middle management of technology-based or technology intensive organizations expect from technology management function? What instructions, directives, and guidelines are desired in pursuit of a technology management strategy? How can a corporation maintain its technological supremacy? How helpful can the technology strategy be in promoting the innovation culture in an organization? Apart from strategic technology management, are there other applicable strategies for surviving in the competition? The study also addresses many of these questions.

Being an area of recent origin, relatively scant literature is available about the Indian context. The research conducted on technology management in developed countries does not provide much insight into the technology management practices in developing or under developed countries in general and in India in particular.

2. Methodology

A questionnaire survey was undertaken in the Indian automobile industry covering 33 automobile vehicle and component manufacturers. A total of 152 respondents with average length of experience of 16.83 years replied to a questionnaire measuring 25 variables quantitatively. Tables 1 and 2 present the profile of the sample who responded to questionnaire study.

Three cases were prepared of the firms which have acquired technology from abroad. Table 3 presents the profile of the executives interviewed. Profitability, liquidity, and turnover ratio analyses exercise have been done on last three fiscal years data of each firm, assuming that after fierce liberalization, the impact on finances was felt from the fiscal year 1993-1994. A brief past history of the organizations studied was obtained to understand their technological backgrounds. Interviews focused on the perspectives of the decision makers of the technology management function. The relationship of the effective technology management to organizational growth was emphasized. The cases were analyzed applying the situation-actor-process-learning-action-performance (SAP-LAP) paradigm

Table 1
Sample profile

Code	Designation description	No. of respondents
01	Chief Executive Officer (CEO)	8
02	Chief Technology Officer (CTO)	23
03	Chief Production Officer (CPO)	13
04	Senior General Manager	3
05	General Manager	14
06	Deputy General Manager	4
07	Assistant General Manager	20
08	Senior Manager	24
09	Manager	18
10	Deputy Manager	9
11	Assistant Manager	5
12	Senior Engineer	7
13	Did not mention	4

Table 2
Questionnaire respondents' functional areas

Code	Department description	No. of respondents
01	R&D/Engineering	44
02	Product Engineering/Product Development	11
03	Manufacturing/Production	60
04	Vendor Development	02
05	Marketing	12
06	Corporate Planning	3
07	New Projects	10
08	Quality Assurance	3

Table 3
Length of experience of executives interviewed

Length of experience (years)	No. of respondents
25 and above	22
20-25	8
15-20	7
10-15	7
<10	4
Total	48

(Sushil, 1994) to bring out the finer issues. Syntheses of learning issues were then performed to ascertain the commonalties and diversities in the approaches of these firms (Fig. 1).

The combination methodology covered the following attributes: collaborators, products, market, technology history of the organization, corporate philosophy, technology

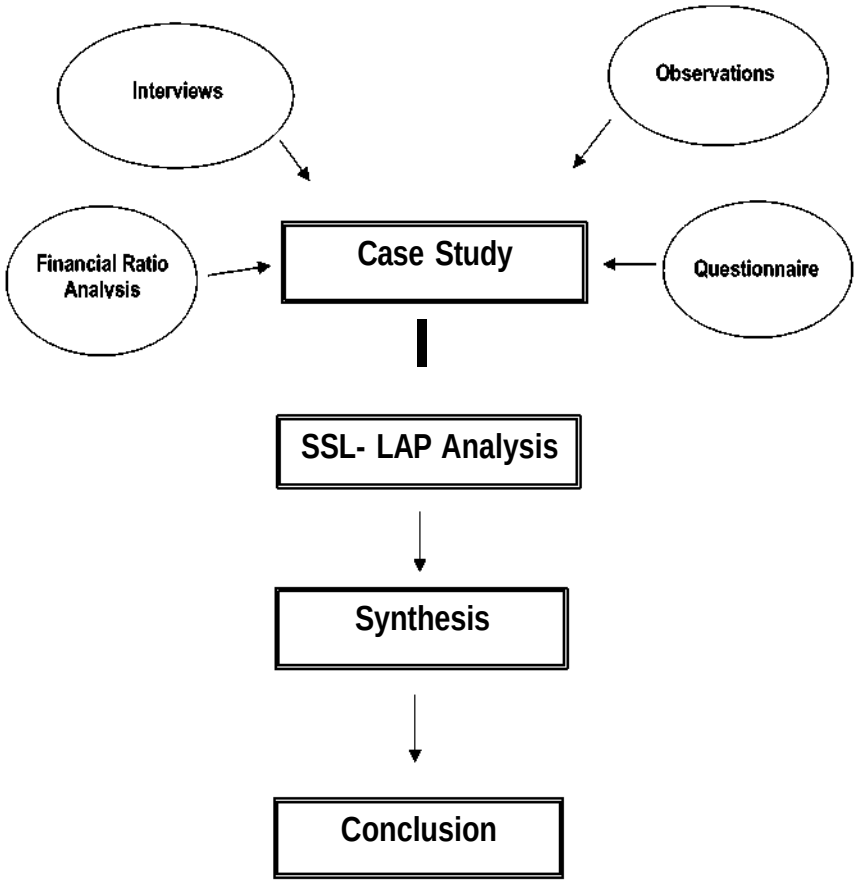

Fig. 1. Methodology adopted for the case preparation.

strategy, technological strengths and weaknesses, integration of technology strategy with corporate strategy, effectiveness of technology alliance, clarity in technology acquisition, innovation flexibility, flexibility in technology strategy, research productivity, technology waste, resource leverage, relationship with technology providers, technology absorption model and vendor development and indigenization. The firm's averages are compared with industry averages on select variables measured through questionnaire survey.

The SAP-LAP analysis was used to learn about the handling of the technology management function in the firms constituting the sample for case studies. In each case, the context of the situation has been identified. The roles played by various individuals and parties involved have been described. The current situation of the organization and the operating environment have also been described. The learning issues have been outlined, possible actions have been suggested, and expected performance have been envisaged. Fig. 2 shows the interaction of situation, actor, and process with learning, action, and performance in the SAP-LAP paradigm. Learning issues have been synthesized. Conclusions and limitations of the study are noted.

3. Tata engineering and locomotive company limited

For over a century, the house of Tatas has been in the forefront of Indian industry in a wide range of activities. The Tata Engineering and Locomotive Company Limited (Telco) is India's largest engineering company in the private sector. With a turnover of Rs. 75,000 million, the company accounts for over 60% out of the total heavy and MCV in India.

Telco came into existence in 1949 and began operations with manufacturing of locomotives. It commenced manufacturing commercial vehicles in 1954. Since then, the company has established a strong foundation in automotive manufacture, with an enduring commitment to technology and quality. Today, Telco is in a position of leadership with an annual production of 200,000 vehicles in 2-35 ton range. Telco is the largest commercial vehicle manufacturing company in India. World wide it ranks among the top 10 in manufacturing companies in 5-15 ton segment. To maintain high level of indigenization, Telco designs and manufactures its own machine tools, process equipment, heavy dies, metal patterns, testing equipment and electronic controllers for machine tools.

Telco stands not just for producing durable automotive products—but for a much more reaching value—the Value of Trusteeship. This, in the contemporary view, is known as 'partnership development'. The concept of partnership, for Telco, includes labor management cooperation, employee development through cross-functional training, vendor development, customer development and strategic alliances.

Success in today's competitive environment demands technologies and work processes that are results oriented. Incorporating these technologies into all manufacturing processes, Telco has focused their manufacturing strategy on developing world class production facilities and a high level of indigenization. Telco has three automobile manufacturing facilities located at Jamshedpur started in 1954, Pune in 1966, and Lucknow in 1992, to cater to the domestic and overseas demand for its vehicles.

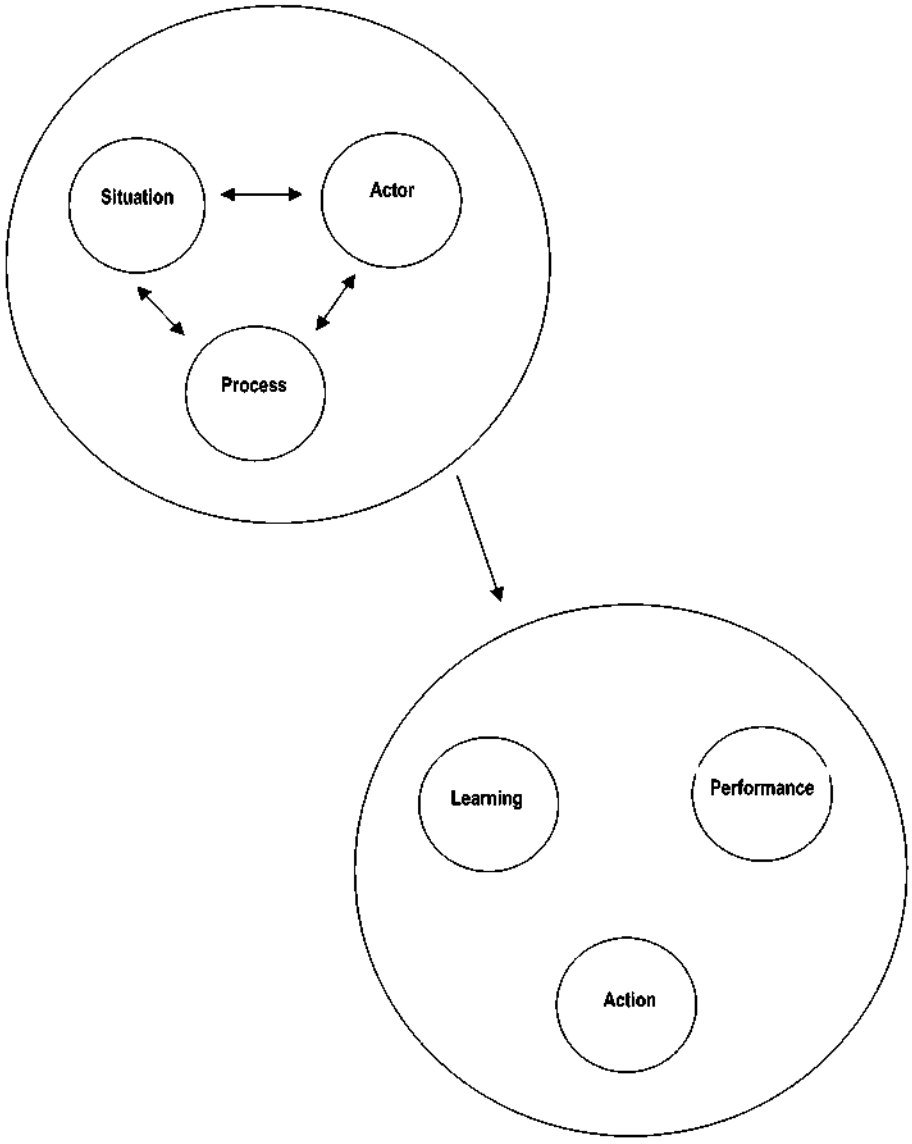

Fig. 2. SAP-LAP paradigm.

3.1. Telco 's technology strategy

Telco' s technology strategy is to offer opportunities to its technologists in developing new processes and technologies, but does not hesitate in acquiring state-of-art from pioneering firms all over the world without loosing time. The focus is on maintaining competitiveness and building technological leadership locally and globally by either developing technology

in-house or acquiring the state-of-art from others. Local technologists are encourage to improve upon and innovate the acquired technology apart from adapting it for Indian conditions. Engineering Research Centre (ERC) has also achieved major breakthroughs in variety of areas. A large number of Telco products are designed indigenously."In Telco the investment in R&D is considered like investment in a child, which replaces the elders in the family after growing, but remains an expenditure in the balance sheet of the family, it pays you in the long run by proving the continuity in technology assimilation over a period of time," says the CTO. "When we pursue a project, cost-benefit, risk and ROI analyses are of course done but the most important consideration is to achieve and maintain the technological leadership, which cannot be compromised," says the CPO.

3.2. Technology management at Telco

Telco has created the largest and most comprehensive design and development set-up. Its ERC is equipped with state-of-the art facilities in designing, manufacturing and testing. It has developed core competencies in designing automobiles such as light commercial vehicles (LCVs), medium commercial vehicles (MCVs), heavy commercial vehicles (HCVs) and multi-utility passenger vehicles (MPVs) for Indian conditions. The centre takes pride of developing an LCV which has successfully competed with latest international brands. Telco has put in major design efforts for intermediate commercial vehicles and new passenger car model in the MPV category. Telco's ERC employs the finest and most dedicated automobile engineers, who make use of state-of-art R&D facilities to put the company and the country in the world's automobile technology core group.

Sophisticated equipment installed at ERC include high capacity automatic press and forging lines, high pressure molding lines, CNC machining centre for dies manufacturing, laser cutting machines, transfer lines, special purpose machine tools, process equipment, software for parametric research and CAD/CAM centre. Manufacturing automation protocol (MAP) is also being considered for implementation.

Telco's growth and its technology consciousness is securely anchored in the skills of its employees. The technology training imparted by Telco training school is comparable with any world class automotive training centre. It has created an invaluable source of skilled craftsman, who are periodically retrained, to prevent obsolescence. Telco has a pool of highly qualified engineers, whose innovativeness gives it a distinct competitive edge.

Telco continues to introduce cost effective and environmentally sustainable technologies, ensuring that all of its vehicles meet the international norms on emission and safety.

Telco makes its commitment to technology management visible by spending around Rs. 1100 million on in-house R&D which amounts nearly to 1.4% of its annual revenues. This amount is much higher than the spending of other manufacturers in the Indian automobile industry, however it is much lower than what a firm of the same size (in terms of revenues) spends in Japan or US. It employs nearly 800 scientists and technologists in its ERC which is more than the number of people employed by an equivalent firm in the developed countries. In fact, Telco's ERC has proved to be breeding ground for the automobile technologists for the entire automobile industry in India. Credit for developing ERC to its present form goes to Air-Chief-Marshal (retired) and Ex-Chairman Telco, Mr. S. Moolgoankar, who envisioned the need for creating a technology base after Telco's collaboration with Daimler Benz of

Germany (Mercedes) expired in 1975. As a result of ERC's initial efforts, Telco was selling the same HCV in African market at half the price than that of Mercedes. This experience of Telco helped it in understanding the importance of indigenization and advantage of having a dedicated R&D facility equipped with state-of-art design and testing instruments. High degree of vertical integration helped initially in maintaining the quality of components.

Telco has experience of acquiring technology from a large number of countries and has tried various models of technology transfer. "The technology strategy of the firm is based on the assumption that no firm in the world will provide the technology from which the firm itself can extract mileage. Technologies mature for transfer either to local or foreign firm(s) when it has finished the growth stage and is entering the maturity stage in the country of origin. The time for a country is ripe for acquiring the technology when the local market has hidden or visible demand for the products based on that technology. Firms in the borrowing country can absorb the technology when a technology base and technology culture exists. There must exist infrastructure to support the activity of technology absorption at different levels (particularly at vendor level)." Taking these factors into consideration Telco believes in developing competencies in-house to meet the future challenges. "If you have developed reasonably high technological capabilities, then absorbing borrowed technology becomes an easier task," says the CTO.

At Telco, investment in R&D is a continuous process, and returns are calculated on long term basis and not on annual basis. "When technology acquisition started in 1983, Telco increased its annual outlay on R&D. We felt that the need of the hour was to develop our technology base, and we decided to enhance our product and process technologies. We are in a comfortable position as far as LCVs and HCVs are concerned, and our MPVs are making in-roads in Indian and foreign markets. These are the results of our last 10 years of efforts and we have concrete plans for the next 10 years," says the CTO. The CTO disagrees to the argument that, the firms with higher volumes can only afford to do R&D. "If the firms in developed countries cut cost exploiting economies of scale, we in India, compensate it with low overheads and therefore, the resources can be spared to do R&D. There should be a commitment and inclination to do R&D, resources can always be mobilized," feels the CTO.

"It is a very modest R&D effort which Telco is putting up in comparison to developed countries, but by Indian standards it is just fabulous," observes the CTO. Telco knows that in order to sustain its current position in the Indian market, its current investments will have to be further enhanced. On the whole, Telco has an enviable track record in technology management process.

3.3. Telco's performance compared to industry

Table 4 shows that Telco is way ahead on technology leadership, corporate growth, value of the firm, level of indigenization, extent of vendor development, capability to exploit economies of integration, degree of technology planning, research productivity, investment on technology, customer need satisfaction, degree of market pull and technology push, strategic flexibility, technology innovation flexibility and technology acquisition flexibility counts. This leading position is clearly visible in the way Telco is working. The responses were measured on a 10-point scale.

Table 4
Values of variables for Telco, Eicher and HML-PCD compared with automobile industry

Code	Variable description	Average optimistic value (for industry)	Average most likely value (industry average)	Average pessimistic value (for industry)	Telco's average	Eicher's average	HML-PCD's average
01	Technology leadership	8.68	6.76	3.34	7.93	6.53	6.52
02	Corporate growth	9.15	4.35	0.85	4.41	2.90	3.15
03	Technology pay-back period	9.15	5.95	2.86	5.88	6.06	5.46
04	Value of the firm	9.15	7.10	2.40	9.15	5.89	6.33
05	Capability to adopt, adapt, and implement new technologies	8.52	5.70	2.72	4.69	5.85	5.92
06	Level of indigenization	9.15	8.48	2.40	9.15	7.35	9.15
07	Extent of vendor development	9.15	8.06	2.40	8.88	8.20	8.40
08	Capability to exploit economies of scale and scope	9.15	6.58	0.85	7.52	5.17	4.89
09	Degree of technology planning	9.15	6.33	0.85	7.35	7.13	4.58
10	Effectiveness of technology alliance	9.15	6.18	2.37	6.11	5.89	4.80
11	Research productivity	8.86	6.21	2.45	7.39	5.89	4.80
12	Technology Waste	0.85	2.78	5.80	2.00	2.92	3.60
13	Investment on technology	7.25	3.58	0.85	4.90	2.32	4.50
14	Extent of technology development	7.80	5.42	2.25	5.52	4.95	4.59
15	Success of technology acquisition	6.80	3.95	0.29	2.39	3.69	2.27
16	Equity participation	5.80	2.93	0.85	2.18	2.88	0.85
17	Technology availability	5.80	3.88	0.29	3.12	4.62	2.69
18	Customer's technology awareness	6.92	4.78	0.66	5.57	5.42	4.46
19	Customer's needs satisfaction	7.41	4.94	0.41	5.39	4.85	5.42
20	Degree of market pull	7.48	3.54	0.29	4.50	2.48	3.92
21	Degree of technology push	8.80	4.62	2.06	4.96	3.94	4.45
22	Conduciveness of culture for making innovations	6.26	3.82	1.11	3.79	3.29	2.98
23	Strategic flexibility	9.00	7.33	3.44	8.18	6.72	6.59
24	Technology innovation flexibility	8.38	7.13	2.07	8.05	5.74	6.19
25	Technology acquisition flexibility	8.27	6.81	1.26	7.19	7.73	5.40

Number of respondents from Indian automobile industry = 152; average length of experience across the industry = 18.28 years; number of respondents from Telco = 7; average length of experience or respondents from Telco = 23.14 years; number of respondents from Eicher = 5; average of length of experience of respondents from Eicher = 15.6 years; number of respondents from HML-PCD = 5; average length of experience of respondents from HML-PCD = 8.4.

Table 5
Financial ratios for Telco

Financial ratio	Fiscal year			Industry average
	1995-1996	1994-1995	1993-1994	1993-1994
RORTA(%)	14.34	12.38	11.42	5.6
RORCE(%)	26.87	23.54	22.63	5.04
ROREQU(%)	21.94	22.46	20.34	12.60
Debt to asset	0.35	0.45	0.48	0.3
Debt service coverage	6.58	6.23	5.22	1.96
Debt to equity	0.53	0.81	0.86	2.164
Current	1.73	1.75	1.56	1.208
Acid test	1.21	1.20	1.16	0.43
Total asset turnover	2.14	2.21	2.02	1.066
Fixed capital turnover	23.25	24.67	21.14	2.512
Current asset turnover	4.01	4.19	4.15	2.087
Working capital turnover	5.60	5.34	5.13	3.48
Inventory turnover	7.90	7.30	7.11	4.049

On the financial front, Telco is performing well consistently. Table 5 indicates the sound financial health of the firm. High rate of return on total assets (RORTA), rate of return on capital employed (RORCE), and rate of return on equity (ROREQU) show the high profitability of the firm. Low values of debt to asset, and debt to equity, and high debt service capacity, current, and acid test ratios show easy liquidity position. Extremely high fixed capital asset turnover ratio shows efficient use of fixed assets. On the whole, the firm is in excellent financial health.

Effective management of technology has kept Telco abreast with latest developments in the automobile industry. After 1991, Telco did not have any difficulty in facing the challenges of multinationals coming to India because it has developed a strong technology base. While other firms of the same age operating in different segments of automobile market are having tough time after 1986.

3.4. Philosophy of vertical integration

When Telco acquired technology from Mercedes to manufacture HVCs in India, a vendor base did not exist. Telco's management also knew that they will have to indigenize the product to maximum extent in order to survive and take lead in the domestic market. It could also envisage the problems it will have to face once the collaboration is over. The Indian component Industry was not that responsive in late 1950s and early 1960s and cost of vendor development was exceeding in-house manufacturing. Telco, therefore, adopted the philosophy of high degree of vertical integration.

Telco's vertical integration encompasses the manufacture of sophisticated machine tools, industrial electronics, and foundry equipment. The company also designs, develops, and tests new automotive products that incorporate newer technologies and designs and manufactures its own tooling for heavy dies to compact high precision fixtures.

Effective vertical integration has helped Telco in bringing out LCV in the shortest possible time. The LCVs introduced by Telco have the largest market share in India and are

exported to a large number of developing and under developed countries. Telco's foray in new generation multi-axle commercial vehicles and 'Sumo', the MPV, have been great successes and are making inroads into the traditional markets.

Lately, in order to quickly respond to the requirements of fast changing Indian automobile market, it has cut down the degree of vertical integration. It has developed a value chain of 500 odd vendors to supply more than 4000 components. There is an effective dovetailing of vendors with the company. Most of them are located around Telco plants in Pune and Jamshedpur and rest of them are in places like Padi, near Madras, and Housur, where the other giant of HCVs and LCVs is situated. The decision of Telco to go in for vendor development on a large scale provided the required flexibility to cater to the market with newer models, and altogether new categories of vehicles which were not operated upon earlier. Vendor development is one of the most coveted activities in Telco after 1990.

3.5. Telco's recent JVs

Telco has entered in technical and financial collaboration with Mercedes to manufacture E220 series of Mercedes Benz cars in India. Mercedes Benz India Limited (MBIL), the JV aims at capturing the developing market in India for luxury cars. It has also entered into a JV partnership with Cummins of US (Cummins), Tata-Cummins Limited (TCL), for manufacturing high performance, cost effective, and environment friendly diesel engines for LCVs and HCVs. Both JVs came in existence in 1994.

A JV has been promoted in collaboration with Holset, a subsidiary of Cummins, Tata-Holset Limited (THL), for manufacture of turbochargers to be supplied for Cummins range of diesel engines. The THL came into existence in 1995.Telco has two JVs abroad. Tata Precision Industries (TPI) is engaged in manufacturing of precision tools and metallic and plastic components in Singapore. Nita Company Limited (NCL) is engaged in assembling Telco vehicles in Bangladesh. TPI has also set up a unit in Dewas, Madhya Pradesh, for manufacturing high precision parts for exports to the electronics and computer industry.

3.6. Economies of integration

Telco emphasizes on exploring economies of scale and scope (Noori, 1990) to keep its products competitive in all segments of LCVs, HCVs and MPVs. Ability to do so has been one of Telco's core competencies. The firm rolls out 750 odd vehicles per day including MPVs. Its product range includes 17 models with average three variants for each model. Telco has developed manufacturing technology and manufacturing process in such a manner that it can deliver any quantity of any particular product without sacrificing the cost and quality. It is the only firm in India which can claim to be able to exploit economies of scope to a significant level.

3.7. Balancing market pull with technology push

Telco is a market leader in LCVs and HCVs, and is consistently pushing up its shares in the booming Indian automobile market. Table 6 presents Telco's market share in four

Table 6
Telco's market share in three fiscal year

Market segment	Fiscal year		
	1995-1996	1994-1995	1993-1994
LCVs (%)	62.4	58.8	43.5
MCVs/HCVs (%)	72.7	71.8	65.6
Luxury car segment (%)	8.8	–	–
MPVs (%)	22.4	–	–

Source: Telco Annual Report 1995-1996 and AIAM Report 1995-1996.

segments in last 3 years. Except for luxury car segment, whose capacity has been utilized to manufacturing Sumo which is a runaway success in Indian market, Telco has improved its market share in all other segments.

Telco is way ahead of its competitors on technology front. Its sole competitor in HCV segment, Ashok Leyland, is having only 27.3% market share. In LCV segment, Telco's competition mainly comprises of Bajaj Tempo Limited (BTL), Ashok Leyland, Eicher Motors Limited, and Swaraj Mazda Limited. Except for Ashok Leyland, no one has put forth plans for expansion of manufacturing capacity. Telco has plans to double its existing manufacturing capacity in LCVs by adding balancing equipments and adopting highly productive technologies. According to industry predictions, HCV sales are likely to grow from950,00 vehicles inFY96 to 109,000 inFY97.Telco'sLCVsales are likely to growfaster than HCVs, from 70,000 vehicles in FY96 to 87,500 in FY97. Its tie-up with Cummins is likely to help Telco in bringing out advanced models or variants of existing products. The JV with Mercedes is likely to add prestige to Telco products. Telco has been able to cash on the booming market because of its technological strength and sensible approach to technology management function. It has entered into need-based technological collaborations and JV partnerships with world leaders in their respective areas.

3.8. Global presence

To meet the requirements of capital equipments for its expansion plans, Telco has developed its own facilities for the manufacturing of sophisticated equipment. Having committed itself to increasing export growth, Telco products are made to stand straight in global competition. This has become possible because of stringent quality standards and a strong philosophy of vertical integration. Telco exports fully built up units to over 60 countries in Europe, South East Asia, West Asia, and Africa. In its pursuit of technology transfer to other developing countries Telco vehicles are being exported in CKD packs to Bangladesh, Kenya, Malaysia and Zambia. This has also helped in developing the local auto component industry in respective countries. Telco envisages further growth in this area in the times to come.

Telco exported 16,581 vehicles of value Rs. 6430 million in fiscal year 1995-1996. The firm is now showing its presence in countries like Spain, Italy, Greece and the Benelux countries, apart from its regular market in developing countries. These new markets are currently offered MPVs, entry into HCV segment is planned in the coming years. In order

to cater to the demand of South East Asian and European countries, major spare parts and warehousing facilities have been established in Singapore and Switzerland. Similar facilities are being planned for in Gulf and African countries.

3.9. Future plans

The firm has made considerable progress in its small car project, 'Indica'. Indica is the first world class contemporary car designed and manufactured by an Indian company to meet the requirements of the Indian people. Design and styling of body of this five-door "hatch-back" passenger car has been borrowed from the Institute for Development of Automotive Engineering, s.p.a., Italy. The factory buildings were under finishing stages and substantial equipment for high volume manufacture have been procured and installed. The pilot batch of the cars for test became available in 1997. Through Indica, Telco wishes to enter in the predominated territory of Maruti Udyog Limited (MUL). Indica is also expected to have interesting export possibilities.

Telco is also launching 25 ton 6 x 2 trucks and buses, both powered by new Cummins engines. Several other LCVs and HCVs will be fitted with turbocharged intercooled Cummins engines which are in advanced stages of development. A new double cab pick-up and army versions of various Telco vehicle have also been developed and were launched in the last quarter of 1996. It also introduced small petrol engine and turbo diesel engine in the market in the fiscal year 1996-1997, to provide customers with a wider choice of engine options.

3.10. SAP-LAP analysis

3.10.1. Context

Making of a multinational company through effective technology management.

3.10.2. Situational analysis

- Technology collaboration with Mercedes got over in 1974.
- Telco was building its technology base ever since the collaboration with Mercedes was over.
- It absorbed and indigenized the borrowed technology and dependence on collaborator was totally eliminated.
- Technological innovations made by Telco have started showing up only after 1985.
- Telco was operating in an oligopolistic situation in HCVs segment of automobiles in India.
- The firm has consolidated its technological, market, and financial strengths after the collaboration got expired.
- Telco is the largest firm in automobile and entire engineering industry of the country.

3.10.3. Main actors

- Mr. Ratan N. Tata, Executive Chairman, as the visionary leader of Indian engineering industry.

- Mr. V.M. Raval, Executive Director, as the CEO and guiding force behind Telco.
- Top management executives as functional heads.
- Employees (40,000 odd) in all four manufacturing units located at three places as the life blood of Telco.
- Technology provider to Telco as JV partners or collaborators or both.
- Technology borrowers as JV partners in other developing countries.
- Customers of Telco as the source of encouragement and new ideas.
- Competitors as the industry watchdogs.

3.10.4. Process of technology management

- Telco is the only company in India which does product design in India.
- It borrowed need-based state-of-art technologies from the technology leader firms all over the world.

Table 7
Learning issues in the case of Telco

Technology strategy and competitive advantage	Technology strategy helps build sustainable competitive advantage. Competitive advantage helps evolve technology strategy.
Technology leadership and competitiveness and core competencies	Effective implementation of technology strategy helps develop core competence, competitiveness helps in sustaining competitive advantage. Effective implementation of technology strategy and sustained competitiveness help building core competence.
Core competencies and corporate image	Core competence helps build corporate image and also helps in consolidation of technology leadership.
Sustained efforts in technology development	Helps cultivate core competence and take technology leadership in the long run.
Effective absorption and new technology acquisition	Effective absorption of borrowed technology pave the way for acquisition and subsequent adoption for new technologies. The same process repeated several times helps developing technology absorption and development culture.
Innovation culture and innovation flexibility	Frequent technology acquisition from different sources and adapting them to local conditions enhances innovation flexibility. Freedom to bring out innovations promotes innovation culture in the organization. Innovation culture covers other soft technologies.
Shrinking degree of vertical integration	Helps in becoming lean, thin, and trimmer, while high degree of vertical integration increases 'innovation inertia'.
Parametric research	Parametric research is crucial not only for leapfrogging and radical innovations but is equally important for incremental innovations. It can also help in reducing the cost and improving the product performance.
What next after having absorbed the borrowed technology	Acquire and adopt yet another state-of-art technology till the firm is not able to develop one by itself.
Role of a strong marketing function	Marketing works as a feed back system for customer preferences and for assessing performance of competition. The people in marketing can provide food for thought for technologists.
When a firm becomes capable of doing fundamental research in the parent and allied industry	The next step is obviously to strive for radical innovation. Phase out or find customer for maturing and obsolete technologies.

- It has an army of 800 plus technologists and engineers involved in R&D in automobile technology.
- If spending on R&D is any measure of technology management then Telco obviously has the most effective technology function across the industry.
- Telco has a state-of-art technology training centre.
- When local component industry was not matured enough, Telco went for high degree of vertical integration, but lately it has offloaded some of its component manufacturing activities to vendors by handing over the technological know-how and manufacturing set up.
- This decision of Telco helped them in reducing the 'innovation inertia' and made it more swift and flexible.
- Technology acquisition is made more effective by quick absorption and timely indigenization of imported components.

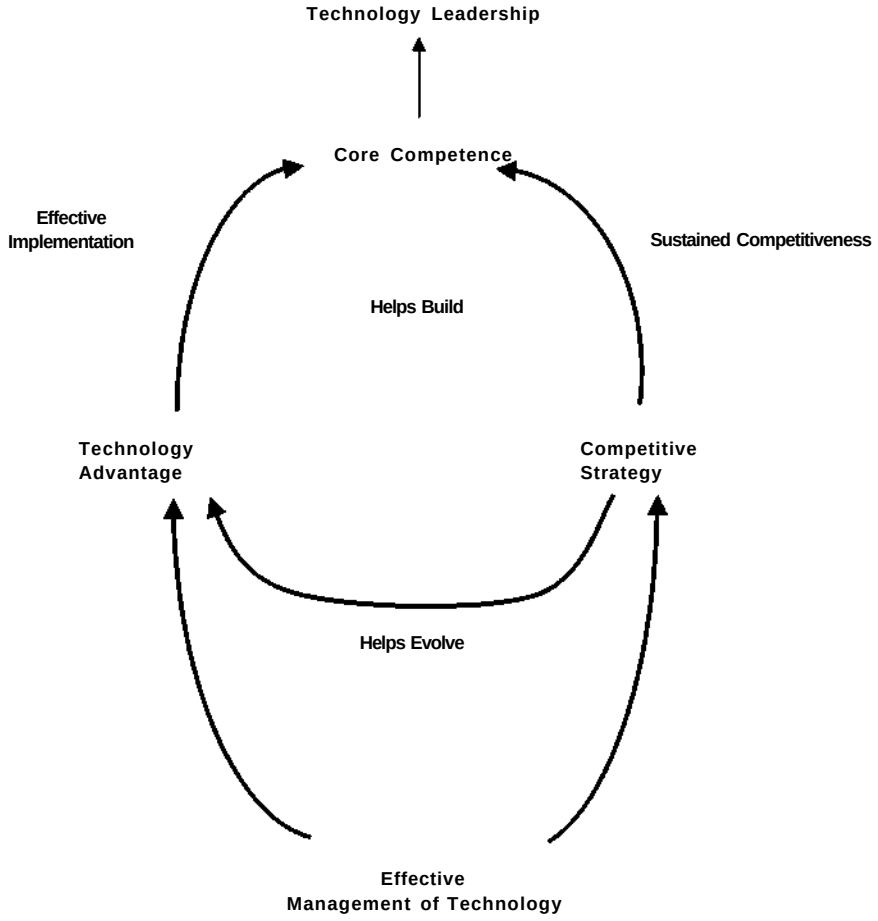

Fig. 3. Relationship among the technology management aspects.

3.10.5. Learning issues

The seed of technological strength was sown in early 1970s and fruits are harvested only now. Telco did not waste time in developing its technological capabilities after the collaboration with Mercedes was over. Though Telco has not been able to reach to the excellence level which Mercedes has achieved over a period of time but it developed technological capabilities to fight foreign multinationals in India on its own. Table 7 presents learning issues in the case of Telco. Fig. 3 shows the relationship among technology management aspects.

3.10.6. Suggested actions

- Telco needs to keep good work going.
- Needs to concentrate on developing machines tools for manufacturing various critical components.
- Parametric research needs to be promoted.
- Telco needs to frame long term technology strategy to fight foreign multinationals.
- Explores possibilities of transferring product and process technology in component manufacturing sectors to developing countries.
- Degree of vertical integration can still be reduced. Presently it is about 45%, it can be brought down to 30-35%.

3.10.7. Expected performance

- Telco has all the capabilities to emerge as an Indian multinational.
- Telco has a tremendously high debt service capacity and hence there is a scope for massive investment in technology management.
- Telco brings up more number of vendors and makes them transfer technology to other developing countries.
- Expand its operations in developing and under developed countries.

4. Hindustan Motors Limited (passenger car division)

Hindustan Motors Limited (HML) is one of the oldest car manufacturers in India. It started operations in 1947 in collaborations with a British company. It had an unchallenged period of about 3 5 years when it led the Indian automobile market in passenger car segment. HML began with assembling CKD parts and with an installed capacity of 10,000 vehicles per year which was enhanced to 30,000 cars in 1980. The model it began with, Ambassador, is still in manufacturing. Government has been the majorbuyer of Ambassador cars because of its ruggedness and low maintenance cost. In first 33 years of its inception, it brought out only three variants of the same model. In 1980, Contessa, 1.8l capacity premium category car, was introduced in collaboration with Vauxhall of UK for suspension and body and Isuzu Motors (Isuzu) of Japan for engine. Premier Automobile Limited (PAL), the first competitor of HML, entered the Indian market in 1950s and started manufacturing cars in collaboration with Fiat of Italy. HML and PAL shared the demand of cars in Indian market till the entry of MUL in 1984.

HML has four divisions which are automobile, earth moving equipment, power product, and passenger car division. The automobile division is based at Uttapara, near Calcutta, and it was formerly known as Hind Motors which was converted into HML in early 1960s. The earth moving division came in existence in 1971 in technical and financial collaboration with Caterpillar Inc. of US and is located at Tiruvellure, Madras, and manufactures dumpers, loaders, crawler tractors and excavators. The power product division began operations in 1981 in collaboration with General Motors (GM) and Twin Disc Inc., both of US and is located at Hosur, near Bangalore, manufactures heavy duty power shift transmission for heavy equipment and other industrial applications. The passenger car division, which is the subject organization for this case, came into existence in 1984, is located at Pithampur, near Indore, and manufactures engines and transmissions for passenger car applications.

The passenger car division of HML (HML-PCD) involves an investment of Rs. 1840 million out of which Rs. 1214 million has been spent on product and process technologies and manufacturing machines. HML-PCD has spent 43% of total investment in technology on imported machines and equipments. It was set up with an intention to assemble passenger cars which was being done at Calcutta. The incentives offered by the government of Madhya Pradesh that time was the basic motivation in locating this facility in this part of the country. The competition got intense in 1984 with the entry of MUL, HML' s market share came down drastically, and HML-PCD could not take off as a passenger car manufacturing unit and became a captive facility of HML automobile division to assemble engines and transmission systems. This experiment was new for HML, because they already had their power product division manufacturing key components for the earth moving equipment division.

A feasibility study was also undertaken to explore the possibilities of assembling HCVs in the present HML-PCD in collaboration with Isuzu. Isuzu is world leader in HCB technology. But sudden spurt in Yen price upset the cost calculations. The HML promoters gave up the idea because it was asking for more investment, and risk was definitely higher.

Financial ratio analysis for three fiscal years presented in Table 8 indicates the firm is showing better performance in the year 1995-1996. This is because of boom in the

Table 8
Financial ratios for HML

Financial ratio	Fiscal year			Industry average
	1995-1996	1994-1995	1993-1994	1993-1994
RORTA(%)	7.11	4.41	2.73	5.6
RORCE (%)	18.66	11.24	8.27	5.04
ROREQU (%)	20.72	14.39	12.41	12.60
Debt to asset	0.48	0.38	0.53	0.3
Debt service coverage	1.51	1.48	0.99	1.96
Debt to equity	1.39	1.23	2.41	2.164
Current	1.37	1.40	1.38	1.208
Acid test	0.38	0.49	0.17	0.43
Total asset turnover	1.69	1.46	1.02	1.066
Fixed capital turnover	2.84	2.50	1.46	2.512
Current asset turnover	4.44	3.72	3.08	2.087
Working capital turnover	15.47	12.27	12.00	3.48
Inventory turnover	5.76	5.39	3.80	4.049

automobile market in India. The firm's debt-to-asset ratio is higher and debt service coverage ratio still lower than the industry averages. The current asset turnover ratio looks healthy on depreciated assets. Working capital and inventory turnover ratios indicate effective inventory and working capital management functions. RORCE and ROREQU are way ahead of industry averages while RORTA has picked up only in the last fiscal year.

4.1. HML 's recent business ventures

After having faced stiff competition in Indian market, HML has entered in JV partnership with two leading car manufacturers from two different countries. General Motors India Limited (GMI), in which GM Germany has an equity share of 51% and balance is shared by HML and Indian public. GMI is located at Halol, nearBaroda to manufacture 'Opel Astra' brand of cars. HM Mitsubishi Limited (HMML) started in collaboration with Mitsubishi of Japan, located at Madras, to manufacture 'Lancer' brand of cars. These two new JVs came into existence in 1993 and 1994, respectively.

4.2. Objectives for promoting HML-PCD

The main objective behind promoting HML-PCD was to shift a major part of operations from Utterpara and start manufacturing new models like Contessa in the new facility. HML-PCD was started as greenfield unit, and HML wanted to plan its facility to match the world standard car manufacturing units. All this planning was done before MUL and competition thereof started stealing HML's market.

The second objective was to reduce the level of vertical integration in its existing set up. Since in the automobile division the vertical integration was of the level of 80% plus, which was like typical old manufacturers of automobiles in US and Europe, the size of the firm was very large and implementing change was extremely difficult because of high inertia. There was no organizational flexibility and introducing new technology was thought to be near impossible. This was the reason only three variants could be developed in 33 years time.

The social responsibility of industrial organizations of developing backward areas formed the third objective to promote and locate HML-PCD in Pithampur. The idea was that the space lying vacant around the HML-PCD's campus can be utilized in locating the vendors' units and the concept of lean organization with a modest degree of vertical integration could be implemented. The planned capacity of the HML-PCD was 60,000 cars per annum which got restricted to same number of engines and transmission systems per annum.

4.3. HML-PCD's mission

HML-PCD having converted into an engine and transmission system manufacturing and assembly unit, planned a course of action for itself. The manufacturing technology which was installed for HML-PCD is comparable to any world class engine and transmission system facility. It could not deliver results initially because of the set back the company went through. The people who joined this division—who were transferred from other divisions of HM—were told that they were supposed to manufacture passenger cars. HML-PCD

took quite some time to come out of this hang-over. In view of poor capacity utilization (around 60%), the enthusiastic and energetic people started feeling demotivated. There was no pressure to improve the capacity utilization because HML's market share was going down and there was no need for 100% capacity utilization. In 1991, when the overall automobile market size grew in India, the demand for HML's products also exhibited some improvement.

HML-PCD's management leadership was changed in 1992 which was instrumental in making HML-PCD competitive in the auto engine manufacturing. The decision of becoming an engine manufacturing unit was seen as a blessing in disguise, and HML-PCD set a mission for itself which reads like this "to become the world's best automobile engine manufacturing unit".

4.4. Technology management at HML-PCD

In absence of volumes the technology related activities remained subdued for a few initial years. There was no proactive approach to develop any kind of technological capabilities. The technology transfer arrangement with Isuzu was on one time basis, hence they supplied drawings and designs. The dedicated technologists, under the leadership of then CTO, took initiative in implementing the details prescribed in design. The mismatches of product and process technologies were handled innovatively by HML-PCD's people but it was very time consuming.

Since the customer was less demanding, product technology did not change quite often. But on its own, HML-PCD incorporated lot of changes in the product technology which includes, substitute material to bring the cost down and improve the engine performance, engine safety, fuel systems modification, and exhaust control.

With regards to the manufacturing technology, continuous updating is undertaken. HML-PCD has never starved on the capital investment count. "Whenever anybody comes out with a new idea for implementation, resources have never been a problem, but this also does not mean that creativity of the people take a back seat," says the CTO. Multi-skilling and multi-tasking have been taken up as a serious agenda item in HML-PCD. Every workman operates several machines together though this led to idling of many machines if an operator is handling the problem on other machine. "HML-PCD's top management compromises on productivity for multi-skilling," says the CPO. On the other hand, there are sections for example, connecting rod and transmission casing, which are totally unsupervised, where no engineering or managerial supervision is provided. The workers on their own decide which machine(s) is/are to be operated by whom. "Connecting rod manufacturing is a fairly complicated activity, but less complicated in comparison to crank shaft, or cylinder block manufacturing. So we thought that we will do a new experiment by not supervising this section. Thanks to technology training division, we have had no problems in this section in last 5 years," says the CPO.

HML-PCD spends 4 days per employee per year for technology training. Innovation culture has picked up in last 5 years, when HML-PCD engineers undertook some projects making use of principles of value engineering and finite element theory for performance analysis of its products. "These projects helped in improving quality and productivity of the overall operations and were highly appreciated by top management," says the CEO. "We

also realized that people have paid for our inefficiencies for so long but now they will not be covered up," says the CTO. The CEO also expressed satisfaction on the developments in absence of volumes. "Once we get an opportunity to churn out high volumes, then we will know our real technological strengths in terms of economies of scale," says the CTO. "HML-PCD now has a culture of multi-tasking and cross-functional groups which are working on many innovative ideas. Some of them have been extremely successful in reducing the cost while others have helped vendors in doing the same," says the CEO.

HML-PCD has not been thoroughly assessed on competitiveness front, because its cost effectiveness is not yet tested being a captive unit of HML. On core competencies issue, the CEO said "technological skills which people have acquired are our core competencies". He hopes to make it an organization which should be able to take advantage of economies of integration. "If we can develop ourselves into a world's best automobile engine and transmission system manufacturer, then automobile manufacturers will come and go but we will remain there forever, and technology is the only thing which can keep HML-PCD alive," says the CEO.

Table 4 indicates that HML-PCD is above the industry averages in level of indigenization, extent of vendor development, and customer need satisfaction. While the firm is below the industry averages on technology leadership, corporate growth, technology pay-back period, value of the firm, capability to adopt, adapt, and implement new technologies, investment on technology, success of technology acquisition, and degree of technology planning. HML-PCD is way behind the industry averages on conduciveness of culture for making innovations, technology innovation flexibility, and technology acquisition flexibility.

4.5. Vendor development at HML-PCD

The history of automobile industry in free India reveals names of few auto manufacturers, and limited auto component manufacturers because the GoI had other priorities areas to be looked into. The market was highly restricted, manufacturing activities generating extensive employment were encouraged, and end-products if creating any kind of unemployment at any level were discouraged. Sophisticated manufacturing technology was not available and imports of capital equipments had terrible restrictions in view of severe foreign exchange crunch during the early post-independence period. This was the period when competition could not grow, new technologies could not be brought in, the number of manufacturers were restricted, hence the customer used to wait for months and years for delivery of vehicles. Under such circumstances, management never cared to update their existing technologies. The impact was on cost reduction not for fighting the competition but for customer benefit and profit maximization.

The crucial components HML-PCD manufactures in engine are cylinder block, cylinder head, crank shaft, connecting rod, and cam shaft. In transmission system, the outsourcing has been restricted to 30% (in terms of value) level. In transmission system, the components manufactured in-house include main drive gear assembly, idler and counter gear, sleeves, clutch hub sintered, shafts, transmission case and rear cover.

In engine assembly, HML-PCD sources 40% components (in terms of value) from vendors, a very few of which are located in nearby areas. The distance from the vendors facility has also played its part in slowing down the growth of HML-PCD. The vendor development

could not be called as a strength of HML-PCD because it could not provide the volumes and basic infra-structural support. An effective dovetailing could never be achieved. HML-PCD has provided to vendors only the technical support which did not yield the results. HML does not have an impressive track record as far as vendor development is concerned. At the time of inception of its first unit at Utterpara, HML adopted a very different model of indigenization than what other firms are following. In early and late 1950s, indigenization for automobile manufacturing firms was to build or develop in-house capability.

HML-PCD was sourcing some of the components from Indian vendors, but their quality was not up to the mark. It started importing these components from abroad to achieve better quality. Examples include many small things like gaskets, oil and gas seals and washers.

4.6. HML-PCD's future plans

"We wish to manufacture engines for Lancers and Opel Astra, and then would like to supply engine to leading car manufacturers in the rest of the world," says CEO. "GMI and HMML would like to source engines from HML-PCD, not because it is a group company, but because we manufacture automobile engines for the most durable car in the country and use state-of-art technology for doing the same," observes the CPO. "We are developing capabilities to develop engine and transmission system for any automobile in the world, our direction are clear and priorities are set right," says the CTO. HML-PCD is concentrating on parametric research and not on generic engine research. The major research projects in hand includes turbo charger engines and multi-point fuel injection system, both these projects on completion will improve the engine performance by 5-15% in terms of engine life, and fuel efficiency respectively.

HML-PCD has plans to increase outsourcing and would like to source the technical and operational capabilities of vendors. The operations which can be done at the vendors place will be got done there only. This will be done to improve the volumes without incurring substantial capital investment. The bottlenecks in the manufacturing process have been identified and would be got over by process simplification or capacity enhancement. "The concepts of modular and cellular manufacturing systems will be made use of," says the CPO.

"To manufacture world class automobile engine, one needs world class testing facilities. HML-PCD is planning to develop state-of-art in-house testing facility to meet the requirements of tomorrow," says the CTO. "We are looking forward to have a technology forecasting and technology assessment cell in collaboration with IIT Kanpur, IIT Kharagpur and Indian Institute of Science (IISC) Bangalore," says the CEO.

4.7. SAP-LAP analysis

4.7.1. Context

Absence of volumes restricting growth of the firm.

4.7.2. Situational analysis

- HML-PCD started off as a car manufacturing plant but later on converted into an engine and transmission system assembly unit.

- Technical collaboration arrangement was one time transfer of designs and drawings of products, specifications of machine tools and plant layout.
- Gaps between the design and implementation of manufacturing systems were to be filled up by local technologists.
- Technology back up support provided was only on select problems.
- HML-PCD was operating in a guarded market (government sector) so could see a very little scope of innovations.

4.7.3. Main actors

- The CEO of HML-PCD as the key decision maker.
- The top and middle management executives as the dedicated lot.
- Employees of HML-PCD as highly motivated work force.
- Competitors of HML as technology gatekeepers.
- Investors and shareholders as the affected parties.

4.7.4. Technology management process

- Technology absorption process got delayed at HML-PCD causing obsolescence of acquired technology.
- Lower volumes obviously caused difficulties in vendor development process.
- Assured sales to parent firm deprived HML-PCD an opportunity to compete in the open market.
- Innovation effort and cost have not been justified for low volumes.
- HML-PCD has done innovations in the product technology under the pressure of the market forces. It has good facility for parametric research in terms of resources. It clearly lags behind in terms of initiative and support from the top management.

4.7.5. Learning issues

HML-PCD belongs to a group which has contributed significantly in building core infra-structural industries of free India. In fact, it is one of the pioneering industrial houses of the country. Technology development and innovation are comparatively more frequent in automobile than that of infra-structural industries. The firm needed to adopt an altogether different technology management strategy when Indian economy opened up in 1985 and new firms were allowed to enter into the Indian market. HML-PCD is a part of that liberalization process only which began during the same time. Some interesting learning issues in the case of HML-PCD are presented in Table 9.

4.7.6. Suggested actions

- HML-PCD needs to gear itself up for manufacturing diesel engines and transmission systems of all capacities and for all manufacturers.
- Plan better capacity utilization of its existing manufacturing facility.
- Vendor development is to be strengthened by not only increasing volumes but also by working closely with them.
- Look for new market overseas which help increasing its volume. Isuzu collaborations in other developing countries can be approached.

Table 9
Learning issues in the case of HML-PCD

Volumes and innovativeness	Volumes do not come in the way of innovativeness. A firm needs to be more innovative in order to improve volumes.
Volumes and vendor development	Strong vendor development needs working closely with vendors and working out their technological and other manufacturing products.
Technology management and group philosophy	Rate of technological innovations vary from industry to industry. An industrial group cannot afford to adopt the same philosophy and technology strategy across the strategic business units belonging to different industries.
Technology transfer arrangement and technology absorption strategy	Firms with strong technology base, having absorbed acquired technologies frequently only can acquire and absorb technology on one time basis. Technologically not so developed firms need to try out other arrangements of technology transfer.
Innovation culture	Only technology training does not promote innovation culture. Acceptability, appreciation, and faith in the local technologists also play important roles in promoting innovation culture.

- HML-PCD can also think in terms of entering into after market of crucial engine and transmission systems spare parts as the number of Ambassador cars in use in India is very large and there still exists market in rural areas where road conditions are not as good as it is in Indian metropolitan cities.
- Automobile market in India is showing a consistent growth in last few years hence image building and focusing the promotion activities at the right target audience may prove to be quite fruitful.

4.7.7. Expected performance

- HML-PCD exploring market of developing countries
- Adapting the product to the conditions of different foreign market on its own.
- Acquiring and absorbing state-of-art technology wherever required.
- Innovation cost and efforts are to be accounted for a longer period of time.
- Taking technology management as a crucial function and considering it at par with marketing, finance, manufacturing and personnel.

5. Eicher motors limited

Eicher Motors Limited (Eicher), began in 1984 in collaboration with Mitsuols Hi Motors Corporation, a subsidiary of Mitsubishi Motors of Japan (Mitsubishi) as a green field project in Pithampur, Madhya Pradesh, and manufactures LCVs. It is an Eicher Group company, Mitsubishi has 15% of equity, and rest shared by Madhya Pradesh Industrial Development Corporation, employees and public. The technology transfer arrangement provided for technology acquisition from AVL and Enpl both of Austria for LCV engines and trailers. The initial investment made was roughly Rs. 200 million.

5.1. Technology transfer: a happy story

Before entering into a collaboration with Mitsubishi, Eicher surveyed the LCV technologies of various manufacturers all over the world. The firms with which technology acquisition was explored include Reno, Leyland, Toyota, Mazda, Nissan and Mercedes Benz. Eventually, it worked out with Mitsubishi, because of the better technology, scale of investment and a variety of other reasons.

It was a technology transfer arrangement in which Mitsubishi was to provide the product and process technology by giving drawings and designs initially, which was to be subsequently supported by technology, installation, manufacturing and maintenance training. After having worked out the details of technology transfer and investment agreement, Mitsubishi undertook a survey of local conditions. It was the first Indian company to sign a letter of intent for technology acquisition and the last one to come out with an LCV which is named as 'Canter'. "A detailed study of available LCV technology was undertaken to ensure that we get the latest vehicle," says the CTO. "It was not a question of coming out first or coming out last, the question was what you are coming out with," justifies the CPO.

Its not that Eicher wanted to enter the market late by design. After the technology transfer arrangement was finalized, Mitsubishi redesigned one of its 6 ton vehicles to suit to Indian conditions. Suspension, braking and transmission systems underwent drastic changes. These design changes were later on incorporated in Mitsubishi's 7 ton vehicles in Japan and subsequently in rest of the Mitsubishi's global operations. "These design changes were worked on jointly by Eicher and Mitsubishi people," says the CTO. In a way, 6 ton vehicle designed for Indian road, load, environmental and driving conditions, became a 7 ton vehicle for Japan and many other countries, with very little increase in the engine power.

The CTO gives full credit to Mitsubishi for successful transfer of technology because its people took interest to see that not only technology by way of hardware gets transferred, but also the software part by way of work and quality procedures, training and change in the mind set of the Eicher employees. Eicher technologists always enjoyed good rapport with their counterparts in Mitsubishi.

"When technology transfer arrangement got over, Eicher had definitely not developed enough capabilities to design an LCV on its own, but it had certainly acquired the know-how and developed know-why to innovate on its existing products," the CTO opines.

The technological collaboration was for 6 ton GBW (local brand name being used in Japan) vehicle for 7 years duration and envisaged payment of royalty. In 1991, both Eicher and Mitsubishi decided that there is nothing to learn more in this product and hence collaboration came to a happy end, however, Mitsubishi's equity holding remains intact. Since then, the Eicher is working on its own as far as technology is concerned. Eicher has an installed capacity of 12,000 LCVs per annum, while presently 6000-7000 vehicles are being manufactured annually. Now, when Indian automobile market is passing through a boom period, Eicher is preparing to sell 11,000-12,000 vehicles every year for the next 3 years starting from 1996. It started off on the pattern of a typical Japanese firm with very low degree of vertical integration, and keeping its primary focus on assembly.

5.2. Technology strategy: lower degree of vertical integration

Now, only very recently the degree of vertical integration has been increased to a level of nearly 15%, and critical engine components are being manufactured in-house. It operates on the philosophy of need-based vertical integration. A high percentage of vehicles are still imported because the technology is not there, or the quality of local products is not up to the mark. Before it started manufacturing the crucial engine components, Eicher was importing the same from Japan and various other countries. The learning of Eicher has made it decide to manufacture such components in-house to improve its competitiveness in Indian market, which is highly price conscious and technologically crucial.

"Eicher plans to indigenize the vehicle to 100% level by the end of 1996 to survive in Indian market," says the CTO. According to him the Indian LCV market has not caught up yet, and it is nowhere near comparable to European, American or Japanese market as far the technology is concerned. LCV manufacturers in India are still selling fairly old technology to their customer, and that is where, the price advantage comes in. An equivalent truck with the latest technology will cost them double the price. Unless the market catches up with the international level technology on emission control norms, on safety and homology, driving comfort, etc.; it is unlikely that commercial vehicle segment of Indian automobile industry will make a major headway in technology.

Since 1994-1995, Eicher has allocated 1% of its total revenues for capital investment in manufacturing technology. Table 10 presents the financial ratios for the three fiscal years of Eicher. It was a loss making firm in the 1993-1994 and had poor financial results. Debt service capacity ratio touching to rock bottom and ROREQU dipping to -24.84. Eicher showed better financial results with ROREQU reaching to 16.33 and debt-to-asset ratio as 0.46 but debt equity ratio climbed up from 0.72 to 0.75 because of large long term borrowing for financing capacity expansionproject. Eicherwas merged with Eicher Tractors and Enfield India to become Eicher Limited in the fiscal year 1995-1996 and hence the financial results of the group improved considerably.

Table 10
Financial ratios for Eicher

Financial ratio	Fiscal year			Industry average
	1995-1996	1994-1995	1993-1994	1993-1994
RORTA(%)	11.83	9.97	-3.48	5.6
RORCE (%)	20.44	15.95	-12.95	5.04
ROREQU (%)	19.50	16.33	-24.84	12.60
Debt to asset	0.39	0.46	0.52	0.3
Debt service coverage	4.65	3.00	0.11	1.96
Debt to equity	0.65	0.75	0.72	2.164
Current	1.75	1.63	1.64	1.208
Acid test	0.27	1.45	1.48	0.43
Total asset turnover	2.17	1.59	1.45	1.066
Fixed capital turnover	3.14	3.04	4.42	2.512
Current asset turnover	3.75	3.29	5.39	2.087
Working capital turnover	2.56	2.16	5.54	3.48
Inventory turnover	9.76	7.50	7.66	4.049

5.3. Competitiveness

Eicher's products were not competitive initially for two main reasons. Firstly, the ratio of Rupee-to-Yen was upsetting the price calculation for Indian market. Secondly, not being able to indigenize because of technological and quality reasons. Eicher decided not to down grade the vehicle than what it originally was and hence got beaten up on competitiveness count. "Cost savings have been targeted everywhere and achieved substantially to remain competitive," says the CTO. And it is only Eicher's commitment to better technology which has helped the firm to establish itself in an extremely competitive market.

Eicher has reduced the cost of the vehicle over time maintaining the same standards of quality and technology. However, it has not made significant ingress into LCV technology. Because the criterion of reducing the cost does not allow taking up technology improvement projects. That being the current scenario in the truck market. However, it is changing with firms like Ashok Ley land coming out with 'Cargo', a current generation vehicle equivalent to Mitsubishi vehicle and has been entered into collaboration with Iveco, Telco joining with Cummins, and much because of commercial motor vehicle (CMV) regulations coming in force from 1998 onwards which is making the manufacturers rethink on technology part. When you think of better product technology, you need equally better process (manufacturing) technology, because both go hand in hand.

Eicher wants to maintain its competitiveness on account of technology it is offering the customers in a price conscious market. It has never compromised on quality and has under priced it vehicle. That is the reason why Eicher's product acceptability has picked up slowly but consistently. People take time to appreciate the product technology in heavy and LCVs. Its cost effectiveness in the long run decides its survival in the market. Unlike car and two wheeler markets, the size is small and cosmetic changes do not catch attention of the customers. A real change which can bring in significant improvement in the engine and vehicle performance takes quite some time to show results in terms of market share.

Since the same technology has been supplied to a Korean firm and similar technology has been provided to other countries such as Taiwan, Indonesia and Malaysia by Mitsubishi, Eicher has not been very successful in the international market. Only very recently, Eicher has started working on left hand driven (LHD) vehicles, and eyeing a suitable market for its modified product. Competition in the domestic as well as global market has increased tremendously in last couple of years. Who all are going to survive and who will emerge as market leader will be determined by the technology and quality of individual firms products. Technology push and market pull will have to be balanced by the firms operating in this segment of automobiles. Eicher certainly has an advantage of lower investment, now when the industry is passing through a phase of rapid advances in LCV technologies, it has a chance to improve its competitiveness by making timely and appropriate investments in technology and related areas.

5.4. Vendor development for low volumes

What really surprises the outsiders and even auto manufacturers is that Eicher operates at such low volumes and still makes profits. It breaks even at 45,000 vehicles. It is working on the Japanese principle of lean organization. Its investments in technology is also not

very substantial. It is a small organization and the scale of operation is also small. Eicher has current market share of 19% and if its plans materialize then it likely to rise to 24%. It has an expansion plan to manufacture 15,000 vehicles every year starting from 1998. To achieve the targeted market share, a firm needs to have a much wider range of models and good number of variants in each of them. Eicher has three models with three variants in each. To achieve its target of selling more number of vehicles. Eicher is entering passenger bus market. It is a small niche, and Eicher's management thinks that they can cater to this. Eicher is looking for a collaborator for its bus manufacturing project. It also plans to enter the HCV market by the turn of century.

One of the important aspects of Eicher's technology management is its vendor development activities. Eicher is a vendor intensive organization. It has developed tremedously high capability to work with vendors jointly. Help is being extended to vendors on technical, financial and marketing fronts. It is a story of working together, vendors and dealers are treated like Eicher's family members. The advantage, which Eicher has taken from lower degree of vertical integration, is low investments in technology compared to total assets. This has helped them in bringing their BEP down by reducing the fixed cost. It has a flexibility to change its models and variants faster, which Eicher has not done so far in absence of market potential. "But now, when Eicher is planning to expand it scale of operations, it is finding it difficult to motivate vendors to expand their operations with equal degree. Vendors are hesitant to react to Eicher plans."

Eicher's speciality with respect to other Indian automobile manufacturing organizations is its cohesiveness (because of its small size) in terms of operations and ease of operatability. This organizational characteristic Eicher has inherited from Mitsubishi. which also operates as a cohesive group of small but closely knitted firms. It is really amazing that 600 LCVs per month are assembled in such a small plant. Its manufacturing overheads are only 2.1% of the total product cost, (which is second to MUL, which is 1.9% where the volumes are one of the highest in the Indian industry) whereas it is beyond 3-5% in case of other automobile manufacturers. "Eicher's real strength lies in its people," says the CTO.

"Outsourcing components is the Eicher's core competence," says the CTO. In view of the fact that low volumes and thin vertical integration makes things difficult for Eicher, sourcing components at reasonable price is really an art, which Eicher seems to have worked hard at. Since the volume was low, Eicher took it up as a challenge and now the strength has got built up. Acquisition of latest technology also helped in the way. Because the technology was new so it had reasonably long life and vendors were made to understand this fact in the process of innovative purchasing.

5.5. Innovation culture and top management support

Eicher has a Kaizen cell and roughly 1000 odd Kaizens are done every month. It is not a very formal process. Anything which occurs to anybody in the organization, after minimum of formalities, can be implemented provided it is worthwhile. Everyone, who presents a Kiazen gets a token of appreciation from management and recognition among the fellow workers. "For major Kaizens, which involves capital investment, product engineering group (PEG) provides the support and does the engineering analysis and then if found suitable they are implemented," says the CTO. Example of a large Kaizen is the assembly

shop conveyor, which has been redesigned by local engineers and a very large part of it has been manufactured by Eicher engineers and workmen in-house. The complete plant uses indigenous manufacturing technology. In engine assembly shop also, all machines are bought or made locally. Modifications in manufacturing technology are, therefore, a routine affair in Eicher. "Every workman is empowered to test his ideas in small test workshop before he can make a case of it to be presented to Kaizen cell," says the CPO. This process is going on since last 10 years which is a testimony that top management supports the idea of promoting the innovation culture in Eicher.

Very low investment in manufacturing technology also paves the way for innovations and innovativeness in the case of Eicher. Its investment in paint shop is unbelievably small. It has invested only Rs. 1.9 crore in paint shop while other are investing significantly higher amounts. And it is claimed to be one of the finest paint shops in the Indian automobile industry.

5.6. Effective management of technology: top management's serious agenda

Effective management of technology is a very serious agenda for Eicher's top management. It spends roughly 3% of revenues on R&D activities which does not include the salaries of the engineers and technologists working in the PEG, and any fixed or capital expenditure. "I would doubt your survival in the long run, if you spend less than 2% of revenues on R&D," says the CTO. Today when Eicher has no collaborator, technology has become a major thrust area. Eicher is planning to compete with big giants like Telco and Ashok Ley land on its own, in its base product market segment.

As regards the testing facilities, Eicher is in the process of building it. "I do not think, as the head of PEG, I will ever be happy with the in-house testing facilities, but we have very rapid growth rate. We do not go abroad for any kind of testing, it is either done in-house or done within the country," opines the CTO. "Eicher is planning to acquire all the testing facilities, which are of strategic importance. Having a full set of testing facilities may not be cost competitive."

Eicher has intensive interaction with academic and research institutions of the country. It has several projects going in premier research institutes like IIT Kharagpur, IIT Bombay and IIT Madras. It works quite closely with Automotive Research Association of India (ARAI). Eicher has sponsored a very ambitious project for developing engine software based on the concept of solid modeling for performance analysis of various components.

Commitment of Eicher's top management to technology management function is quite visible from the fact that the budget allocation is not the end of every thing. A new project or good idea does not die down because of unavailability of funds. Any new technology which Eicher needs, the first chance goes to its people for development. If it is not done in-house, then start looking for the best alternative, be it available in India or abroad. Resource availability on the other hand, does not affect the creativity of the Eicher people. Eicher's strategy is to acquire absolutely state-of-art technology. The example which the CTO gives to press his point is of the cabin of Canter. There was some difficulty in indigenizing the engine cooling system. Eicher tried its level best, but could not succeed, now it uses one of the best cooling systems available which it has borrowed from AVL, for its vehicle.

InEicher, training is also a majorthrust area. Everyone requires to go through 12-15 days of training every year, which includes both engineering and non-engineering. "Technology training component would be anything between 35^5%, we are further compiling the quantum of training needs, and it is likely to go as high as 50%," says the chief of human resource management department.

Table 4 shows that Eicher has done well on technology planning, and technology acquisition flexibility. The results show a higher degree of indigenization than the industry average and this does not include the components which it is sourcing from abroad. The firm is particularly not doing well on corporate growth, value of the firm (also evident from financial ratio analysis), and capability to exploit economies of scale and scope. The firm lacks on all other variables.

5.7. Eicher's technology vision

India has the competence to develop world class automobiles and auto components, but it may not be able to do the conceptual research. The conceptual research is too expensive and the need is not that high. "What our people can afford to concentrate on, is parametric research. That's what Japanese did," says the CTO. The patents, ideas, and concepts can be bought, and detailing can be done in context to application. Indians are particularly good when it comes to parametric research, and it can, therefore, be one of the strong areas in technology management. Eicher wishes to concentrate in future more on parametric research and aims at developing facilities to build conducive environment for the same.

5.8. SAL-LAP analysis

5.8.1. Context

Low degree of vertical integration and problem of exploiting the economies of scale.

5.8.2. Situational analysis

- Eicher is facing stiff competition from other players in the market.
- Technology collaboration with Mitsubishi has come to a happy end.
- Eicher is working on the Japanese principle of lean organization.
- Because of low volumes, Eicher is banking on foreign vendors for key components and local vendors could not be developed.
- Increasing value of Yen is upsetting the pricing structure of Eicher's products. Earlier the vehicle was selling being a high technology product, now many equivalent products are available and price is generally the deciding factor.

5.8.3. Main actors

- Corporate management of Eicher Limited as the savior.
- Top management executives of Eicher as the struggling lot.
- Employees of Eicher as the heart and soul of the firm.
- Customers as judges of Eicher's technology.

- Competitors as technology watchdogs.
- Shareholders as investors.

5.8.4. Technology management process

- PEG is a forward looking set up emphasizing heavily on parametric research.
- Low volumes have created vendor development problem, hence Eicher chose to indigenize a select set of components.
- Working very closely with local vendors and still enjoying good support from ex-collaborators.
- Still depending on heavy imports of components and spares.
- Started with a minimal degree of vertical integration, stuck to it for quite sometime, only now began to improve upon in-house manufacturing capabilities.
- Not having committed much of resources initially during collaboration period.
- Excellent innovations done in process technologies.

5.8.5. Learning issues

The firms under collaboration arrangement for a fixed period of time ought to absorb marketing, process and testing technologies and should reach to a stage of absorbing product technology. If the investment in technology is not substantial during the collaboration period then it would have come in immediately after the collaboration was over. Eicher has been a typical case of technological collaboration in which the technology providers have a stake which does not provide it controlling rights. The learning issues are presented in Table 11.

5.8.6. Suggested actions

- Eicher needs to work out effective indigenization program of imported components.
- The firm needs to go for aggressive marketing of its products. Product technology and features are to be appropriately highlighted.

Table 11
Learning issues in the case of Eicher

Technology transfer arrangement and indigenization	Indigenization should be achieved before technological collaboration gets over.
Vertical integration and technology leadership	Low degree of vertical integration makes the firm more flexible in responding to technology change but below desired level of indigenization increases dependence on local and foreign vendors.
Technology planning and implementation	The time gap between the technology planning and its implementation should be minimized to reap the benefit of being an early bird.
Chaos handling capability and adoption of new technologies	'Lean' organizations have tremendous adaptability to new technologies with minimum of chaos. But economies of scale and scope demand development of chaos handling and technology absorption capabilities even when the organization cannot afford to stay 'lean'.
State-of-art technology and cost effectiveness	State-of-art product technology should be supplemented by the cost effectiveness of a firm in absence of which a firm cannot strive for technological leadership.
Technology leadership and market leadership	Technology leadership has to be manifested in market leadership in the long run.

- Economies of scale have not been explored which has kept indigenization and vendor development of imported components on low key.
- Product (incremental) innovations should be a regular feature.
- Capabilities and creativity of the people should be explored in parametric research.
- Take up value engineering projects to slash the cost further down.

5.8.7. Expected performance

- Eicher brings down cost of its existing products to be able to compete both on technology and cost grounds with established competitors like Bajaj Tempo Limited, Telco and Ashok Ley land.
- Active on technology front. Emerge out and sustain technology leadership in not only Indian but in the entire developing world.
- Adapt the product to be able to sell in foreign market.

6. Discussion and synthesis of the three case studies

6.1. Technology strategy

In absence of a clear statement of strategy the firm keeps hitting in the dark. Short term success in the market does not guarantee the ruggedness of technology strategy. Rugged technology strategy ensures long term success in the market. The top management commitment to building strategic attitude is of utmost importance and needs to be visible in its decision making process in general and regarding technology in particular. Quick and effective adoption of the product technology to local conditions, developing capabilities to adopt manufacturing technology, promoting innovation culture, degree of vertical integration and formation of core technology group are few determinants of technology strategy. Technology strategy needs to be derived from the long term corporate goals and should take into account each and every component of technology management function in an organization. Short term strategy may emphasize on product and technologies absorption and making incremental innovations an continuos basis but long term strategy must clearly indicate the firm's intention of cultivating the core competencies. The firms, cases of which are presented in this article, had rightly identified the need of the hour as indigenization. Absence of competition deprived them the opportunity to develop innovation capabilities

6.2. Competitiveness

Vision to develop core competencies can only keep a firm front runner in the race of competitiveness, which can only be based on competitive advantage. A firm essentially relies on technological strength to achieve sustainable competitive advantage while it seldom depends on market forces, which are highly dynamic in nature, and beyond one's control. Telco, and HML could flourish under protected market. Telco could envisage the need for developing technology base as an effective way of sustaining competitiveness. HML got exposed with the entry of new passenger car manufacturers in Indian market. It is not that

every thing is lost for HML. They are still considered as rugged, sturdy and spacious car manufacturers of the country. They need to concentrate on their technology and do away with the fat of inefficiencies, which has been borne by Indian customers up till very recently. Eicher needs to be more competitive in terms of price and performance of its products. Except for Telco, competitiveness of these firms is not yet established.

6.3. Economies of scale and scope

Market leadership, cost effectiveness, and vendor development suffer if the economies of integration are not taken advantage of. Economies of scale and scope have long term repercussions on technology leadership ad may erode the technology base of a firm if not handled effectively. Along with technology, substantial marketing efforts go in reaching to a stage where economies of integration can be made best use of. This is an important interface where technology management function interacts actively with marketing function. Restricting entries of new competitors could also be considered as another advantage of being able to exploit economies of integration. Telco, to a great extent, has been able to exploit economies of scale and lately developed capabilities to explore economies of scope and hence thereby able to restrict the growth of competition under control. After collaboration of these firms got over, they got the cover of protected market. A large number of such firms that had acquired technologies under such arrangement did nor gear themselves up for exploiting the economies of integration. The government regulations were also not very conducive since there was a restriction on the number of vehicles to be manufactured. This also hampered the development of capabilities to produce more at lower cost. Eicher has been a case of low volumes and it is therefore, suffering on competitiveness count.

6.4. Technology leadership

Capability to develop technology on its own, being able to provide technologically superior products, being able to compete at the global level, to be able to afford state-of-art technology in the core and allied industries, competence to make breakthroughs and radical innovations, and ability to retain competitive advantage in terms of technology are the characteristics of technology leaders. Telco seems to be marching ahead on this aspect in entire Indian automobile industry. When the hand holding (collaboration) part was over, these firms were supposed to work out their future survival and growth plans. Concern for technology leadership and technological independence figured in the strategy of Telco only. Others also had a fair amount of chance since there was no impediment in developing their technological strengths. In comparison to active transfer of technology (Husain and Sushil, 1996) cases, long term collaborations stand better chances of developing themselves as technology leaders at least in the domestic market.

6.5. Vendor development

Effective vendor development brings down the total investment in the automobile manufacturing project and obviously reduces the risk. It also provides flexibility to introduce new models in minimum time. The foreign exchange rate fluctuation effects can also be

minimized to a great extent with local vendor development. Volume plays an important role in vendor development activity. Telco and HML started with high degree of vertical integration because that time there was no base of component manufacturers. Telco later on reduced the degree of vertical integration and created a vendor base after the collaboration was over which paved the way for the firm to increase the volume of manufacturing and enter the international market. HML also tried vendor development but its slow progress in international market and labor problem at home turned out to be major constraints. Eicher on the other hand started with extremely low degree of vertical integration but banked heavily on foreign vendors. Lately, Eicher started manufacturing crucial engine components in-house. Eicher's vendor development within the country suffered on account of low volumes.

6.6. Indigenization

Government regulations should not be the guiding force behind indigenization agenda of the firm. Indigenization process may be looked upon as a measure of technology absorption capability. Low volumes, poor capacity utilization and higher investment will always disapprove the economics of indigenization only initially, but efforts on the global marketing and quality fronts will restore the balance. In collaborations, the firms know that they need to be self sufficient or at least reduce the dependence on technology providers considerably after the arrangement is over. There is fair amount of clarity in indigenization schedule. The domestic firms can always expedite implementation of indigenization programs. The capability to indigenize is the important step in the process of realizing technological innovations and subsequent developments.

6.7. Effectiveness of technological collaboration

Success of collaborations lie in the faith which the partners have in technological capabilities of one another. Clarity of technology transfer and subsequent absorption also plays an important role in smooth functioning of local firm. Efforts should be directed towards reducing the dependence on technology providers. Generally, the problem arises when the firm grows strong in the local market and starts planning for market expansion. A healthy collaboration is one which develops its own strengths and exploits the opportunities it is exposed to. Management control by technology providers should be used to strengthen the firm technologically and financially.

7. **Conclusion**

Collaborations are very effective when the local firm has the competence to absorb the acquired technology within the period already decided by both the parties. JVs have the advantage of attracting the foreign investments and therefore have the commitment of the technology providers towards market success. In view of the fact that no technology provider transfers state-of-the art technology to a JV located in the same or different country, the technology acquired in JV is either in the late maturity stage of technology life cycle or an obsolete one. In JVs, the process of transfer of out of use technology continues and

JV becomes the dumping ground for old technologies. As long as the products succeed in the market, technology borrowers do not mind such an arrangement. The concept of leapfrogging (Sharif, 1989) cannot be applied in the case of JV if it affects the interests of technology providers.

In case of collaboration, the short term or one time arrangement succeed only when the firm has enough experience of technology acquisition and subsequent absorption. When the hand holding part is over, the firm is free to acquire-state-of-the art technology and stand in front of its earlier collaborators in the international market. The analogy of a young child comes across very well with respect to collaborations and JVs. In JVs, the child attains the physical age but remains mentally undeveloped because it depends on technology providers for future support. While in the case of long term (for about 10-15 years) active collaboration the child (the firm) develops both physically (commercially) and mentally (technologically). Active long term collaborations are essential for building technological strengths in the firms of developing countries.

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