Innovation Activity in the Indian Software Industry

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Abstract

The study primarily investigated whether there has been a tangible shift in the activities of the Indian software firms towards higher end of the value chain and factors that helped the firms to make transitions. The objectives were examined by broad examination of thirty nine software firms and deeper investigation based on case study of three firms derived from the above selected firms.

It was found that firms are active in different areas/subareas of software industry including the embedded software segment. The firms obtained various types of quality certifications but these certifications were mainly restricted to process standards. Acquisitions and joint ventures were exposing firms to new knowledge, new hardware and software platforms. It has also helped the firms to move into niche areas and enter new markets. Linkages between firms and with academia were also important factors in firm's enhancement. From the case study it was possible to discern how the firms are developing capabilities. The three firms show that they have evolved over a period of time, moving from simple to complex operations mainly through incremental innovations. The study shows that among the thirty nine firms, a few firms have significantly moved up the value chain. Nevertheless, it is important as it shows that a few of them have broken away from the mould and achieved success.

Keywords: Innovation activity, Indian software industry, linkage, Core competency, Case study

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Introduction

Impressive growth in the Indian economy in the last few years, experiencing an average growth rate of 8% has been primarily attributed to the strong growth in India's service sector. The service sector is now accounting for 61.8% of India's real GDP, 39% in overall exports and 81% of FDI share (Mani 2008). The software services in particular are acting as the main driver behind the service sector growth, which is experiencing a phenomenal compound annual growth rate (CAGR) of about 50% since 1991.The service driven software export has jumped from $1.76 billion in 1998 to $23.6 billion in 2006; in the total export basket software constituted only 1.9% in 1994-95 that shot up to 18% in 2002-03. This sector has also significantly contributed to employment generation at a comparatively lower capital investment with minimal government support and intervention.

The business model of majority of Indian software firms is mainly confined to the vertical integration "at lower end of the value chain" with major MNCs. Influential writings (see for example D Costa, 2003, Kattuman and Iyer, 2001) points to the low end manpower intensive services provided by majority of the firms. Arora (2001) observed that although the software sector is human capital intensive, the Indian software industry does not require exceptional skills beyond academic training at the first-degree level. Analysis of NASSCOM (1999-2000) points out that large numbers of firm are offering the same kind of services and competing with each other on the basis of cost-price advantage. The above observations support the internationalisation argument of Bhagwati (1984)

> trend in innovations in services can be described in terms of splintering of goods from services, and internationalisation of services. Progressive part of the old services would be incorporated in a material product, leaving behind a reduced and unprogressive service. The latter part is the one that bears high transaction cost and internationalised. Both innovations and internationalisation are the intended actions of the mainly top multinational of the world, developing countries are at the bottom of this process".

The above viewpoint of innovation in services is being increasingly challenged by the changing industry trends particularly in the high technology sectors. ICT sector is a typical case in point. The rapid paces of technological change, growing complexity, technological convergence are intrinsic factors motivating this change. This new trend is leading to 'globalization of innovation' (Krishna & Sujit, 2007). *Globalisation of innovation relates to various components of knowledge production and innovation chain which are not hierarchical but are horizontally connected networks and geographically dispersed across various actors, agencies and regulated by institutions at different levels and locations.* Innovation networks are increasingly being used in ICT for client tailored innovation services- to design custom chips and supply chain software algorithms. This brings in a new class of services 'product engineering services'. New technological developments such as ASIC chip[1] are facilitating this process. Thus in this new scenario, firms will not simply source low-cost talent but invention services (R&D services) in one country and transformation services (manufacturing services) in another country and build products for a global economy. Radjou (Forester Research, 2006) increasingly see the role of India and China in this type of configuration with US firms; India expected to do the invention service and China the transformation service. Chesbrough (2003) has termed this as 'open innovation' model, a new paradigm of innovation where firms will not carry the baton of innovation all by itself. As Ernest (2005:72) observes, even big firms like IBM are in no position to 'mobilise all the diverse resources, capabilities and bodies of knowledge internally'.

[1] ASIC chips (Application specific integrated circuits) can be programmed for a specific application (for example a device for a sound card/video card), without having the chip manufactured in large quantities.

Pradosh and Hazra (2002) have used the widely acknowledged software development process the Waterfall model proposed by Royce in 1972 to understand the software market. The Waterfall model proposes a strict order that is followed in software development: moving from concept, through design, implementation, testing, and installation, troubleshooting to the last phase of testing and maintenance. In this model, the complexity of the task, the innovation involved also follows this order, moving from highest to insignificant at the last stage. They posit that later stages which are non-creative routine segments are the visible part of the market. The other phases constitute the inaccessible high investment/high risk and high skill activities, are part of firm's growth strategy and are developed in house.

We argue that the new concepts 'open innovation', 'globalisation of innovation' that have emerged due to new competitive demands, radical technology shifts have forced firms to open out the creative routines involving even their competitive partners. *The outsourcing model is no longer restricted to non-creative routines*. These new developments auger well for country like India that can participate in at the creative level, part of horizontal linked network that will increasingly help it to move up the value chain in the process.

In the last few years there are indications of this type of shifts with some Indian software firms undertaking higher investment in R&D, and creating the other essential requirements that are pre-requisites of research based firms. The linkages with international firms have also expanded in breadth and scope and in some cases have translated into higher order vertical linkages. Leading firms such as Infosys, TCS, and WIPRO are involved in 'product engineering services', protocol standards, participating in international innovation chains. A good example where Indian firm is a crucial player in the globally dispersed networked innovation is Infosys participation in Automotive Open Systems Architecture – Autosar. It is network of major global automobile manufacturers involved in R&D and standardization of software for auto electronics innovation. Firms such as Toyota, Bosch, BMW, Volkswagen, Siemens, Ford, DaimlerChrysler and Continental Teves are partners in this global network (Krishna and Sujit, 2007). A handful of small companies such as Sasken, ittiam, i-flex and others are trying to break the mould of IT services and develop their own patents and license to others (The Economist, 2005).

Source of the changing perception are however still primarily observed from media reports, business magazines, and anecdotal accounts. Changing shift can be discerned under three broad domains namely (a) Indian firms undertaking complex tasks (Kash *et al.* 2004) (b) creating global footprints through opening up international subsidiaries, merger and acquisitions and in the process increasing its knowledge base and competency (c) foreign firms establishing research centers that are internationally independent laboratories involved in developing novel products/processes. This includes firms in the software segment.

Research Questions

Drawing lessons from the above literature review, a cross-section of Indian software firms were examined to see whether there has been a tangible shift towards higher end of the value chain, major factors that helped the firms in this context, whether research partnerships are being established, to what extent software firms are involved in research and innovation activities, are they participating in global innovation chains and the outcomes of these involvements.

Innovation is defined in broad sense borrowing from UK 'Community Innovation Survey'. Innovation is defined as occurring when a new or significantly improved manufactured product, or service product, is introduced to the market (product innovation), or when a new or significantly improved production, or delivery method, is used commercially (process innovation), and when changes in knowledge or skills, routines, competence, equipment, or engineering practices are required to develop or make the new product, or to introduce the new process. Thus, we also do not count as product innovation, changes which are purely aesthetic (such as changes in colour or decoration), or which simply involve product differentiation (that is minor design or presentation changes which differentiate the product while leaving it technically unchanged in construction or performance). The implementation of a quality standard is not innovation unless it is directly related to the introduction of technologically new, or significantly improved, products or processes.

Thus within the above context we tried to capture 'product innovation', 'process innovation', 'longer term innovation activities' (to develop or implement technological change not directly aimed at imminent new products or processes), and 'wider innovation' (Changes in advanced management techniques; changes in organisational structures; and changes in marketing strategies)

Methodology

To address the objective of this study, two approaches were undertaken. First, involved a broad analysis of a sample of software firms; case study of a few software firms was undertaken in the second part.

The population consisted of all public limited firms that had made investment in R&D at-least within the last three years. Public limited firms were chosen as the study depended to a large extent on capturing information from secondary sources. As per government regulations, public limited firms have to divulge detailed information of their financial expenditure including expenditure in R&D and are also obliged to spell out details of their activities. The listing details of these firms (red herring prospectus) also provide rich insights of their activities. We postulate that firms that do not make investment in R&D are not in a strict sense involved in research and innovation and this guided our consideration of choosing only firms that had invested in R&D.

The population consisted of 70 software firms that had undertaken R&D investment over a five year time period: from 2000 to 2005. There was lot of missing gaps in the latter years in terms of firms providing detailed financial data to the company affairs and thus it

was not possible to correctly estimate how many firms had undertaken R&D expenditure. Multiple approaches were undertaken to capture the data. Firms were asked to send two page fact sheets on their profile, main products, major activities, R&D expenditure, technology absorption/adoption, benefits acquired through R&D, products developed etc. Missing response and other details were supplemented through accessing company web-sites, database of newspaper clippings, annual reports, Red hearing prospectus (stock exchange listing), etc. Commercial databases such as Prowess (CMIE), Capitaline, IBID were extensively used. From the above population, detailed information could be collected for 39 firms. This was the sample used for this study. The sample included large firms as well as medium and small firms. This was a good representative of the population. Financial statistics was collected from 1990-91 to 2004-05. The research and innovation activities were uncovered to the latest as possible.

The second part of the research covered case study of three firms: Cranes Software, HCL Technologies, and Sasken Communication Technologies. The three firms were identified from sample study i.e. from the 39 firms examined. These firms had evolved over a period of time and have created niche capabilities by adopting various strategies; were now operating in the value added software segment. 'HCL technologies' is one of the representative firms of the industry and the other two were small companies. In depth examination of these firms helped in understanding how firms (large and small) develop competency and also allowed deeper introspection into the innovation process. The case study approach is ideal for detailed examination as it helps to understand a phenomenon when it is difficult to separate the phenomenon and the content (Yin, 1989). Case study allows collection of data from multiple sources and the interpretations of the findings are based on evolving linkages between observed data.

Findings

Broad characteristics of the sample

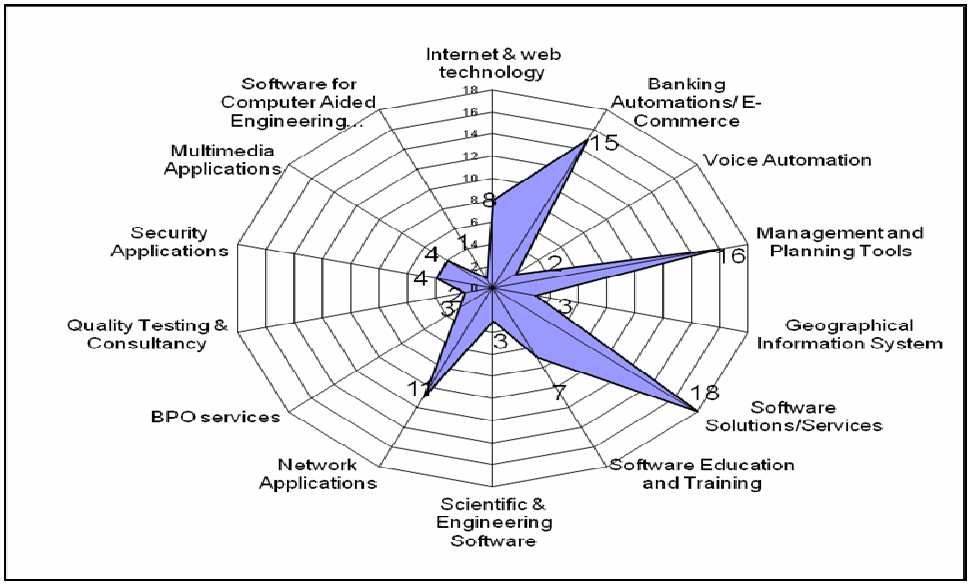
Table 1: Broad Statistics of the 39 Software Firms

Year	Sales	R&D	R&D as %age of Sales	Exports	Imports
1990-91—1994-95	2,640.02	17.75	0.67	698.02	570.08
1995-96—2000-01	14,329.25	816.19	5.69	6,245.64	3,321.67
2000-01—2004-05	55,309.19	542.38	0.98	45,183.28	20,377.81
1990-91—2004-05	**72,278.46**	**1,376.32**	**1.90**	**52,126.94**	**24,269.56**

All figures in Rs Crores

Significant increase in sales, exports, and imports can be observed in the later periods indicating growth in this sector. The sharp negative change in R&D intensity in comparison to 1995-2001 implies that firms R&D investment is not commensurate in the same proportion with the increase in sales.

Figure 1 highlights the main areas of operation of the selected 39 firms.



Firms exhibited diverse range of activities with many having positioned themselves in multiple application oriented areas. Many firms had shifted their focus onto software as its core area of operations in view of the changing scenario in the sector and decline in margins in the hardware segment. At the lower end of the value chain we find a number of firms involved in distribution activities. They are mainly having re-seller agreements to sell products of major software firms. Firms such as those providing network products require some level of expertise as they have to configure the network for the clients. Another firm NIIT has created a brand value through its education and training. Some firms have evolved from providing simple service oriented operations to developing their own in-house service products. A few firms were involved in more complex operations such as embedded software development, voice automation, etc.

Out of 39 firms, 19 firms had obtained quality certifications. These standards have been obtained from India and also from foreign countries. Majority of the standards obtained were ISO or ISO type standards (TickIT, BS799). ISO are set of quality management standards; all ISO standards are process standards (not product standards). Three firms, Satyam, Tata Elxi, and Zenser have obtained level 5 CMM (Capability Maturity Model). This is a highly regarded standard for software development process, level 5 being the highest level. Specific certifications have also been obtained. For example, Bathania has obtained 'National Software Testing Laboratory' certification for voice automation products, Flexotronics and Tata Elsxi obtained certification for 'information security management system' (ISMS certification). It is important to observe that firms when they are moving into specific domains are also trying to obtain quality standards of that domain. Infosys involved in developing applications in the aerospace sector had obtained AS 9000 which is 'Aerospace Basic Quality System Standard'. Similarly, a firm involved in health sector has obtained OHSAS 1800, standard for occupational

health and safety management system. The above statistics indicate that firms have paid attention to 'quality certifications'. These are more or less a pre-requisite for a firm to enter a regulated market or serve international clients. The majority of the firms are well equipped in this regard. It is however, difficult to judge whether this has contributed to the research and innovation activity.

Acquisitions and joint ventures have also helped firms to move into new areas. For example 'Goldstone technologies ltd.' alliance with Forte has helped it to foray into 'enterprise application'. Differentiated profile is observed within each application areas where a number of firms are visible. For example in e-commerce application firms focus on its different segments: procurement, customer relationship management (CRM), payment gateway services, etc. *A firm moving into a new area signals a transition is taking place*. It is an indication that firms are developing new competence and is willing to take the risk in operating in a new area (a major factor for innovation).

How Firms are developing domain knowledge and creating core competency

Firms in this study set have adopted various approaches to develop their competency.

Acquisitions, joint ventures and memorandum of understanding are exposing firms to new knowledge domains and state of art hardware and software platforms.

Investigation of the different M&A show that firms have used this as an instrument to externally acquire capabilities developed by their "partners". These acquisitions have contributed to the innovation activities of the firms. Some of the examples drawn from the sample are important in this context. Aftek Infosys Ltd has signed an agreement to acquire a significant stake in V-Soft Inc of the US. The company has also acquired Arexera, a telecom company in Germany. It has signed a memorandum of understanding (MoU) with 3G Tel of the UK to set up Aftek 3G Tel and will be involved in wireless and mobile and focus on 3G and other emerging technologies. Goldstone technologies ltd (GT) has acquired StayTop Systems Inc of the US (provider of Oracle consulting services), and Bancmate Banking Software from Natural Technologies. With this, GT holds the product rights and patents of the bilingual banking software. Goldstone alliance with Forte is helping it to develop niche capability in enterprise application integration.

Acquisitions also have a strong element of convergence. For example Bathina Medical Information Services Limited (BMISL) merged with BTIL (Bathina Technologies(India) Ltd (BTIL) BMISL has expertise and intellectual property in medical information-based information systems while BTIL is a leader in voice automation technology and product development. This new configuration would allow voice automation features to be incorporated in medical information.

Creating separate/specialized divisions

Some firms have tried to separate its R&D division from its other services. For example, Danlaw Technologies India Limited (DTIL) has two divisions, engineering & information technology. The engineering division is concentrating on development of software services and products for the automotive sector through embedded software development. The other division is involved in routine offshore software services.

Linkages

Linkages could be distinguished under service/distribution tie-ups and R&D collaboration. In some cases they are leading to creation of institutionalised entity through joint venture. Distribution tie-ups are evolving leading to firm getting sole distribution rights, re-seller rights for a number of countries. R&D linkages are important in the context of our examination. R&D linkages were visible not only among firms but also with academic institutions and research organization. Interpersonal linkages have evolved in some cases such as making him/her as board of director, consultant, etc. This type of configuration allows tacit knowledge to be exchanged. Linkages are evolving from loose coupling to more formal linkages i.e. knowledge links are getting further institutionalised. Some of the R&D linkages that led to tangible outcomes are illustrated below.

Creation of new entity

Joint ventures and other collaborative linkages were leading to the creation of new entities. The MEMS (Micro-Electro-Mechanical Systems) design and test laboratory was set up by Cranes software in association with the 'Centre for Sponsored Schemes and Projects' of Indian Institute of Science (IISc), Bangalore. It focuses research on nanotechnology and continuously evaluates the commercial potential of the research. 'NEC HCL System Technologies Ltd' was created through joint venture between HCL technologies ltd and NEC Corporation (Japan). This entity is undertaking R&D in network and security, embedded software, hardware design, high performance computing and mobile technology.

Arm's length linkages (transactions)

Cranes software has provided financial support to Indian Institute of Science (IISc)/ Industry collaboration, i.e. "ESOUBE Communication Solutions Pvt. Ltd." which is involved in designing and developing Proprietary IPRs and Products in the areas of Voice over IP (VoIP), Speech/Audio and Wireless Communication.

Learning

Firms show addition of new services, further enrichment in their existing services, developing service products, etc over a period of time. They are entering into new domains. It shows that the firms are 'learning-by-doing' and 'learning by using'. Learning's are facilitated by the interactions the firms have with other actors. Rosenberg and others have highlighted the importance of learning in the context of innovation undertaken by a firm. For example Danlaw Technologies by gaining experience in 'web based technology' has been able to move into animation and multimedia. The case study latter enumerates the learning experience of three firms.

Type of knowledge/innovation being created

Delivery capabilities: Service innovations have mainly concentrated on creating new delivery methods to serve their clients. This includes portals that allow easy access to a range of services.

Development of embedded software is a high investment, high risk and high skill venture. Embedded software is increasingly part of sophisticated machines; these machines become useless without the control provided by the software. From textile

machinery to consumer goods, automobiles, airplanes we find embedded software playing the key role. India's insignificant presence in embedded software segment has been a matter of intense discussion. Five firms in the study set were involved in embedded software domain. Firms have developed capabilities in embedded software in the area of network monitoring and access. One of the firms, HCL has made significant technology leap by co-developing a control chip for Boeing 787.

Firms are involved in developing customized software in different sectors. Banking and medical (mainly hospital) are sectors where a number of firms are involved. Some have developed products that specifically cater to this sector. Finnacle, the core banking software solution of Infosys is a good example. This is a proprietary product respected in the banking sector and used as automation solution in different countries.

Firms are developing reusable bits of software or processes that it can draw to serve its clients better. The intention is to build up IP library, to reuse components and frameworks across projects and thereby increase quality and productivity. This knowledge is being strategically used by the firms. However, only a few firms are involved in patenting. Plausibly their contractual obligations with clients are preventing them from taking proprietary protection. The innovations are created mainly to satisfy the needs of their clients i.e. more efficient services, new delivery methods etc.

Further Insights into the R&D and Innovation activity: Case Study

As the analysis of the sample set illustrates, a few firms had significant involvement in R&D and have capitalized on it. Among them is Infosys, a firm that has created a global delivery model – framework for globally dispersed project management and multi-location execution of R&D and services for innovation. It has rich clientele from different sectors such as aerospace, banking, telecommunications. It participates in global network, one of them involving different players in the automobile segment. Another firm in the study set was NIIT that has created global footprints through its education and training. On the other hand we also found a handful of small firms that are developing their business by investing in R&D. They have evolved from small entities to firms that have developed core capabilities. Three firms stand out in this sample. These firms are Cranes, Sasken, and HCL technologies. Closer examination was undertaken to gain insights of their evolution, and processes that helped them to develop capabilities.

Cranes Software International Limited

Cranes Software International Limited (formerly known as Eider Commercial Ltd), was co-founded by Mr. Asif Khader and Mr. Mukarram in 1991 in Bangalore. Cranes has created a unique business model driven by multi-industry applications of mathematics, statistics, data visualization and related analytical techniques. It has played a major role in the usage of software based scientific and engineering tools in India, creating a market for these types of products. The company has also developed capabilities in

microelectronics and computer-added-engineering. The evolution of the company from a software distribution[2] company to the present stages involved significant transitions.

Initially when it was a software distribution company it strengthened its position from a normal distributor to sole distributor of reputed software. Reseller arrangement[3] with Texas Instruments (TI) for Digital Signal Processing (DSP) tools was an important tie-up in these initial periods. As latter sections highlights, the M&A and linkages helped the firm to evolve as a specialised company addressing three differentiated technology categories: (i) Mathematical Modelling and Simulation tools; (ii) Embedded Software and Controls; and (iii) Business Modelling and Simulation solutions. According to revenues centric groups, Cranes's activities can be divided into two groups viz. engineering and analytic. In engineering, automotive is a major revenue generator, while lately it has forayed into aviations and aerospace. Some of the products developed for engineering sector are: suite of CAE design, embedded engineering, control system design and testing, and finite elements. For analytic, the focus of the company is on pharmaceutical, environment sciences, social sciences, telecom, and BFSI (Banking & Financial Service Institutions). To address the retail credit, it created a risk analysis product *Predica* in 2008. The two approaches (M&A and Linkages with academia) that helped the firm to evolve to the present status are enumerated below.

Merger and Acquisition

Merger and acquisitions were done with the intention to strengthen its existing product lines and enter new domains. It helped in the transition of the company from a mere distributor to one encompassing expertise and niche software based products/services in engineering and analytic domains. The firm made two significant acquisitions in 2000. It acquired U.S.-based AISN Software's range of visualization software products e.g. TableCurve 2D, Table Curve 3D, Autosignal and PeakFit. In the same year, Cranes Software acquired from SPSS their highly acclaimed statistical software SYSTAT, which brought with it a global base of over 64,000 licensed users. These acquisitions transformed Cranes from software distributer to a company having its own line of products. Moreover, it was the sole owner of the monopoly rights, intellectual property and the know-how of each of the products. Thus this proprietary domain knowledge provided the firm possibility of exploiting it further.

The firm has continually upgraded the SYSTAT software by bringing new rich features; upgraded its platform from FORTRAN to C and incorporated several new features such as Markov Chain Monte Carlo (MCMC) techniques and quality analysis. This helped the firm to target specific user groups. Additionally, it created Japanese and Korean language versions of this software (Annual Reports, 2003-04 and 2007-08).This gave the company a strong leverage to penetrate the user base in two lucrative markets of Japan and Korea.

[2] Early 1990s, Cranes started with distribution of MATLAB-technical computing software that has now base of 5 lakh technical users spread across 100 countries.

[3] This alliance has evolved into more creative engagement. Products such as MathWorks and Tektronics for the global wireless industry were developed thorough the collaborative work of these two firms (Annual Report, 2003-04).

The previous acquisitions was strengthened in 2004, when Cranes acquired the marketing, licensing and development rights for the Sigma product line from SPSS Inc., including the flagship SigmaPlot® offering, SigmaStat® statistical analysis package, and SigmaScan® image analysis software. These statistical packages were highly complementary to Cranes current portfolio in terms of cross-selling potential within existing users and addressable markets. The acquisition included 100,000 customers largely in the pharmaceutical and biotechnology marketplace, personnel, fixed assets and all related intellectual property. Users included Merck, Eli Lilly, Pfizer and NASA, each of which had over a thousand desktop installations. Acquiring the development rights and intellectual property helped in developing its domain knowledge. This also allowed it to further upgrade on this software product- helping it to address its clients better and create potential customers.

In 2005, Cranes made another significant transition by acquiring the Indian arm of Engineering Mechanics Research Corporation (EMRC). *This acquisition added a new domain new business line different from the statistical tool product namely* services *based on Computer Aided Engineering (CAE).* It positioned itself more firmly in 2008 in targeting its CAE capabilities in automotive sector. This was facilitated by acquiring 'Engineering Technology Associates Inc.' (US firm), and Tilak Auto Tech (Indian firm). The firm developed capabilities to design embedded control systems for the automotive sector particularly in the areas of auto safety, vibration, and noise testing products. Lately, the firm has also addressed the aerospace and industrial instrumentation using the same tools/knowledge it has acquired.

The company has also diversified into e-banking, mobile solutions by making a number of acquisitions of small foreign and Indian firms from 2007 onwards.

Linkages with academia

Cranes developed strong relationships with one of the premier universities in the country, the Indian Institute of Science (IISc) which has been instrumental in its entering the area of wireless and wireline networks, and 'micro-electro mechanical systems' (MEMS). In association with IISc, it created CranesSci MEMS[4] design and test laboratory in 2004. The Lab has started working on cutting edge research in MEMS and nanotechnology that has wide applications[5] in textile designing, farming technique, etc. IISc and Cranes will jointly own the intellectual property for technologies and products developed by the Lab.

The company has acquired microelectronics knowledge through this association. It has helped it to understand the embedded software and control systems and develop solutions for automotive sector (where acquisitions also played an important role), and industrial

[4] MEMS integrate mechanical components and their control electronic circuits on the same chip. These mechanical components have sizes ranging from one thousandth of a millimeter (micro-meter) to a millionth (nanometer). MEMS is expected to provide next technological leap as it provides the possibility of creating complete system on a chip (Annual Report, 2003-04).

[5] The firm is involved in designing textiles using nanostructuring that has hydrophobic qualities i.e. less absorber of detergent and water. It is doing research in developing nanotechnology based energy efficient sensors and actuators, with automatic monitors for computation that can help farmers to find the optimal requirement of moisture content at different sections of the land. (see for example Interview of Dr. Rudra Pratap Singh, Chairman Board of Directors, Cranes, March 2006 available on www.itmagz.com)

control and measurement systems applicable to various industries. Microelectronics knowledge also helped the firm to develop real time operating system on SIC33209 32-bit processor. This chip is low power processor and is thus useful for hand held devices such as mobile, palm tops etc. Designing a new operating system for this chip can improve the utility of this chip.

The firm strongly associates itself with IISc's industrial interaction initiative through its incubator programme termed as 'Society for Innovation & Development'. A spin-off firm 'ESOUBE Communication Solutions Pvt. Ltd' was created through this association. This firm is involved in designing and developing proprietary products in the areas of voice over IP (VoIP), speech/audio and wireless communication. ESQUBE has developed a proprietary voice dialler application, speech recognition algorithms and audio coder (TARANG), which is an alternative to MP3. The company is carrying out research to build WiMAX base station and the WiMAX customer premises equipment. *In 2008, Cranes acquired this spin-off entity.*

The company's association with TI and IBM led to the setting up Cranes Varsity in 1998 to provide post-professional technical training in niche domains such as DSP, Real Time Embedded Systems (RTES) and mathematical modeling for the academic and corporate sectors. The intention behind starting this entity i.e. Cranes Varsity was to create a usage and demand for scientific and engineering tools.

Interactions with academia also played a role in attracting eminent academicians Dr. Rudra Pratap (nanotechnology) and latter Dr. Manju Bansal (computational biologists) on Cranes's Board of Directors.

Overall position of the firm

Over the years Cranes has reduced dependency by increasing proprietary product portfolio. The company earned almost 82% revenues by selling proprietary product in 2007-08 FY (see Table 2).

Table2: Business wise revenues (Rs. millions)

Sector/activities	2005-06	2006-07	2007-8
Proprietary products	1661	2252	3247
Product alliances	390	491	607
Training and services	57	94	98
Total	2108	2837	3952

Source: Annual Report, 2007-08.

HCL Technologies Ltd

HCL Technologies (HCLT) is a part of the HCL enterprise, the country's oldest hardware firm. HCL enterprise was conceived in 1976 by the group of former employees of DCM Limited headed by its founder director Shiv Nadar. The company got opportunity when IBM walked out of India on the foreign equity issues. HCLT could target the emerging domestic market by lunching it first commercial PC in 1978. It was difficult for the group to tap international market through hardware operation. Diversification to software resulted in the creation of a separate entity in 1991, HCL technologies. The company

started its US business in 1994 and its Europe and Asia Pacific business in 1998. The software operation of HCL enterprises grew enormously in the late 1990s to dominate its overall business—the ratio of hardware to software has consistently declined from 83:17 in early 1990s to 38:62 in 1997–98 to further 23:77 in 2000–01. HCL Technologies has been instrumental in this change.

HCLT has pursued growth through organic as well as inorganic route; each complements the other. The firm operates in two segments: one is the traditional mode in which majority of the Indian software firms are present i.e. service operations (outsourcing type/BPO operations) and the other is its activities in the embedded software. In both the areas, it has extensively used M&A and joint venture as strategy for entering/consolidating in new areas and new markets; latter sections dwell on this issue.

Like other Indian software companies, it used the outsourcing route/BPO operations to start its activities. In its software service role, it continuously expanded its activities in terms of new clients and entering new sectors. M&A (or obtaining substantial stakes in companies), and Joint Venture helped the firm in fulfilling this objective. One can observe this process from 1996 with the target firms being Indian as well as foreign firms. Its strategy was to enter a new market or new area of activity through any of the above routes and then consolidate further following the same strategy. Two important instances can be observed that was very useful for the firm. The joint venture with Perot Systems Inc. (US) in 2003 led to the creation of the new entity 'HCL Perot System'; it helped the firm to become a leading outsourcing and systems integration company with major clients in the banking, energy, healthcare, insurance, and manufacturing and telecommunications industries. Acquisition of the UK-based Axon Group for £441 million ($658 million) in 2008 helped it to enter the SAP market (estimated to provide $26 billion market opportunity).

The important transition of the company was its efforts over the years starting from late 1990's to develop domain expertise in aerospace- safety and mission critical real time avionics systems involving both airborne avionics systems and ground-based systems. HCLT focused on developing embedded software in the above specific areas. HCLT enhanced its engineering knowledge by its association with NEC Corporation (Japan). In 2005, NEC and HCLT came together in a joint venture to set up a new facility, 'NEC HCL System Technologies Ltd' to provide high-end offshore-led software engineering solutions in network and security, embedded software, hardware design, research and development, high performance computing and mobile technology.

The domain knowledge expertise it developed in aerospace helped HCLT to forge partnership with Airbus for co-development of an embedded chip for communication with ground control. Successful development of this chip led to its implementation in the Airbus A380. The same chip will also be used in Boeings 787 Dreamliner (formerly known as the 7E7). The company earns 6% revenues from this segment and it is likely to jump to 20-22% in future. Currently HCLT counts several global leaders[6] in aerospace

[6] HCLT is associated with 35 aerospace companies. For example HCLT has developed AIRBUS A340 flight warning system for AIRBUS France and for flight management system for Smith Aerospace, and Aerospace Systems and Equipment Company. (www.hcltech.com)

amongst its key customers, to whom it provides services in hardware, embedded software, CAD/CAE and application development.

HCLT is also applying its embedded system capability that it has developed in diverse areas other then its core focus on aerospace sector. The company has filed a patent application in the Indian Patent Office on a GPS based navigational tool for finding potential fishing zone. It has created a chip that measures how much insulin is needed to be injected in a patient who requires external insulin intake. This chip can mitigate the difficulty in giving proper dosage, particularly for those patients who require injection of insulin through nervous system.

The firm was able to enter the area of software based applications in 'mathematical modeling and statistical applications' by collaborating with Saila Systems Inc. (Japan). The partnership resulted in the development of a statistical analysis tool (Panax Finder), useful for the pharmaceutical companies in the drug discovery process. It is a user friendly tool, more efficient and cost saving in terms of manpower involvement and in finding the desired candidate molecules. The software utilises 3D quantitative structure activity relationship (QSAR) to guide the chemical synthesis.

Sasken Communication Technologies Ltd.

Sasken was conceived by Mr Rajiv Mody, who went to US for a job and returned to India in 1991 (subsequently Sasken shifted to Bangalore) after establishing this firm in a garage in Fremont, California in 1989. The company has evolved over the years to become a leading provider of telecommunications software services and solutions to network equipment manufacturers, mobile terminal vendors and semiconductor companies around the world. It delivers end-to-end solutions that enable richer content delivery on next generation networks by building on its accumulated technical expertise in wireless and broadband technologies, signal processing and IC design. The company's 'mobile software group' has successfully launched several data protocol stack products like GPRS (General Packet Radio Service), 3G.

The company, unlike majority of the companies in India, has built its business by investing in R&D. It spends more than 10% of its sales in R&D. It has a highly qualified manpower[7]. The company has reputed academicians[8] on the list of Directors. It has established over the years, R&D centers in different parts of the world: Bangalore, Pune, and Chennai (India); Kaustinen, Tampere, Oulu and Turku (Finland), and Monterrey (Mexico). Of the 3800 employees, 300 are deployed full time in R&D. The R&D centers are involved in joint research activities as well as work in specific niche areas.

[7] Of the 3611 Sasken employees in FY 07, 67% were graduate engineers, 22% were master of engineering, and 1% had doctorate degrees (Annual Report, 2006-07).

[8] Dr. Jhunjhunwala, a Professor at Dept. of Electrical Engineering at IIT, Chennai, and Prof. J. Ramachandrans, Professor of Business Policy at IIM, Bangalore are currently on the list of Directors of the company

The company has developed Symbian-a wireless handset operating system that is a leading operating system at present and is certified by Texas Instruments as an independent OMAP (Open Multimedia Application Platform) technology centre. OMAP family of semiconductor has been specifically designed for use in 3G wireless communication and application processing. The announcement of 3G policy by Government of India in August 2008 and subsequently launching the same in 2009 has brought new opportunities for a company like Sasken as there would be increasing demand of mobile value added services (VAS). India has one of the largest mobile phone populations with around 350 million phones in the country, out of which 5 million subscribers use 3G enabled phones. It has also developed High Speed Packet Access (HPSA), a collection of mobile telephone protocol, which will augment 3G technologies to a high bandwidth path straightaway. Camera enabled phones, polyphone ring tones, and multimedia services will further add up as value additions in the 3G technologies. In order to cut the packaging and silicon cost, Sasken developed single mixed signal chip that can replace multiple chip handling baseband, RF, memory, PLL etc.

Like the other two firms in the case study, M&A and linkages played a key role in the firm's evolution as a value added IT software firm. The section below highlights how these two approaches played a major role.

Mergers and Acquisitions

Sasken's business comes from wireless software products and services that includes software for mobile phones, and has clients such as Nokia, Motorola, Philips, Samsung and Vodafone among many others. The company was listed in 2005. In the same year it launched its wholly owned subsidiary, Sasken Network Engineering Ltd (SNEL). This subsidiary provides network planning, deployment, commissioning integration and network operations support to network equipment vendors and operators. SNEL was formed following Sasken's acquisition of Blue Broadband Technologies business in 2004. Sasken became software development partner for Philips Nexperia home and mobile products. It has joined the S60 product creation community for the Symbian smartphone operating system, which would enable it to add value to the S60 ecosystem.

Sasken enhanced its capabilities in wireless communications by adopting knowledge gained from further acquisitions. In 2006, Sasken acquired Botnia Hightech, Finland-based wireless research and development and testing services provider. Subsequently in 2007 it acquired Integrated Soft Tech Solutions Pvt. Ltd. (iSoft Tech), and Botania Hightech, Oy Finland. This was instrumental for the firm in establishing itself more firmly in the area of data network wireless LAN, hardware & mechanical design, RF design, and testing. *Deficiency of connectivity in software was solved by acquiring another foreign firm-Nokia'a Adaptation Software R&D, Germany in 2008.* Sasken's strategic entry in to the Western Countries, especially Nordic country like Finland proved fruitful, because Europe is the world's largest wireless communication market. Being the birth place of GSM[9], a 2G technology and presence of world's leading wireless vendors including Nokia, Ericsson, Alcatel, and Siemens in the region, Europe till date remains

[9] Before the development and subsequent launch of 3G technology, GSM was the most preferred digital air interface standard (Lal & Rai, 2004).

the single place, where single technology/protocol[10] existed. As a result of its foray into the Europe, Sasken was able to fit its own IP in over 4% of the phones shipped in 2005, and over 7% of phone shipped in 2006 across the world (Annual Report 2006-07).

The company shifted focus from software products for telecom to a product-and-service strategy by establishing an international development and support centre in Mexico. The centre will focus on embedded system software development. It has joined ARMs proved Design Centre Programme and will build solutions around the ARM processor using the technologies that it will gain access to through the programme.

Linkages

Sasken entered a new sector- the automotive sector in 2008 primarily through its association with TACO (A Japanese firm). A joint venture was formed, leading to the creation of a new entity 'TACO Sasken Automobile Electronic Pvt. Ltd.'; to create software solutions for automotive sector. It has created another joint venture with 'Connect M Technologies solution Pvt. Ltd.' in the area of network engineering services

Sasken has proprietary technologies in telecommunications and is aggressive in protecting it through patents, unlike other Indian firms. These intangibles are strength of this company. It has been granted 16 patents in the US, and has filed 13 and 18 patent applications respectively in the US and the Indian Patent Office. It has also filed patents in Europe and Japan. The firm has built up its patent portfolio from 2001 onwards. In patent terminology, the firm has thicket of patents in mainly two key ICT domains: power reduction, and network management. These patents address power efficiency reduction in micro-processors and mobile 3G system, congestion reduction in networks, and multimedia applications (picture retrieval, efficient transmission of multimedia content). Among the patent technology is the Optimized Multimedia Subsystem. It is considered to be best in its class globally, as evidenced by its deployment in commercially released mobile handsets by many tier-1 vendors. This product is in more than 50 models and over 50 million phones across networks in Australia, China, Europe, Hong Kong, Japan and Taiwan earning development and maintenance license fees as well royalties for company. The learning and challenges in developing the multimedia subsystem in mobile phones has effectively been used in development of the company's other products. The team is already engaged in enhancing the system to include new features such as mobile TV using DVB-H and Video over IP.

Discussion

The study tried to uncover whether there has been a tangible shift towards higher end of the value chain. The other prime objective was to investigate the factors that were instrumental for the firms in moving up the value chain. This also provided some insights into the process of innovation. However, we do not divorce our self from the fact that capturing the innovation process requires a deeper investigation and engagement (Pavit, 2003). The first objective was mainly addressed through the broad examination of 39

[10] Developing countries like India is just an opposite case having adopted multiple technologies/protocols e.g. in addition to GSM, it has CDMA, WLL, and DECT technologies in the operation.

firms. Further, insights were obtained through the case study. The second objective was mainly revealed through the case studies.

The broad examination showed that firms were active in different segments of the software industry. The firms were also moving to address different sectors. Firms had also paid due attention to 'quality certifications'. These certifications were pre-requisite for firms to enter regulated markets or attract clients. By examining two aspects (a) how firms are developing domain knowledge and creating core competency, and (b) type of knowledge/innovation being created; it was possible to uncover factors that helped the firm to move up the value chain and reveal tangible outcomes. Through the case study, a more informed picture could be discerned.

Acquisitions and linkages were found to be the main contributing factors for firms to enter new areas, new markets increase their domain knowledge, gain knowledge in a new field, create novel products, etc. Strict differentiation in the extent of value addition was not possible. For example, among the eleven firms that are in network applications, there were some involved in the routine service oriented part whereas a few of them were creating applications that enhance the efficiency or deliver novel products based on network applications. To a large extent the value addition is more in the second case. Thus, we distinguished instances that showed a certain activity can be attributed to higher value added segment or were novel initiatives.

The case study provides some insights of how firms move up the value chain over a period of time. For the three firms investigated: HCL technologies, Sasken and Cranes; the role of acquisition, joint ventures, and linkages were again visible as the main drivers that helped them to move up the value chain say build up their domain knowledge and foray into new application areas. Each of the three firms had niche areas of operation; Sasken in telecommunications, HCL technologies in engineering solutions and Cranes in software based scientific and engineering tools. Each of these firms had integrated and built upon their acquired knowledge to deliver highly competitive products. For example, Sasken had designed embedded multimedia chip for mobile handsets. Cranes enhanced the functionality of its acquired statistical software SPSS, and created Japanese and Korean language version of this package. This incremental innovation helped the firm to penetrate the user base in Japan and Korea. HCL technologies learnt about engineering solutions through its joint venture with NEC. It partnered with Airbus for designing an embedded chip for communication with ground control.

Conclusion

In the Indian software industry which is mainly service driven, inventiveness is monetized in work done for clients, not as an income source in its own right. Thus it is difficult to assess the innovativeness that is taking place. In other words, innovations are mainly in processes rather than in products. Keeping this problem in consideration, innovation was defined in a broader context so that it would be possible to capture innovation in its various facets: process innovations, incremental innovations, non-technological innovations which are generally neglected but play an equally important role as product innovation or radical innovations

The investigations show that some firms exhibited significant movement from simple to complex services, and created novel service processes/products. Firms had taken different paths to develop their expertise. The M&A and strategic technology alliances have mainly been used by the firms to absorb new technologies from their partners or to jointly develop new innovative capabilities. The findings are in conformity with (Kogut (1991), Auster (1992) findings that learning through alliances complements endogenous learning to create new competencies. Case study provide more details of how these strategies are useful but it is also true what (Hagedoorn and Schakenradd, 1994) says ' the extent to which such strategies are successful is not always clear'.

Linkages were varied and ranged from strong horizontal/ vertical linkages to loose couplings. Tangible outcomes through linkages could be discerned. There are also many causes of concerns. R&D investments were sporadic. Niche operations, services or products were few. Only a few firms have proprietary products. Every firm had shown commitment towards gaining international quality certification. They do realize that it would not be possible to attract high value clientele without attaining certifications. As we had clarified earlier, the implementation of quality standard is not innovation unless it has direct bearing on the products or processes. It was not possible to uncover this relationship.

The case study show how learning and incremental innovations have helped firms transition to complex technologies. All the three firms examined show that they have been receptive to new opportunities; taken actions to take advantage of new opportunities. Their interactions with foreign firms have evolved from low end vertical linkages towards horizontal linkages.

The study shows that a few firms have been able to address higher value in the software development process. They have used a different business model for growth, the mainstay of which is developing innovative capability. It would however, be premature to generalize this to the overall view of Indian software industry. Among the 700 to 800 public limited software firms, only a handful (approx 10%) have undertaken investment in R&D. The sample of 39 firms was selected from this population. The study is thus the reflection of a limited sample from the constrained population. The true population would constitute along with public limited firms, private firms that have undertaken R&D investment[11]. We have no proper estimate of private firms involved in R&D. But, on the hindsight it is possible to postulate that this number would not be very high to change significantly the observations and conclusions of this study.

Recent study estimates 277[12] foreign firms in ICT sector involved in R&D activity in India. It calls for a separate study to uncover nature of knowledge creation in these entities and how knowledge spillover is taking place. The central question in the context of the present study would be whether they have forged linkages with Indian firms and

[11] It is safe to assume that firms that have not undertaken R&D investment are not involved in the innovation activity.
[12] Centre for Studies in Science Policy (CSSP database)

whether that has contributed to enhancing their research and innovation capabilities. We have been able to get some insights of interactions with foreign firms while investigating the linkages of the firms in this study.

The present study is limited and further detailed investigations are required to capture innovation in the Indian software industry and come to the conclusion of what extent innovation has taken place. Nevertheless, from this study, it is refreshing to observe some firms have tried to break away from the mould and achieve success.

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