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Editorial

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Strategic Flexibility for Competitiveness

We are in exciting times

New millennium has opened up new opportunities and challenges for firms and industries across continents. The bonanza of business generated for Indian software services firms due to Y2K and Euro conversion is just one example. Full implementation of WTO promises to open up new opportunities for industries such as textiles and pharma. The terrorist attacks at World Trade Centre and subsequent events brought paradigm shift having repercussions for many industries.

Indian firms are lagging behind in leveraging flexibility for enhancing competitiveness

Competitiveness in such challenging times will demand among other things flexibility, especially on strategic dimensions. For instance, decade long liberalization has brought unparallel survival challenges to many industries in India due to increased intensity of competition. Research indicates that public enterprizes, small and medium enterprizes and Indian firms have been lagging far behind their MNC counterparts in leveraging new environment to enhance their competitiveness. MNC firms might have been more successful at leveraging flexibility by acting strategically on the options created by the liberalization.

Strategic flexibility can be a key enabler of competitiveness

Growth will demand flexibility to play in multiple geographies

Growth and sustainance can be considered as an important continuum of strategic flexibility. Strategic flexibility can be visualized on many parameters. Growth based on sustainable core competence can create opportunities for enhancing quality of life for masses. Among many options for growth, geographical, product/service and value chain extension are three basic alternatives. Many firms in India grew rapidly by venturing into unrelated industries as industries were opened up in early 1990s. Not having or unable to rapidly develop core competence, they could not sustain such growth and many had to retreat as real global competition emerged in late 1990s. Similarly excessive focus on the US and neglect of trade with large economies such as Japan and China has resulted into sustainance problems for many industries in India; slowdown in software is just one recent example.

Strategic management of technology can create sustainable competitive advantage

Success in new era will demand pragmatic excercise of strategic options by firms. For instance, IT industry in India is at the cross-road post burst of US tech bubble. The industry was excessively dependent on US technology and has not managed technology that well strategically to create competitive advantage. The sustainability of services based on US technologies to win emerging large oriental market or create sophisticated domestic market is questionable. Compare that with IT and mobile revolution China is able to bring, due to indigenous capability building, and one may learn many lessons on economic progress.

K. Momaya
Deputy Editor

Framework & Approach

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Organizational Integration in Supply Chains: A Contingency Approach

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Abstract

Logistics has been defined as the integration of somewhat disparate activities of transportation, procurement, inventory control, distribution management, and customer service and has received a major thrust in many firms in recent years. Realizing the synergies that exist in these functions, many companies have extended the concept further upstream and downstream outside the company to include vendors and their vendors and customers and their customers. Supply chain management, as the concept is now called, consists of the entire set of processes, procedure, the supporting institutions, and business practices that link buyers and sellers in a marketplace for effectively managing the flow of materials from suppliers to final customers. Many experts have proposed large scale adoption of supply chain concepts and integration among supply chain members. While some companies have initiated supply chain integration with a lot of fanfare, others have questioned the rationale for sharing confidential and often proprietary data with supply chain partners. What were the challenges that the firms faced for integrating their supply chain networks? Which firms are willing to integrate and under what conditions? Which ones do not find the proposition appealing and why? In this paper, we examine these issues and challenges faced by companies in integrating their supply chain networks and present a contingency theory to explain the nature and extent of supply chain integration in various firms under various circumstances.

Keywords : competitiveness, integration, logistics, supply chain management

Introduction

The world economy is in the midst of a profound transformation, spurred by globalization and enabled by the rapid development and adoption of information and communications technology. In today's competitive marketplace, as companies strive to create better value for their customers, they realize the important role supply chain management plays for better management of commercial transactions and transaction-generated information. Realizing the synergies that exist in such disparate functions as procurement, production, transportation, inventory control, distribution and customer service, many companies have done away with their old organizational structures. Fragmented activities slotted into multiple functions are yielding place to integrated logistics function. Many companies, forced by the market forces of globalization and enhanced competition, have decided to look beyond the fire walls of their organizations and include suppliers and customers for further operational synergy and called it supply chain management. Supply chain management links a firm with its customers, suppliers and other members of the chain including transportation and warehousing companies.

A supply chain consists of three major components: (1) activities, (2) organizations, and (3) processes and operations. Together they become a long chain of activities and decisions. They are embedded within a supply chain management environment that guides and seeks to buffer the process from outside disturbance. The chain is further linked to a corporate environment that influences the strategic objectives for the supply chain. An external environment of industry, technology, local and global political issues further modify the impact of these issues. These are shown in Figure 1.

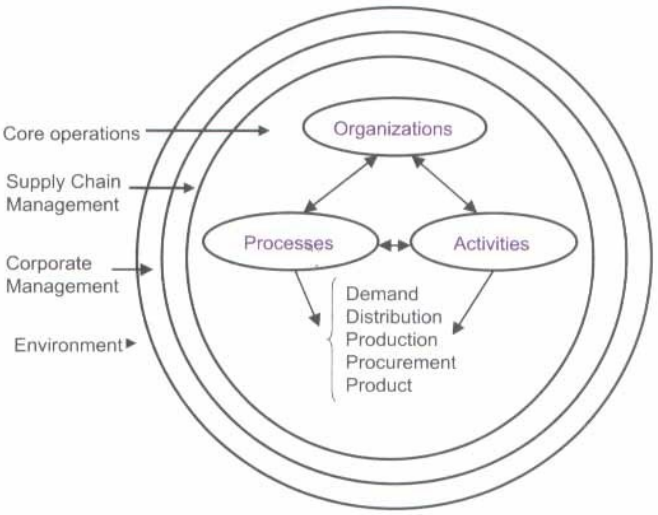

Figure 1 : The Framework of the Supply Chain
Source : Schary and Skjoett-Larsen (2001)

The supply chain, at its core, functions as a network of facilities and actors that procures raw materials and component parts, transforms these into intermediate goods and sub-assemblies, and then builds the final products, and makes it available to the global marketplace for consumption

by the final customer. The emphasis on both physical supply (inbound material flow) and physical distribution (outbound material flow) is not merely on the immediate suppliers and customers, but often on supplier's suppliers and customers' customers. The links are often several echelons deep on both procurement and distribution sides as would be evident from Figure 2. These links are nowadays enabled by inter-organizational process integration involving close coordination among partners providing access to each other's business and manufacturing plans. As a result of such integration, suppliers may gain access to manufacturers' production plans and can reduce their reliance on uncertain forecasts. Likewise, manufacturers may obtain early warning about possible disruptions of parts supply due to unforeseen events faced by the suppliers and can reschedule their plans and avoid costly disruptions. For instance, the recent recession in the high-tech industry in the United States has caused a large increase in the inventory of electronic components among Electronics Manufacturing Services (EMS) suppliers in Asia. The objective, with better supply chain integration, would be to reduce the severity in crises of this nature. Additionally, inter-organizational integration can ensure smooth flow of information pertaining to order, product design and development, production scheduling, delivery, payments etc. for managing coordination among the various partners in the supply chain.

Many companies, forced by the market forces of globalization and enhanced competition, have decided to look beyond the fire walls of their organizations and include suppliers and customers for further operational synergy and called it supply chain management.

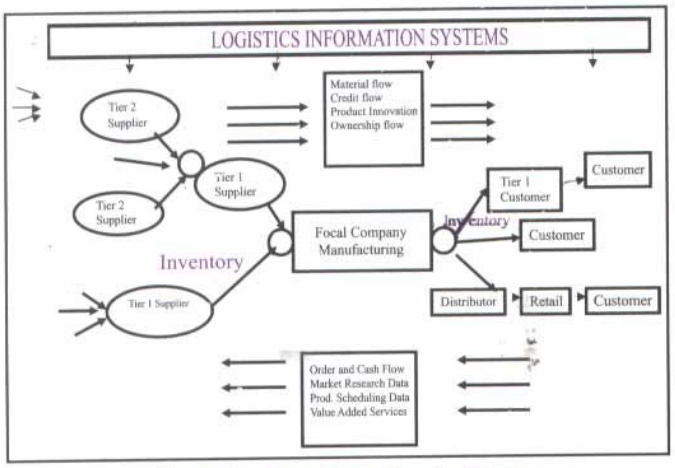

Figure 2 : Flows in a Supply Chain
Adapted from : Bagchi (2001)

In this research, we consider the challenges faced by companies desiring to achieve integration with internal and external partners in the supply chain and review the dilemmas and issues faced by them. Specifically, we examine the conditions under which firms desire supply chain integration. First, we describe inter-organizational integration and define the stages of integration in a supply chain based on a discussion of several working examples. Second, we explain the various factors that influence the nature and extent of supply chain integration using several industry examples and provide explanations for the nature and extent of integration. Next, we offer a contingency approach describing the nature and extent of supply chain integration based on the cases studied. Finally, we offer our concluding remarks and propose avenues for further research.

Inter-Organizational Integration and the Supply Chain

Integration has been defined by some researchers as the quality of the state of collaboration among departments to achieve unity of effort demanded by the environment (Lawrence and Lorsch 1967, Galbraith 1994). While this definition refers to integration internal to a firm or organization, our emphasis here goes beyond the firm and encompasses external entities that are players in a supply chain. Extending this definition, we believe supply chain integration involves rallying the key members of a supply chain network including external entities towards a common goal. The success may depend largely on the openness and extent of sharing of the fruits of the new relationship. An integrated supply chain should not only reduce cost; it must also create value for its customers, shareholders and all supply chain members (Lambert et. al. 1997). Used judiciously, it should ensure long-term business success providing a forum for benchmarking and acquiring core competencies through association and idea sharing with like-minded organizations. To be effective, organizational integration must encourage partners to become more entrenched members of the network and instill a sense of belonging to the supply chain. It should become easier to generate trust among partners in an integrated supply chain. Trust should promote collaboration and decision realignment, reduce irrational behavior and "second guessing" among supply chain members thereby reducing the need for safety stocks. A well-knit integrated supply chain can also act to consolidate business standings of network partners by providing a barrier to entry. The objective of organizational integration is not merely to resolve conflicts should they arise, but rather to recognize and avoid potential conflicts and/or divergence of interest in advance and devise a governance structure to forestall or avoid it. True organizational integration thus should pave the way for individual members of the chain to behave more like a unified entity sharing ideas, skills and culture alike.

What is an Integrated Supply Chain?

In our study we have defined two stages of supply chain integration. Table 1 shows some important differences between a more integrated and a less integrated supply chain. Communications systems are often inadequately connected and the information flows often follow formal command paths

with few direct contact points in a supply chain with low integration. With high integration, there will often be many direct connections between people at various decision levels across the inter-linked firms in the supply chain. Technicians from the buyer will communicate directly with technicians of the supplier. Production planners at the supplier will be in close contact with purchasing personnel at the buying company. Supply chains with low integration will often have incompatible legacy systems, while well-integrated supply chains may have implemented ERP systems such as SAP, Oracle, Baan or PeopleSoft. Another important difference is the focus on risk, cost and gain sharing. In an integrated supply chain, the participants are expected to share the gains proportionately to the risks and costs that are imposed in the collaboration. If there is no balancing of gains and risks the collaboration will terminate sooner or later. Especially, in the grocery industry the large retail chains have been reluctant to share gains with the suppliers. As a result the efficient consumer response initiative has had limited success with notable exceptions, such as Wal-Mart and K-mart.

Inter-organizational integration can ensure smooth flow of information pertaining to order, product design and development, production scheduling, delivery, payments etc. for managing coordination among the various partners in the supply chain.

Table 1: Characteristics of Low and High Integration in Supply Chains

Inter-organizational Integration in Supply Chain	Low Integration	High Integration
Communication across the supply chain	• Few contact points between companies in the supply chain • Incompatible information systems—often using legacy systems • Lack of agreed upon procedure	• Multiple contact points at all management levels • Regular contact at top/senior levels • Standardized operating procedure shared across the supply chain • Compatible information systems
Shared decision-making	• Internal orientation	• Inter-organizational orientation • Common database
Risk, cost, and gain sharing	• Internal company focus	• Supply chain focus
Sharing ideas and institutional culture	• Inward looking	• Open exchange
Skills sharing	• Few chosen areas	• Frequent technology forums • Group design teams • Sharing across the supply chain
Investments	• Company-specific	• Co-specialized investments (Joint investment in specific technology)
Formal lateral organizations	• No teams across the supply chain	• Teams across the supply chain • Primary allegiance to the team

A highly integrated supply chain is also often characterized by joint investments in specific capabilities or technology, e.g. development of common training programs, specific production equipment or implementation of software packages. These investments are often of limited value in alternative uses. Within the Japanese automotive industry investments in relation-specific or co-specialized assets are often embedded in the supplier-automaker relationships. A high degree of trust, information sharing and credible long-term commitments to suppliers increases the willingness of both parties to make relation-specific investments. Similar trends can be noticed in the U.S. and European automobile industry where car manufacturers and their suppliers are becoming more willing to invest in relation-specific assets. For example, in Smart Ville, seven first-tier suppliers have co-invested in a supplier park adjacent to the assembly lines of DaimlerChrysler's production of the Smart Car in Hambach, France. Other car manufacturers have adopted a similar concept. Thus, General Motors has built a plant in Brazil incorporating the ideas of heavy contribution of supplier capital. Volvo Cars in Sweden, has established a supplier park at the premises of a former shipyard in the Gothenburg Harbor.

Why haven't these ideas been embraced by all? During our research and consulting on supply chain management issues in various industries, we have not found many companies willing to bet their future on such close integration with supply chain partners. While managers are often willing to share some information within the supply chain to ensure smooth flow of materials, they would view integration beyond with a relatively high degree of suspicion. We have been able to devise a framework for explaining the behavior. The root cause for the lack of trust plaguing many supply chains, as we see it, is the fear of loss of such elements of core competence as proprietary technology, business plans and competitive strategy.

Analysis of Factors and Discussion

Core Competence

Firms succeed offering superior products and services that result from superior technology and management. Not all businesses however, need to have superior skills in the identical aspects of technology and management. Depending on the nature of the products, markets and level of competition, firms may choose a specific set of skills in which to develop extraordinary capabilities to compete better. These skill-sets residing within various functions in the organization or collective wisdom that enable a firm to excel, differentiate its position in the marketplace and define its special standing

in the eyes of the customers are often referred to as core competence. The ability of Honda Motor Corporation to manufacture small efficient engines or Wal-Mart's expertise in logistics to ensure efficient flow of materials are often cited as these firms' core competence. What differentiates competitors in the marketplace may be product quality, purchase price, function, or provision of time and place utility. To succeed, each competitor must offer unique advantages to its customers and the skill-set that enables it to do so is its core competence.

Building core competence is thus the most important function of management strategy and it is a long-term arduous process involving costly acquisition and nurturing of technology, personnel and experimentation. While it does not clearly show up in the books of accounts, it certainly manifests itself in the company's products, services, organization, culture and market reputation. Naturally, firms must also feel obligated to guard core competence with utmost care to avoid losing their distinctiveness and cherished position in the marketplace. When a few senior logistics managers deserted Wal-Mart and took management positions with Amazon.com, Wal-Mart went to court to curtail loss of logistics and supply chain management wisdom, its core competence. Similarly, faced with a severe loss of logistics and supply management knowledge to its competitor when a senior executive defected to Volkswagen, General Motors Corporation went to court to restrain the executive from sharing company secrets. Collaboration in core areas with external entities, therefore, must pass through a very rigid and detailed examination as to the need for and the sanctity of the relationship. Firms must carefully consider the chances of potential loss of proprietary information against any possible gains. Inter-organization relationship in these firms must pass through a careful scrutiny in order to safeguard core competence. What then are the conditions when firms should elevate supply chain partnership to become inter-organizational integration?

To be effective, organizational integration must encourage partners to become more entrenched members of the network and instill a sense of belonging to the supply chain.

Market Evolution

Firms that do not rely too much on own proprietary technology may be more willing to engage in inter-organizational integration with supply chain partners. The changes that one can observe in the computer industry present an example worth studying. In the 1970's and prior to that, computer industry relied mostly on mainframe computers. Companies such as IBM, competed on new innovations in large mainframe computers. Customers usually waited sometime—from a few weeks to several months–for their chosen models during which time companies could organize production and supplies. With the advent of personal computers the rules of the marketplace drastically changed. With much more fragmented customer base and a radically different type of customer, the competitive equation changed significantly. Personal computers became more like commodity products—most used the same technology and had similar capabilities. It became increasingly difficult to distinguish them in the marketplace. Firms in personal computer business began competing more on price and ease of doing business. Brand loyalty gradually gave way to store loyalty, easy availability, ease of doing business, and price. Firms reconfigured their competitive strategy to reflect the marketplace changes. Product and technology innovation yielded place to speed of technology adaptation, customer service and time-to-market as the chosen strategy. Companies like Dell take pride on the speed with which they acquire new technology from other innovators such as Intel and others to configure new products. These companies, who compete on price, speed and customer service, are always looking for ways to minimize cost. To them supply chain management offers a 'gold mine' of opportunity for cost reduction and becomes the competitive strategy of choice. These companies do not hesitate to form close inter-organizational integration with supply chain partners and are willing to share much more business information with them as they do not have as much secrets to lose. Moreover, breakneck speed of product introduction often ensures that before sensitive information gets out in the open, the companies move on to the next generation of products. Imitating the market leader or a "me too" strategy would not be a good recipe for success in such fast moving markets. Before the imitator catches up, the leader has gone on to newer designs and technology often resulting in significant price discounting for older designs. These imitator firms lose out on both ends of a product life cycle, the first time due to late product introduction and again due to massive discounting at the end of the life cycle. There is nothing like sustained competitiveness in this market and quite often there is too much upheaval. In such markets, companies often go out of business or get acquired by others giving it an ever-changing landscape. Speed of technology adaptation is the forte for success in these markets. Tapping into supply chain partners' skills forming inter-organizational integration happens to be a proven strategy to beat the odds. Such market dynamics also reduces the likelihood of opportunistic behavior among supply chain partners and stable partnership in the form of supply chain integration results.

Innovative or Functional Products?

Fisher (1997) found that if one classifies products on the basis of their demand patterns, they fall into one of two categories: primarily innovative or primarily functional. Each

category requires a distinctly different kind of supply chain integration. This is illustrated in Figure 3.

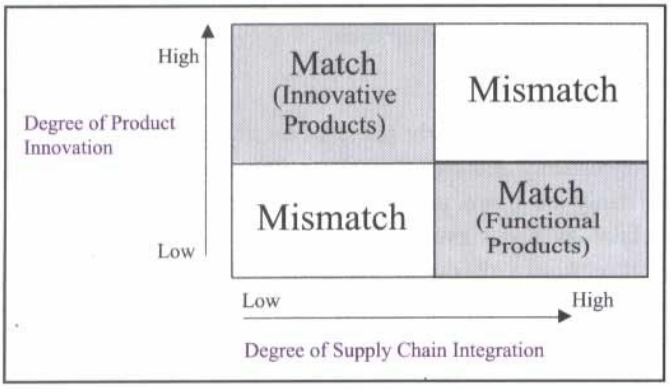

Figure 3 : Matching Supply Chain Integration with Product Innovation

Firms that compete with innovative products and technology would have less incentive to share sensitive product and/or business information with supply chain partners. Therefore, we will expect a relatively low integration with their supply chain partners (top left quadrant in Figure 3). That is not to say that these firms do not engage in partnership in supply chains. They often restrict supply chain partnerships to sharing of information for smooth flow of materials. When it comes to core competence areas, they would not be as much interested to share information with supply chain members. In these firms, while there may be very close partnership culminating in sharing planning and logistics data, partners are not likely to participate in design and development of core items. A firm like Volvo works in close partnership with 15 key suppliers located in a supplier park close to Volvo's assembly plant sharing procurement and delivery data on a real time basis. These key suppliers are assisted in many ways to ensure the high quality and timeliness of its supplies. Often they are invited in technology and management forums organized by Volvo and future production plans are shared with key suppliers upto a year in advance to offer them adequate lead-time to organize production changes. However, when it comes to core items such as engines or body platforms, the suppliers are joint ventures or subsidiaries of Volvo. Few, if any, suppliers are invited to participate in core design teams nor does the company trust external entities to supply technology or systems in core areas such as engine, transmission or safety engineering, elements that give Volvo distinctive competence in the marketplace.

These imitator firms lose out on both ends of a product life cycle, the first time due to late product introduction and again due to massive discounting at the end of the life cycle. There is nothing like sustained competitiveness in this market and quite often there is too much upheaval.

For companies offering primarily functional products, products with a fairly stable and predictable demand and long life cycles, the incentives to integrate with their supply chain partners are much higher as these products naturally attract more competition thereby enhancing the need for cost efficiency. Here, we will expect extensive use of collaborative planning and design, vendor managed inventory (VMI), continuous replenishment programs (CRP), dedicated account teams and frequent exchange of personnel. An example is Wal-Mart's collaboration with Pfizer on the forecasting and replenishment of over-the-counter pharmaceuticals and healthcare products. Wal-Mart has better knowledge of the customers' preferences. Pfizer knows about the drugs they produce and is better equipped to make use of external data, such as weather forecasts and pollen figures, to estimate demand patterns. The matching integration is found in bottom right quadrant in Figure 3. The other two quadrants in Figure 3 are irrelevant combinations and rarely do successful companies position themselves in these cells. A manufacturer of innovative products would not like to risk losing valuable proprietary information through supply chain integration. On the contrary, in a competitive marketplace for a functional product, the firms naturally seek high integration of the supply chain for efficient operation in procurement, production and distribution.

Similar scenario emerges from an examination of Bang & Olufsen Company (B&O). B&O is a high-end manufacturer of audio and video consumer electronic equipment based in Denmark with a loyal customer base. The company launched a supply chain excellence program several years ago the cornerstone of which was the establishment of close partnerships with key suppliers and customers. B&O works closely with suppliers in many areas—design and manufacture of plastics parts, ornamental parts, and a few other supplies—shares production plan information with suppliers and other logistics partners but not in industrial design known to create its distinctive appeal to customers—its core competence.

When it comes to more functional products manufacturers often invite key suppliers to participate in the design process in order to accelerate time to market. An example is Dell Computers that works closely with its key suppliers when it comes to designing common platforms across several products and using common components. Dell's competitive strategy is the capability of designing products that are easy to customize. By sharing design databases and methodologies with key suppliers, Dell Computers is able to speed time to market—often dramatically.

Governance Structure

Using similar reasoning, it is easy to see why a firm marketing a new product in the early phase of its life cycle

would not be keen to engage in a close inter-organizational relationship with its supply chain partners. This view also receives support from the transaction cost theory (Williamson, 1985). The basic premise of transaction cost theory is that governance is the mechanism through which a firm manages an economic exchange. For standard off-the-shelf type of items or functional products, firms rely on market governance when they interact with other firms. For innovative products and during the early stages of product life cycle, firms usually rely more on product-specific assets—specialized knowledge, process skills or technology—owned by them. That is, at the early stages of a product's life cycle, firms use hierarchical governance when the required assets are available within the firm's boundary. At mature stage of a product's life cycle when more competitors come to the market and competition intensifies, firms may try to leverage supply chain partners' rare skills in addition to their own in order to achieve higher cost efficiency to stay competitive. This push to become more competitive, leads to what is called *intermediate governance* in transaction cost theory when alliances with supply chain partners are resorted to and inter-organizational integration results.

Firms that compete with innovative products and technology would have less incentive to share sensitive product and/or business information with supply chain partners.

An interesting example can be found in the Italian clothing company Benetton, which for many years was the archetype of the network organization—that is an organization based on outsourcing, subcontracting and developing relationships in a tiered structure of supplier networks. Benetton used to outsource the labor-intensive phases of production, such as tailoring, finishing and ironing, to small and medium sized companies. However, the relatively more innovative operations, such as design, quality control and dyeing, or operations that required heavy investment (weaving, cutting, pick-pack and storage) have always been performed in-house. Benetton has recently moved to more upscale clothing and transformed its global network (Camuffo et. al. 2001). Upstream, they have gradually increased vertical integration of textile and thread suppliers to ensure direct control over the supply of materials and exercise quality control sooner. Now, Benetton can send the materials directly to the production facilities without further controls and thereby reduce both transport costs and production lead times. Downstream, they have set up a number of megastores throughout the world owned and managed by Benetton itself. This allows Benetton to get closer to final customers and collect data on their last-minute needs, expectations and buying habits. At the same time, Benetton has reduced the basic product assortment and increased the number of seasonal collections to respond faster to changes in market trends. That is, as Benetton transforms its product line from a relatively more functional products to a relatively more fashion clothing, it has restructured its organization from an intermediate governance structure consisting of supply chain integration to a more hierarchical governance mechanism resorting to vertical integration.

Industry Maturity

An industry in the early phase of its life cycle exhibits a lot of uncertainty and changing technology. While products may certainly be more innovative in nature, their design and technology keeps evolving. The industry is often in a state of flux. Above all, during this phase, firms and organizations also tend to safeguard their selfish interests of acquiring as much market share as possible. Companies in such situations tend to discourage too close partnerships with external entities and are generally averse to sharing too much sensitive information for very obvious reasons. At the early phases of a product's life cycle, companies are busy trying to cash in their proprietary technology to ensure secure competitive position in the market. Accordingly, firms try to organize all activities such as manufacturing, sales and marketing, logistics, distribution and service support within the firm boundaries. As customers, dealers and other service providers become more knowledgeable of the technology and as reliability of the products improves (so that service requirements decrease), the manufacturers do not feel the same compulsion to keep a total control of all activities. The success of IBM in relation to Sperry-Rand is often traced to the intensive service support that IBM provided for its then relatively unfamiliar but complex product in the 1950s. Today, external vendors contracted by the manufacturers often provide after-sales service support in the same industry.

Also, as industries mature and firms dig in and consolidate market share, scale of production increases, uncertainty reduces and products and processes undergo standardization. In a less uncertain environment, companies realize less need for vertical integration. Additionally, as the scale of production increases, asset specificity increases as general-purpose flexible machinery makes room for automated and dedicated capital equipment for achieving higher operational efficiency. The scale of investment required proportionately rises putting it beyond the reach of most firms creating a natural barrier to entry. Thus, in a mature industry, while there is more intense competition, frequently there is no company that produces everything. Instead, companies become more open to close inter-organizational relationship with capable external entities for the provision of products and services more efficiently. It is easy to argue that as firms find investment needs beyond their reach, they adopt more pragmatic strategies and look for supply chain partners who

can complement their capabilities and resources. So, as products and processes mature and undergo standardization, companies can place greater reliance on the market for recurrent acquisition of parts and components leading to greater supply chain integration.

The emerging contract manufacturing industry further illustrates this trend. Contract firms have built up competencies within a well-defined part of the total production process. By offering production capabilities to global OEM-companies they can obtain highly efficient and fast operations and economies of scale. Contract production is growing within fashion goods, electronics, chemical and pharmaceutical processes. For example, companies like Flextronics has taken over the assembly of mobile phones for Ericsson and Siemens who retain the R&D, industrial design and marketing. Figure 4 shows the relationship

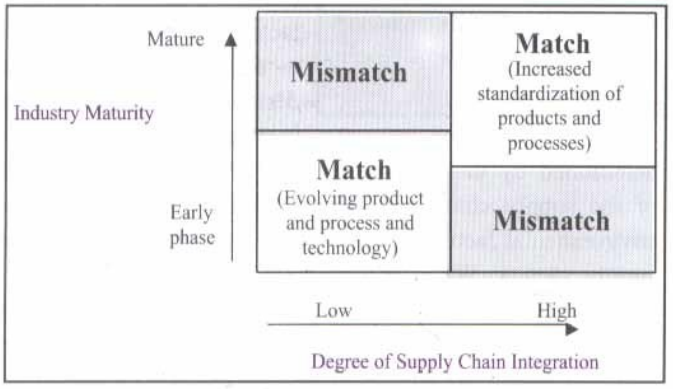

Figure 4 : Matching Supply Chain Integration with Industry Maturity

between the degree of supply chain integration and industry maturity. As would be evident from Figure 4, at the early phase of product life cycle low supply chain integration appears to be the norm, while in a mature industry it is easy to find firms adopting a high supply chain integration strategy.

As Benetton transforms its product line from a relatively more functional products to a relatively more fashion clothing, it has restructured its organization from an intermediate governance structure consisting of supply chain integration to a more hierarchical governance mechanism resorting to vertical integration.

Dominance and Supply Chain Integration

Seldom, is power equally distributed among the participants in the supply chain. A firm's power in a supply chain is its potential for influence on other participants' attitudes and behavior. Often, one participant has a dominant position, either because of purchasing power, market share, or access to proprietary technology and knowledge. In the automotive industry the car manufacturers are often in a dominant position relative to the suppliers and can influence the upstream supply chain. In the grocery industry, the large retailers are the dominant players and can dictate the conditions for collaboration even with the major brand manufacturers such as P&G and Nestle. LEGO Company, the Danish manufacturer of construction toys, sells 80% of its total sales through five retail chains in the US. LEGO Company is interested in developing strong relationships with their key customers. However, large customers such as Toys-"R"-Us, Wal-mart and K-mart wield the real power to initiate collaboration in the supply chain. LEGO Company is receiving point-of-sale data from their large customers and is also participating in automatic replenishment programs. However, LEGO Company is decoupled from the direct access to the end customers and their expectations and preferences. Power or dominance is therefore an important factor in determining to what extent a supply chain is suitable for integration and the level of supply chain integration. In supply chains where one firm is highly dependent on the other participants but not vice versa, the less-dependent firm will have a power advantage and can force strong and effective relationships in the supply chain. In situations with low dependence between the dominant firm and the other firms in the supply chain, we will expect to find low integration. Supply chain integration blossoms when the self-seeking dominant partner is convinced of the need for integration and takes initiative to mobilize all partners.

If we have a supply chain with high dominance in a market with low competition, we will expect a low integration. Carlsberg Brewery, which has a market share of about 85% in the Danish market, presents an interesting example. By virtue of its dominant position in the Danish market, Carlsberg decides the level and extent of supply chain integration it desires. With little or no competition around, the company is happy to hang on to its market share without any significant pressure to improve. The opposite is true in the UK market, where there is a heavy competition between the different market players and where access to the consumers is vital for survival. Here, vertical integration, joint ventures or strategic alliances are common in order to get access to or control over the distribution channels including the pubs.

Whereas, if the dominant player is working in a competitive environment, we expect the company to be more proactive and aim for high integration with their supply chain partners. Examples can be found in the automotive industry and the fashion industry.

However, if none of the partners in a supply chain has a dominant position and the market competition is relatively low, we will expect a stable situation with a low degree of integration. The building construction industry presents a good example. In highly competitive market situations and balanced power relationships among the participants in the

supply chain, the degree of integration depends very much on the industry culture and traditions. In some industries, we will expect limited integration and a reactive adoption of new technology. In other industries, there might be a tradition for collaboration and specialization. For instance, in industrial districts in Northern Italy small firms are collaborating very closely in networks and with highly sophisticated technology. Examples are found within fashion clothes, ceramic tiles, and leather and shoe industries.

Contingency Approach

Supply chain integration is not a question of "high integration fits all". The degree of integration depends on a number of situational factors. In our study we have identified the following:

- Core competence
- Market dynamics
- Type of products (functional or innovative)
- Industry maturity
- Power-dependence relationships

As products and processes mature and undergo standardization, companies can place greater reliance on the market for recurrent acquisition of parts and components leading to greater supply chain integration.

The situational factors are illustrated in Table 2, where we have shown the most important combinations.

Table 2 : A Contingency Approach to Supply Chain Integration

Situational factors		Stage of supply chain integration
Competence	Core	Low
	Non-core	High
Market Competition	Low	Low
	High	High
Type of Product	Innovative	Low
	Functional	High
Industry Maturity	New market	Low
	Mature market	High
Power/Market Competition	Dominant/Low competition	Low
	Dominant/High competition	High
	Balanced/Low competition	Low
	Balanced/High competition	High

The contingency approach emphasizes the importance of flexibility in designing the supply chain after a thorough investigation of the environment in which the business operates. The situational factors outlined in this article can be combined in several ways. For instance, a dominant partner with low dependency between the partners in a growing industry with low market competition and selling innovative products, is expected to lead to low integration in the supply chain. On the other hand, a dominant partner with high dependency between the partners in a mature industry with high market competition and selling functional products is expected to integrate with its partners in the supply chain. A review of these factors and their effects on supply chain integration would help managers to understand the opportunites and threats involved in such arrangements in individual situations and thus help them in better organizing the supply chain in a flexible manner.

The contingency approach has its limitations. The cause-effect relations between the situational factors and the design recommendations might be ambiguous. Also, one situational factor might recommend higher integration while another factor favors low integration. In case of conflicting recommendations, the contingency approach is not very useful as a decision tool. Finally, it is sometimes difficult to decide whether a factor is a situational factor or a design parameter. The design of the supply chain is of course to some extent determined by the environmental factors, but the members of the supply chain has some autonomy to influence the environmental factors by developing new and more efficient supply chains. When Michael Dell developed the direct business model, he changed the traditional way of selling computers through distributors. The concept of direct selling and distribution has later been adopted by Dell's competitors. Wal-Mart's automatic replenishment system and cross-docking distribution centers gave Wal-Mart a competitive advantage relative to its major competitors and also changed the power relationships between the major retailers and their suppliers.

Conclusion and Suggestions for Further Research

All this suggests that firms of rapidly evolving industries will often prefer not to seek close inter-organizational partnership within the supply chain. As the threat of opportunistic behavior recedes with industry maturity, firms gradually open up and seek close integration with supply chain partners. Because it can be costly and even impossible to develop competitive capabilities in all areas, firms identify areas where they should develop or acquire capabilities on their own and where they can rely on supply chain partners to provide the required competitive capabilities. On the contrary, in case of functional products where the market is stable but very competitive, firms prefer to tap into complementary capabilities of supply chain partners through high inter-organizational supply chain integration to gain efficiency and competitive edge. In inter-organizational relationships, the dominant partner usually dictates the nature and extent of the relationship and supply chain integration blossoms if the dominant partner is willing and eager for a close partnership.

Supply chain integration should be selective. Contrary to what is popularly argued, more integration is not always better than less. In this paper, we have presented some preliminary findings on which situational factors influence the degree of integration in a supply chain. Further research is needed to verify our propositions and to add other dimensions of relevance for the flexible integration process. Many questions remain to be answered. For instance, what are the differences in terms of supply chain integration between various industries? Charles Fine (Fine, 1998) introduced clockspeed as a concept to characterize different rates of evolution in various industries. By studying supply chain design in industries with a fast clockspeed, such as multimedia, electronics and communications, we can learn about the peculiarities of changes in supply chain in these industries. Similar studies in other industries with varying clockspeeds may offer clues to more appropriate supply chain integration strategies.

Another research question is the impact of new information technology and communication systems on integration. The easy access to the Internet and better software packages within Collaborative Planning, Forecasting and Replenishment (CPFR) enable firms in a supply chain to exchange and share information much easier than before. The development of common standards for transferring XML-files between firms in a supply chain and other improvements in communications technology have also been advanced as ways to enhance the opportunities for integration. Research can be undertaken to verify these and many other similar claims of flexibility in supply chain integration.

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Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Supply Chain Integration"* on the following points:
   - Flexibility in terms of ***"options"***
   - Flexibility in terms of ***"change mechanisms"***
   - Flexbility in terms of ***"freedom of choice"*** to participating actors.
2. Identify and describe the types of flexibilities that are relevant for your own organizational supply chain integration? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational system on following continua of Supply Chain Integration issues. (Please tick mark in the appropriate box(es)).

Direction of Integration

Upstream ☐☐☐☐☐ Downstream

Competence

Core ☐☐☐☐☐ Non-Core

Product / Service Innovation

Low ☐☐☐☐☐ High

Overall Integration

Low ☐☐☐☐☐ High

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Supply Chain Integration"* relevant to your organization.

Reflecting Applicability in Real Life

1. What is the level of integration of supply chains in your industry and why?
2. What elements of which framework of supply chains are critical for your organization?

Case Studies

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A Comparative Analysis of Flexibility Practices in Two World-Class Companies – General Electric and Cisco

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Abstract

Business Environment is undergoing a rapid change. Companies are finding more and more difficult to cope up with the fast-paced changes in technology, customers' preferences and the diminishing barriers. Competitors may appear from nowhere and globalisation may yet challenge the local inefficiencies and the manner of doing business. In such an uncertain environment, new business philosophies and paradigms are appearing from time to time, to deal with these changes successfully. In effect, we are living in an age of experimentation. Flexible systems management offers one key approach to deal with business issues. Practical experience suggests that companies which have kept their systems flexible, be it in manufacturing or finance or in information systems or at the level of strategic dimension, have been better able to cope with the sudden changes in the market place. Here an analysis of two world-class companies is undertaken to show how these two companies with their flexible management styles were not only able to cope up with sudden twists and turns in a volatile market, but also create wealth. Between the two, GE has been better able to weather the effects of a slowdown in the economy, while, Cisco because of its not-so flexible approach, has been hit the worst, since the technology slump began. Once the icon of the 'new economy', Cisco is today, standing at an edge and only the future will tell whether its past policies played any role in its not-so-stellar performance. A comparative analysis brings out the flexibilities in various dimensions of the two companies and how the management styles of the CEOs of the two companies played a vital role in shaping the company's growth.

Keywords: flexibility practices, world-class companies

Introduction

Businesses are under constant pressure because of ever-faster changes in the market place and changing nature of competition. New challenges are arising on account of faster pace of technological change, increased globalisation and changes in customers' preferences. Product life cycles are getting shorter and strategy cycles are shrinking too.

To meet these challenges, businesses are discovering new management philosophies and paradigms. Companies, at the current turn of great turbulence, are discovering virtues in flexible systems management and flexibility practices that can enhance their ability to manage rapid changes in the environment.

But what is the flexibility paradigm and how is it defined? The word 'flexibility' is not an antonym to 'rigidity'.

Upton (1994) defined flexibility as the following:

"Flexibility is the ability to change or react with little penalty in time, effort, cost and performance."

Another definition of flexibility is given below-

'Flexibility means exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts.'

For the enterprise, "flexibility means creating 'options' at various levels in the enterprise, developing ways and means of change across the range of options and providing 'freedom of choice' to various actors in the enterprise for making this change happen with minimum time and effort" (Sushil, 2000).

Bahrami (1994) refers to flexibility as a polymorphous concept, whose meaning varies according to the situation. According to him, flexibility means the following:

"Flexibility is a multidimensional concept-demanding agility, and versatility: associated with change, innovation, and novelty: coupled with robustness and resilience, implying stability, sustainable advantage, and capabilities that may evolve over time."

Thus flexibility in its various dimensions connotes multiple meanings. Among other things, it implies an openness in thinking, adaptiveness to changing environment, responsiveness to change, versatility of action, contingency, non-rigidity, freedom, liberalization, adjustment, multiplicity of process setting, resilience, compromise, autonomy of function, broadening of the mind and vision etc.

Results and benefits of a flexible approach to management are many and varied. Flexibility in management instills a new sense of competitiveness and dynamism in the enterprise and generates organizational and managerial effectiveness, excellence, outstanding corporate performance, motivation and liberation and enlightenment.

Pasmore (1994) enlists the benefits of flexibility as follows:

"Flexibility becomes the source of competitive advantage, as the company's products, services, and ways of doing business evolve more quickly than the competitors. The organization becomes an industry leader and remains in a leadership position by virtue of its ability to adapt. Examples are- Merck, 3M, Proctor and Gamble."

Businesses are practicing flexible style of management in many functional areas. The most common practice is in manufacturing, while other areas where flexibility practices are becoming a rage are human resources, strategic management, operations management, organizational management, marketing management and information systems management.

Manufacturing Flexibility

Currently, businesses are facing threat of an uncertain and varied demand, as competition hots up in the marketplace and customers demand more and more choices and options in the products and offerings. Car manufacturers in particular, are using the same manufacturing platform for vehicles to turn out more and more range of products. This allows product differentiation without sacrificing the economies of scale. Honda, General Motors and others are coming out with newer offerings by using this approach. Manufacturing flexibilities created by them allow them to switch over production to models most in demand, at a very short notice. Thus they can remain ahead of their competition by adopting flexibility in their manufacturing systems. This also helps in bringing down cost of their products.

"Flexibility becomes the source of competitive advantage, as the company's products, services, and ways of doing business evolve more quickly than the competitors. The organization becomes an industry leader and remains in a leadership position by virtue of its ability to adapt. Examples are- Merck, 3M, Proctor and Gamble."

Manufacturing flexibility generates flexibility in several aspects, such as in products, processes, operations, volumes, machines, routing, action, state, expansion, design-change and in labour practices. Upton (1994) has also proposed a framework for analyzing manufacturing flexibility in terms of dimensions, time horizon and elements.

Organizational Flexibility

When the business environment is changing constantly, the organizations cannot remain static. They too need to be flexible in their design, culture and the processes involved in running day-to-day affairs, in order to be effective. A flexible approach to the organization ensures faster adaptation to change, quick response to new threats and opportunities, and in better management of diverse and decentralized operations.

Based on the field study of 37 high-technology firms in Silicon Valley, Bahrami (1992) enlists some of the features of the emerging flexible organization. The building blocks of flexible organizational designs are multi-polar organization, dualistic systems, front-line organizations, multi-skilled employees and semi-permeable boundaries.

While dealing with the issue of strategic change, Pasmore (1994) treats flexibility as the ability to change everything, all at the same time. He defines organizational flexibility as such:

"Improving organizational flexibility starts with the recognition that organizational change and human change are one and the same thing."

Hammer and Champy (1994) have the following to say, in the context of re-engineering the corporation:

"Not a company in the country exists whose management doesn't say, at least for public consumption, that it wants an organization flexible enough to adjust to changing market conditions..."

Hodgetts et al (1994) have described the world-class organizations to be characterized as fluid, flexible or virtual organizations, which increase the fluidity and resilience by developing a multi-skilled workforce.

Peters and Waterman (1982) have in their study found that excellent organizations have simple fluid structures with flexible and permeable organizations sub-units and discourage rigid job descriptions.

Organization flexibility in the larger sense includes flexibility in human resources, i.e. the ability to adjust the number of workers, or the hours worked, in line with changes in the level of demand. It also denotes ability to deploy workers over a broader range of tasks in line with changes in the nature of demand.

Thus flexibility in the organizational dimension brings a number of benefits in dealing with uncertainties in the market and enhances the competitiveness of the organization.

Financial Flexibility

Businesses have already been practicing a flexible approach in the financial field, for long. Generally in the assessment of financial parameters, a range rather than a fixed number, is referred to. Budgets are nowadays flexibly planned, which gives several estimates in different assumed circumstances. For example, revenues estimated from a new project are taken along optimistic, most-likely and pessimistic dimensions, instead of a sure-certain figure.

In the world of financial uncertainties, flexibility in budget planning, revenue estimation, combination of debt and equity ratios, goes a long way in creating a sound financial architecture for the company.

Strategic Flexibility

As marketplace becomes more uncertain and complex, there is a need to demonstrate flexibility in the macro and micro level strategies designed to steer course to the direction of the organization. One fixed and rigid strategy to achieve leadership may fail, when there is a change in the situation. Thus great success strategies fail when times change because companies fail to put strategy on the change list. Corporate transformation is a multi-stage and reiterative cycle. As mentioned above, Pasmore (1994) treats flexibility as the ability to change everything, all at the same time.

Strategic flexibility connects a flexible approach towards the company's objectives, the mission statement that it writes for itself. One single approach for all times in the future may not work and the company could be losing market-share to its competitors.

According to Cannon, transforming organization to face the turbulent twenty-first century needs creative destruction of the old task and relationship hierarchies.

Flexibility in the organizational dimension brings a number of benefits in dealing with uncertainties in the market and enhances the competitiveness of the organization.

Studies of global organizations in America, Europe and Japan suggest that the successful companies have a clear strategic intent with flexible means of achieving the outcome. In this era of environmental turbulence and 'real time fast response', strategy management is undergoing rapid changes.

Kanter says that the new era will require strategies that are embedded in the organization and that depend on the capabilities of all members. Total transformation is possible only if the capabilities are improved continuously.

Therefore in the new age, organizations will have to design strategies to use the hidden resources of creative innovation and strive to achieve continuous transformation. Strategy then becomes not a fixed destination, but a continuous journey in search of excellence.

Human Resources Flexibility

Organizations of today face a number of problems. Placed in this situation, it is not possible to have a fixed strategy on human resources. Inflexible labour laws in most countries are one problem for the organizations, when they cannot make use of skills of their employees at a time when the demand goes down. Similarly, hiring of fresh workers is under constraint even in good times, when companies have their order books full, for the fear that when the markets go down, the companies will be strained to keep them on rolls. There are other inflexible ways of operating–such as employees having only one type of skill and/or not being given more than one type of responsibility.

We are living in the age of tele working, where more and more workers do their work from home, rather than commuting to the office. Women in particular, like flexible hours of work, so that they can look after their families and children as well.

The HR flexibility therefore allows companies to make the best use of the human resources and enable people to learn and apply a wider range of skills. Flexibility allows to adjust the number of workers, or the hours worked, or to deploy workers over a broad range of tasks in line with changes in the level of demand. Thus flexibility in HR practices is a useful tool to meet with continuously changing nature of demands on the system.

Flexibility in Information Systems

Information systems play a vital role in the effective functioning of the organizations. Therefore organizations have to spend a fortune in creating the requisite information system, which takes care of the smooth operations of the entire range of processes, from back end to the front end. But information technology is changing faster than ever. Competitors may install the latest systems, which gives them an edge over their rivals. There may be new demands from customers to provide latest services and the new technology. Therefore technological up-gradation, or installation of an entirely new IT system may be required, discarding the existing system. Thus companies have to constantly invest in new technology to keep them abreast with the market demands.

Information system flexibility is the capacity of the information systems to change or adapt and adjust to new responses or conditions, demands or circumstances both within and outside the enterprise. It includes both systemic flexibility (flexible for organizational requirements) and usage flexibility (flexible for users).

Some benefits of IS flexibility are the following:

- It increases organizational flexibility.
- IS are easily modifiable as per demands.
- It takes care of changing needs of management.
- Better back-end or front-end integration can be achieved.
- Better adaptation to regulatory or other changes.
- New applications can be built with reduced cost.

Organizations have to keep an eye on the development of technology and how it is affecting the entire business processes. New players have the advantage of installing new technology, as they do not have an installed base. For the existing players, the costs become prohibitive, since they have already invested in the IS system which is costly to replace.

But information systems are fast acquiring a status, whereby they can change the ground rules for competition. For example, in the banking industry, providing an ATM Card brings a competitive advantage and customers may switch over from one bank to another based on such attractive facilities. Now Standard Chartered Bank in India provides an ATM Card, which can be used in the ATM network of other banks, without paying any additional charges by the users. This facility has drawn many customers, who otherwise may have to travel some distance to use the ATM facility of the bank of which they are customers.

Advantages of Flexibility

Flexibility in these areas permits the companies to derive a number of advantages. It brings down the costs, speeds up the process of development of products and delivery thereof to the customer. It also creates new value for the customer, in the range of products and the services that the company offers.

Scope of the Study

Besides flexibility in the areas discussed above, the topic can be further sub divided to define flexibility in other areas of organizational operations and performance. However they are not being discussed here, as the objective is to study flexibility and understand the concepts in order to draw a comparison between two companies, namely General Electric and Cisco.

Studies of global organisations in America, Europe and Japan suggest that the successful companies have a clear strategic intent with flexible means of achieving the outcome. In this era of environmental turbulence and 'real time fast response', strategy management is undergoing rapid changes.

Recent events have demonstrated that companies cannot afford to stick to one strategy and vision for decades. As product improvements take place and newer commodities come out of the R & D laboratories faster, companies feel the pressure of introducing new products. Companies may drop one line of business and enter into another, quite different from the existing, in order to serve the shareholders and other stakeholders better. In order to deal with such frequent changes, companies have to be flexible and agile in their thinking.

In this paper, an attempt is made to demonstrate that top-level strategies drafted by companies in their various dimensions have to constantly undergo a change, so as to utilize their inherent strengths and for offering better returns to the customers. Companies have to have a flexible approach in dealing with customers, different markets, technologies and their own people.

In order to demonstrate the effectiveness of a flexible systems approach, here case studies of two world-class companies, namely General Electric (GE) and Cisco have been undertaken to show how far these two companies have benefited by their flexible approaches in meeting the effects of rapid changes in the business environment, particularly the impact of the current slowdown in the world economy.

While GE has been consistently rated at the top spot for the last five years, in the list of 'most admired companies' by the FORTUNE publications, Cisco has recently lost its reputation. (Forture 2002 (c)), Cisco slipped to number 10 in the ranking for 2001, against number 2 in 2000, number 4 in 1999 and 8 in 1998. (The ranking of 2001 was published in March 2002).

Company	Ranking in the Year* ('Most Admired Company' By Fortune Publications)				
	1997	1998	1999	2000	2001
GE	1	1	1	1	1
CISCO		8	4	2	10

*Ranking of a particular year is published in the subsequent year.

The 'Most Admired List' is prepared on the basis of nine attributes – quality of management, quality of products and services, innovativeness, long-term investment value, financial soundness, ability to attract, develop and retain talent, community responsibility, use of corporate assets and global business acumen.

Market realities since last year have completely changed. The slowing American economy since April 2001 and particularly after September 11, has taken a toll in all sectors of the economy. There is a synchronized recession worldwide. All big companies have seen a major impact on their sales and profits. Technology companies, in particular are the hardest hit.

With the retirement of Jack Welch, a new CEO has taken charge in GE. Cisco has gone down badly, since the 'new economy' companies tanked and dotcoms went bust. The presumptions under which Cisco projected an infinite growth met its Waterloo in the technology bust.

First a study of flexible practices followed by GE would highlight as to how the company by adopting flexible practices over a period of time has survived the changes taking place in the marketplace.

Case of General Electric

General Electric (GE) has been one of the best-run American companies. When Jack Welch took over the reins of General Electric in 1980 from John Reges, GE had been a financially successful and widely admired company for most of the 20th century. One would have thought that there was just no need

of making any changes in GE businesses. But Jack still wanted a revolution and what he did in next twenty years is worthy of emulation.

GE's share prices outperformed most other companies' for much of the 1980s and 90s, when Jack Welch was in charge. Average annual return to the shareholders during 1982-2000 has been 25% against 17% for Standard & Poor's 500-stock index. Last year GE raked up $130 billion in sales and $12.7 billion in profits.

As the following would demonstrate, continuous success at GE has been, in a large measure, because of conscious flexibility policies and practices crafted by Jack Welch the CEO (Retd). Following are the details of flexibility practices in different areas, which has given GE an edge over competitors:

1. Strategic flexibility
2. Organizational and operational flexibility
3. Manufacturing and marketing flexibility
4. Flexibility practices in human resources
5. Flexibility in information systems

The HR flexibility therefore allows companies to make the best use of the human resources and enable people to learn and apply a wider range of skills. Flexibility allows to adjust the number of workers, or the hours worked, or to deploy workers over a broad range of tasks in line with changes in the level of demand.

Strategic Flexibility

GE's flexible ways of evolving strategic policies over decades, to create newer value for the company and the shareholders, has been the key attribute in its success. GE first flush of success was based on cost cutting by shedding unprofitable businesses and laying off people, which earned Jack Welch the nickname of 'Neutron Jack'. Beginning with this, there has been a continuous renewal and changes at the strategic level for taking the company forward–globalization in 1980s, a move from products to products plus services in 1995, the six-sigma quality programme from 1996, and e-business since 1999. There was continuous improvement in performance in the Jack era, in the 1990s as he switched from manufacturing to services, then by embracing globalization and adopting Internet as new platform to connect the buyers and sellers and create economies of scale.

Jack Welch took over as the CEO in 1980 under difficult circumstances, even though his predecessor Reg Jones was rated as the best CEO of the times among Fortune 500 CEOs by the Fortune magazine. Economy was coming out of one recession and about to enter into another. Prime rate was at 21.5%. Dow was hanging at 937, the level it had reached 15 years earlier.

To begin with, Jack changed the GE's goal. GE's turnover then represented 1% of GDP and its only ambition was to grow faster than the GDP. But Welch gave GE a new mission: to be the world's most valuable company. GE was then No.10, but to become No.1, the entire organization had to be shaken. Welch declared that every business in GE had to be No.1 or 2 in its industry, another radical change in self-assessment. In his first year, GE entered 118 new businesses, joint ventures or acquisitions, while at the same time selling off 71 businesses from the GE control. The vision for GE was to become a service company and to get out of businesses in which the company had no competitive advantages. Welch did not hesitate in selling off an Australian coal outfit, Utah International, Reg Jones's largest acquisition, as it did not fit into new GE.

Jack's vision moved ahead of the market demand or of the competition. He could change the direction of a conglomerate like GE with the speed and agility of a small firm. He created a boundaryless company. He created a new culture to boost performance by removing hurdles, in the nature of the corner offices, the bureaucracy, 'the not invented here' syndrome etc.

Welch's vision demanded not to follow the established wisdom, but rather act in a flexible manner. He believed in the 'creative destruction' of the old, to regenerate the business. He blew up the existing paragon—the portfolio of businesses, the bureaucracy within GE and the culture as well as the practices and traditions. Had Jack stuck to the old paradigm, he would not have been able to take a $14 billion company (market capitalization) to over $ 300 billion. Jack's only regret later was for not having moved even faster.

GE now, however, needs to do much more to remain as the world's most admired company. As Jack envisioned, the next step is globalization of intellect. The real challenge will lie in the globalization of the mind of the organization. The next paradigm is to capture the intellect of other areas. For example, Asia has a disproportionate share of engineering talent. Therefore setting up R & D laboratories in Bangalore and building foundries in Czech Republic are laudable steps. GE is making its biggest bet on India. The only R&D center outside Schenectady N.Y. is being set up in Bangalore, where top class engineers are easily available dirt-cheap.

Like other companies, GE too is facing fresh challenges since the economic downturn has taken place after the events of September 11. Many GE businesses—including jet engines, aircraft leasing, broadcasting and reinsurance are not doing well. However, some businesses, such as power systems, medical systems, and capital services are prospering. Enhanced military sales and cost cutting is likely to boost the earnings. Prevailing lower interest rates may help the financial activities, while lower equity prices may fuel more acquisitions for GE capital.

The CEOs of GE have traditionally enjoyed full power to do things that they desire in order to enhance performance. The new CEO Jeffery Immelt is doing things in his own style and he has already made some difference. He has reiterated the GE ability to win. He has a 'relaxed' approach to work, to win peoples' confidence, so as to get the best out of them.

The new CEO has declared digitization as the next winning move, thus creating another flexible dimension to move ahead of the competition. Online-sales is another strategy to gain an advantage. It is estimated to save $1.5 billion annually for the company.

Flexibility of re-organizing business-units within GE is often considered necessary, in order to make them more competitive. GE announced that effective August 1, 2002, GE Capital would be divided into four sub-units. The new businesses are GE Commercial Finance, GE Insurance, GE Consumer Finance and GE Equipment Management. Some support functions within GE Capital, including risk management and treasury, will now report to Dennis Dammerman, 57, a G.E. vice chairman who preceded Mr. Nayden as GE Capital's chief. Immelt's justification for the break-up was to have more direct contact with the financial services teams.

Thus it is seen that GE has been working with an open mind as far as business re-structuring is considered. This strategic flexibility has given it an edge over its rivals.

General Electric (GE) has been one of the best-run American companies. When Jack Welch took over the reins of General Electric (GE) in 1980 from John Reges, GE had been a financially successful and widely admired company for most of the 20th century.

Organizational and Operational Flexibility

GE's working would show that the company over the years has evolved highly flexible organizational and operational policies to achieve a high growth. When Jack took over, a new world was emerging. The old world of manufacturing was guided by the ideas of scientific management, where workers were programmed with detailed procedures, manuals and hierarchies. Jack saw the change coming and he faced up to the huge challenges of transformation even though the process was painful. He led his managers into this new world and he showed everyone how to attack the change of any kind.

Local managers were given authority to make GE more efficient and accountable. Empowerment at the local level called for dismantling the corporate strategic planning division and giving freedom to each of the individual businesses. The old GE created blue books, the famous five volumes of thick books for guidance of the managers. Welch burnt those blue books. His new message to the managers was: you own those businesses and take charge of them. Get the HQ out of your sight, fight the bureaucracy, hate it, kick it and break it. The fundamental philosophy was to nurture local talent, let ideas bubble up from the bottom. Welch wiped out entire layers of management, including one high level layer Jones had installed. "Town meetings"–meeting of employees at all levels of an operation together with their bosses, to ask questions and make proposals about how the place could be made better. 80% of all issues had to be resolved then and there. This was a true cultural revolution. It taught everyone that they had a right to speak up and be taken seriously. Those with bright ideas were rewarded, as were those who implemented them. Then those ideas were to be spread across the company. Borrowing good ideas from other companies also made sense. GE learnt about asset management from Toyota or about quick market intelligence from Wal-Mart.

Candidness in personal meetings with managers came where those meetings became much more focused with commitments from individual managers. Employees were graded each year on a scale of 1-5 and the bottom 10% either moved up or were moved out. Welch followed the principle: 'Change before you have to'.

GE's goal is to enmesh global set of standards, tools and principals with local conditions. Core values are not negotiable and local bosses are supposed to run their businesses within these global standards. The firm is highly centralized as far as core values and issues are concerned–financial targets, promotion and expulsion are decided centrally. But local issues are left to the regional bosses to manage.

GE has a strategic plan of cross-border leveraging–of using people, processes and products in the most effective manner, to enhance businesses in other countries. This strategy has been applied in Asia, which has a huge demand for manufactured goods and which in global terms produces even more. For example, in medical systems department, global products and local markets are combined for the business. GE makes its machines in countries, which offer the right level of engineering talent and the best-cost structure. GE medical has eight factories in Asia–one each in Japan and Korea and three each in India and China. All the factories sell domestically as well as abroad. But the marketing and services functions are done with a local flair.

In the GE's push for globalization, locals have been given a larger role. Many expatriates working with GE were sent home and replaced with the local managers. GE operations are particularly huge in China.

Organizational and operational flexibility practices have given a definite edge to the GE in keeping it updated on the market trends.

Manufacturing and Marketing Flexibility

Manufacturing and marketing flexibility practiced by GE has given it an edge over the competition. The push for globalization meant catching opportunities in non-traditional markets. However globalization could not have been pursued within the rigid framework of the old policies. Major changes in approaches, policies, procedures and philosophies of the organization were called for. GE's formula was to take a universal corporate culture and transplant it into a multitude of native soils and then by nurturing local talent let it grow to suit local conditions. Earlier this formula had worked wonders in Europe and was being tried in Asia.

There is flexibility in Asian operations. GE's globalization began when Jack spotted major opportunities in China, India and other non-traditional markets. Given Asia's size, complexity, and diversity, a localized approach has appeal. GE has devised not one strategy for Asia; there is a strategy for each business in Asia. Asian revenues at GE are already growing twice as fast as revenue elsewhere and margins in Asian businesses are also higher. Asian operations are designed according to business needs and geography. Plastics head in India reports to Netherlands, while medical business reports to Tokyo. Country heads again are designated on the basis of need. For example, in China and Japan, country heads have no responsibility of any line of business, whereas in Indonesia and India, head of one of the businesses is also the country head.

Welch's vision demanded not to follow the established wisdom, but rather act in a flexible manner. He believed in the 'creative destruction' of the old, to regenerate the business.

Manufacturing and marketing operations and strategies are combined to achieve best results. The policy of cross-border leveraging–of using people, processes and products has increased the business opportunities in other countries. As stated above, GE makes medical systems wherever the right level of engineering talent and the best-cost structure is available: Global products and local markets are combined to maximize on the highest turnover across different countries. The policy on globalization is suitably mixed with localization.

By relying on local talent, GE has been able to increase sales many times over. GE Plastics in China is doubling up sales every year. Medical division is also doing good business there.

E-business has opened up an additional channel of sales, bringing in additional sales of 15% of plastics in China. Flexibility through the medium of Internet is driving the customers. Customers can now put in their specifications at the design stage and get several different recommendations on materials they want. By getting orders online, GE plants can adjust their manufacturing operations quickly as the customers make a change in their choice of the design.

E-business is also transforming GE's global supply chains. GE operates everywhere and therefore it can get the best deals by buying in bulk from one place. GE bought goods worth $ 20 billion online last year. The old EDI system has been replaced with GE Global exchange Services (GXS).

GE Capital, which has 28 subsidiaries and accounts for nearly half of the revenues ($55 billion out of $124 billion of GE's turnover), does insurance, leasing and lending. Asian strategy in 1990s was to gear up enough of a presence to understand what was happening in the markets and then wait and see how things would evolve. In Thailand, operations started on a small scale in 1993 but when Thai baht collapsed, a major opportunity came in buying distressed loans.

In Japan, turnover in operations has grown from $1 billion in 1995 to over $ 40 billion today. Japan has the world's fastest ageing population and thus it offers the biggest life insurance market. GE has thrived because of a primitive financial system and weak domestic competitors in Japan. It has acquired a life insurer, a consumer finance firm and two leasing companies. It expects Japan to generate 25% of its worldwide life insurance business within next few years. Since 1997, Japan has been GE's fastest-growing national market in both revenues and profits.

Thus we see that GE has greatly benefited from its flexible policies and entered into new territories of business with additional sources of revenues and profits.

Flexibility in Human Resources Policy

After Jack Welch took over as the CEO, he brought about a revolutionary change in HR policies and practices. He energized and inspired thousands of people in GE across a range of businesses and countries. Jack's singular achievement was in creating a GE culture among people, which gave them the freedom to work freely, so as to give their best to the company.

Seven 'mantra' of Jack set the tone and benchmarks for performance. For example, every division had to be either no.1 or 2 in its industry or close down. A culture of entrepreneurship was embedded in the DNA structure of the people.

While moving to the new territories, Jack created a sense of ownership and belongingness among the locals. Local managers were promoted at the cost of expatriates, which created huge opportunities in those countries to do business.

Jack played the role of a gardener providing nourishment to people. By creating a cultural revolution where people

could share from each other, Jack abolished the barriers of various sorts, which existed among people and departments. 'The not invented here' syndrome, the 'the corner offices' and the bureaucracy gave way to a culture where the objective was to look after the company's interests as a whole.

Jack followed a highly flexible HR policy and the speech that he gave at the time of retirement makes it amply clear. He said: "to be vital, an organization has to reposition itself, start again, get new ideas and renew itself". Believing in this philosophy, Jack did not stay on the board, so that his successor felt free to do whatever he wanted to do. This flexibility in a key HR dimension is quite contrary to the practice prevailing among US companies, whereby the retiring CEO usually stays as a member of the board.

Flexibility in Information Systems

GE has always demonstrated a positive approach and has been on the leading edge of the emerging technological and information systems. When the Internet arrived in 1997, GE created one of its biggest electronic buying networks and emerged as one of the world's biggest industrial buyers. The GE Information Services (GEIS) division was one of the few networks in the B2B (Business-to-Business) segment of e-commerce.

The new CEO has declared digitization as the next winning move, thus creating another flexible dimension to move ahead of the competition. Online-sales is another strategy to gain an advantage. It is estimated to save $1.5 billion annually for the company.

GEIS was based on electronic data interchange (EDI) system; a way of exchanging formatted purchase orders and other documents electronically. EDI transactions are carried over private, secure networks or leased lines, run by third-party service providers. It served more than 100,000 companies that collectively processed more than a billion transactions a year.

After arrival of the Internet, GEIS became an outdated system. Initially, Jack Welch was not very enthusiastic about the Internet. But a close interaction with Scott McNealy, the CEO of Sun Microsystems convinced him about the benefits of the Internet based transactions. Once he embraced faith in Internet, e-business became his strong priority. Jack then devised "destroyyourbusiness.com", encouraging each division to reinvent itself before someone else did it.

In March 2000, GEIS became GE GLOBAL exchange services (GEX), a software and marketplace builder.

GE's each division runs its own web marketplaces, both for internal and external use. Three initiatives, 'e-buy', 'e-sell', and 'e-make'— are digitizing the main functions of running the conglomerate, saving money, reaching customers faster and using Internet technology to extend the focus on quality which was the driving passion for six-sigma manufacturing.

The new CEO, Immelt has declared the move on digitization as his highest priority in company.

Lack of Flexibility in Some Areas

Inspite of an outstanding record on flexibility policies followed in a number of areas by GE, there have been some pitfalls too. Jack failed to show flexibility in dealing with the EU's competition commissioner, while arguing the Honeywell's merger case. A lack of strategic flexibility in understanding the sensitivities of the Europeans and the legal differences on anti-trust issues between the EU and US, cost the company dearly. Jack simply went by his American (arrogant) style and failed to read the message on the board. It brought negative publicity for the company and waste of efforts on an issue, which had engaged the attention of the CEO for a long time.

Shortage of minorities and women at decision-making levels in GE has raised public concerns. Another issue was lack of timely attention on the pollution caused in the 'Hudson-river', due to waste disposal by the GE units, created a public furore. The US government then had to order for cleaning up of the river by GE. This created an embarrassing situation for the company.

The lesson to be drawn is that as the company grows bigger and prosperous, it has to craft a flexible policy on public relations as well. Corporate social responsibility is another dimension, which need to be flexibly assessed from time to time.

Flexibility Practices Followed at CISCO

"Not a one product, one market or one geography company, but a company that constantly re-invents itself. It's in the DNA of Cisco"–John Chambers.

This is how the CEO of Cisco drew a vision for the company. There are hidden meanings of flexibilities in this statement. First of all, a company that constantly re-invents itself has certainly strategic flexibility inbuilt into its vision.

Then there are obvious manufacturing and marketing flexibilities, as Cisco's reach extends beyond one product or one market.

Cisco has been a world-class company, which consistently appeared, from year to year in the list of 'most admired companies' compiled by FORTUNE. Till recently and before the slowdown, Cisco had been the darling of the stock market too.

Cisco was a paragon of high-tech growth. It took a decade to hit $1 billion in sales in 1994, but the sales quadrupled to $ 4 billion in next two years and quadrupled yet again in fewer than 4 years. It grew consistently at over 75% a year

for 13 quarters in a row during the bullish 90s. Cisco achieved the highest market capitalization of $550 billion on March 27, 2001, surpassing those of Microsoft and General Electric.

The financial markets always loved Cisco, the greatest networking company on earth. Its rapid rise in the last decade beat the records of even Microsoft. Between December 89 to December 99, share price of Cisco went up by 125,000%, highest among all tech stocks, beating Dell and CMGI. Customer's demand for more and more speed kept the company growing at over 40%, since the IPO was launched in 1990.

Cisco always figured in the list of 'most admired companies' compiled by Fortune. In fact in 2000, it improved its overall ranking from 8th in 1999 to 2nd. It used to be at the top in the ranking of companies in the category of 'Electronics and networking'. It also figured high at number 3, in the Fortune's compilation of 'The 100 Best companies' to work for, in 2001.

An ex IBMer John Chambers, who took over as CEO of Cisco in 1995 worked hard to bring up Cisco. Market cap was a mere $9 billion and since then he has created a value of more than $100 billion. 75% of Net traffic today travels through Cisco products. Number of Internet users is expected to grow from 300 million to 1 billion by 2005, according to one estimate. The question is whether the growing community of net users will also boost the growth and bottom line of Cisco and allow it to regain its lost status.

While all these steps helped Cisco in generating business with big profit margins, success made Cisco blind in its strategy. It kept harping on the successful past strategies, thinking that the same would also work for the future as well.

Cisco's finances remain always up-to-date and the company claims that it can prepare accounts of book-closure in a day and make perfect financial forecast. Cisco relied on the acquisition strategy for growth, ingesting companies and their technologies with great fanfare. It was the leader of the new economy, selling gear to new emerging companies, which were expected to supplant the old behemoths (which did not happen).

The slowdown in technology business and the burst of dot-coms hit Cisco, the icon of the new economy, the worst. Its share price tumbled to a low of $7 and its market cap dropped to less than $ 100 billion. Is Cisco's way of working responsible for what happened? The company never expected any kind of slowdown in its business, as the Internet was supposed to be expanding northwards only. There appears to be some failure in the vision-strategy of the company.

The positive side of the business at Cisco shows that it did create a saga of unprecedented growth in a short time. Cisco is still strong. It has a cash pile of $16 billion and sales gear to 85% of US Corporations. In spite of fall in share prices, investors who invested money in the IPO of 1990 are better off than if they had invested in S&P index.

Here are some critical highlights of Cisco's highly flexible systems, which contributed a great deal in their achievements. Some rigidities though contributed in sudden failure at Cisco.

Strategic Flexibility

In the growth model that the company followed, strategic flexibility has played a vital role. Outsourcing production, relying on acquisition as a tool for growth, using shares as the means for acquisition and making creative use of Internet for growth, were Cisco's mainstay in business. Thus Cisco remained ahead of the competition and its business grew by leaps and bounds.

It developed a flexible manufacturing systems by outsourcing production to contract manufacturers like Jabil Circuit. Heavy investment in plants and factories thus could be avoided. Another flexible way of growth for the company was through the strategic route of acquisitions. Cisco's share price became the currency of acquisition. Since 1993, Cisco spent $35 billion to buy 71 companies. In 2000 alone, the company acquired 22 companies. Cisco treated buying start-ups as outsourcing research. It helped buy disruptive technology, enter new markets and bring in highly qualified engineers. Cisco also made creative use of the net to bolster its growth.

While all these steps helped Cisco in generating business with big profit margins, success made Cisco blind in its strategy. It kept harping on the successful past strategies, thinking that the same would also work for the future as well. No new choices were developed to meet with the new challenges. Since the American economy tanked and telecom markets took a beating, Cisco finds itself in a very difficult situation. Cisco's share price has gone down by more than 90%, making acquisitions difficult.

John Chambers failed to recognize the market trends and continued with the old tune. His oft-repeated statement: 'Cisco does better during the tough times' continued to reverberate even after the economy and telecom sector, in particular were severely hit. Cisco assuredness bordered on the naïve. Cisco had full faith in the upstarts. Its revenues from them kept on growing to reach 50% finally. But Cisco bet on the wrong segment of the market. New telcos were poorly managed, had weak business plans or failed to meet the earnings target. Many simply vanished.

On the other hand, Cisco did not have good relationship with the old economy companies like AT&T, which

contrary to belief, are still in business. Established companies looked upon Cisco with suspicion. No one liked Chamber's idea that the voice would be free, since the telcos had already made huge investments in circuit-switched networks.

Cisco is now having a tough time in deciding about the future direction. Cisco's high optimism got it where it is now. The tech industry woes stem from not just weak demand, but also from excessive optimism that it would continue to grow at breakneck speed. IT spending worldwide, however, has slowed down and there has been negligible growth in 2001 (growth in 2000 was 12%).

The company is facing the biggest challenge of its life. Markets think that overheads and cost of manufacturing at Cisco are high and stock is constantly getting hammered. 44,000 strong Cisco for the first time in its history retrenched 8,000 people, unheard of in Cisco culture.

Cisco also faces challenges from start-ups like Juniper Networks. Juniper came out with high performance core routers, and has captured over 30% of the market share.

In the new emerging scenario, question is whether Cisco would be able to come out with successful strategies for the future, to deal with a market situation where demand is growing slowly and competition is getting tougher.

Cisco diversified its client base in to different markets. Focus on the fast growing markets in Asia, particularly in China and India produced good results.

Organizational and Operational Flexibility

Cisco's flexible growth model of building on outsourcing without raising manufacturing infrastructure, made the organization more effective. It allowed the company to concentrate on its core areas of activity. Acquisition strategy also worked well in an uncertain technological environment, where the company might not have been able to keep pace with the development of the best technology for the market. Operationally, it provided flexibility to the company in choosing the best technology suitable for its business.

Acquisitions are not easy to assimilate, but the company developed a standard model to absorb the bought-out companies in its fold in its own unique way in the Cisco culture.

The acquisition strategy however had its own drawbacks. There was under-investment by Cisco in certain areas where the right technology was not available for buying and it lagged behind its competitors in the new technologies developed by the likes of Juniper Networks.

Cisco has been high on the list of 'Best companies to work for'. Therefore the criteria for selection are also tough. Qualities such as enthusiasm for work, motivation, having the right attitude and commitment to work for the companies' goals and objectives are highly rated.

Manufacturing and Marketing Flexibility

De-regulation of the US telecom industry in 1996 was the starting point for several upstarts to emerge, with the ambition of supplanting the old players like AT&T and WorldCom. Equipment suppliers like Cisco were hugely benefited by the growth in telecom spending, which jumped from single-digit to 14 to 17% annually.

In the booming market, Cisco's order book was always full. Supply trailed behind the demand and the lead times for delivery were getting longer and longer. For some products, the customers had to wait even up to 15 weeks. But Cisco did not own plants except two. It subcontracted manufacturing to Jabil Circuit and Solectron. Real time data was made available to them, so that partners knew what went on in the business, on day-to-day basis.

Cisco developed an excellent supply chain. It also developed an e-business model for sales. The online sales kept picking up and constituted over 85% of the total. Online system allowed Cisco to know the market trends earlier than what would have been available in the manual system of sales. This allowed manufacturing schedule to adjust to the demand. It also created huge savings for the company.

Cisco diversified its client base in to different markets. Focus on the fast growing markets in Asia, particularly in China and India produced good results. China is poised to have the largest number of Internet users in the future. Cisco introduced several promotion schemes in the Chinese market to create awareness about its products.

At a time when even Asian growth is slowing down, the company needs to demonstrate a flexible approach in discarding the strategies that worked in the past. Crafting new strategies requires re-assessing the ground situation and the future demand, looking to the changes in customers' preferences and attitudes and keeping in mind the cost factor in the prevailing buyers' market.

Therefore the company needs to focus more on innovation and future technologies. Optical could be a good area, as the world gets more and more wired. Convergence of various technologies and devices too offers a great opportunity. Discarding the growth strategy of growing solo, Cisco may need to enter into alliances with other players in different areas of technologies to look for synergies and value creation. Shaking hands with rivals like Microsoft, Sun or Oracle to create another kind of value chain may not be a bad idea.

Chamber's promotion of Internet Protocol and his bold statements like 'voice would be free', traveling over the

Internet (of course through Cisco equipment) offended the old telecom players. Chambers used to talk in a language as if he felt sorry for them. His constant use of the derisive language against the established telcos spoiled the relationship. But now is the time to make a new beginning and start building a relationship.

Cisco's belief in continuous growth of the Internet and hence equipment sales proved to be its undoing. When the slowdown began, Nasdaq's darling Cisco was the first to feel the hit. Sales of equipments plunged and excess inventories piled up. In good times when customers had to wait for the products, building inventory was one way of making faster shipments to customers. But faced with a glut, company had to write-off excess inventory for a massive $2.5 billion. Even this step of write-off was looked down upon with suspicion, as many feared that this was to create nice paper- growth in the future.

Cisco was also taken aback by the suddenness of the economic slowdown and the way demand disappeared. It made some bad technology bets. It exhibited a cavalier attitude towards potential customers. It signed long-term contracts with suppliers at just the wrong time. Some of its products were not very good. In spite of the reports of flat spending in 2001 by telecom companies, Chambers was offering investors an upbeat view of Cisco's prospects, despite the demise of Cisco customers. With the demand slowing down, market was flooded with second hand routers, making things even more difficult for Cisco.

Cisco was also taken aback by the suddenness of the economic slowdown and the way demand disappeared. It made some bad technology bets. It exhibited a cavalier attitude towards potential customers.

In nutshell, Cisco failed to come out with flexible strategies suited for good and bad times and the company is paying dearly for this mistake.

Flexibility in Information Systems

Cisco has been using the information systems very effectively. Accounts-closure is thought to be a matter of a few hours, thanks to a wide network of information technology used in all its operations. Its supply chain is one of the best. Cisco is also providing the necessary infrastructure to the companies wanting to create e-business. Online sales at Cisco now exceed 85% of total sales. It is also getting into untapped areas of technology, such as wireless and optical. It has already acquired a few companies in optical businesses and captured 7% of the market. It is spending a higher percentage on R&D (from 9% to 14% in last four years) and developing new products, which exploit the expertise in managing Internet traffic. Internal processes are being automated to enhance productivity.

Use of Information technology and systems by Cisco, like Dell, has given a definite edge to the company in cutting down costs, creating an excellent supply chain and in assessing the customers' needs better.

Flexibility in IS thus has created good market value for the company.

Pitfalls in Flexibility Systems of Cisco

In spite of some outstanding achievements, Cisco's deadbeats are many. Several acquisitions such as Monterey Networks that aimed to route waves of light in fiber networks have not worked well. Pirelli's optical system acquired by Cisco too is doing badly.

Acquisitions, forecasting, technology and senior management have all failed in the past year. But so have competitors' and therefore some relief to Cisco, as it isn't alone in the losing game. But Chamber's promotion of Cisco as a company that was faster, smarter and better than the competition, has not proved right either.

Cisco failed in forecasting demand and lost touch with the ground realities. Customers who could generate revenues were not coming that fast and a situation of over-supply was building all along, which finally depressed the prices of products of the company. Cisco forgot that it too isn't exempt from the law of gravity–that what goes up, will come down. It failed to plan for the bad times.

A Comparative Analysis of Flexibility Practices at GE and Cisco

After having studied the two world-class companies in detail, it would be interesting to make a comparison, as to how and why GE has been able to meet with the emerging market uncertainties better than Cisco. Here are some salient points:

- Nature of businesses of GE and Cisco are different. The former is a conglomerate, which offers a greater flexibility in dealing with the situation of a downturn. Some businesses of GE could still be doing a good business, to compensate for the losses arising in some other businesses. GE's CEO was always alert to the market realities, of its ups and downs and he had some workable strategies in place.

  Cisco on the other hand is a highly focused company, which has been the hardest hit since the technology bust. As the leader of the new economy, its share of the downfall in the total market was again the largest. The worst part was that everything came to Cisco as a surprise, even though facts were known much before the markets actually collapsed. It had no strategies for bad times and it appears Cisco deliberately ignored the realities.

- GE's globalization strategy built up over last several years paid off well in bad times as well. Whereas Cisco's business of networking got simultaneously affected in all the continents. Its Chinese and Indian markets, which weren't big, too collapsed.
- GE always anticipated the markets and developed major strategies to give it a push. Moving from one paradigm to another was the GE way of working, which energized its employees. Cisco on the other hand, went on a linear path, as if good times were going to last forever and the world was never going to change.
- GE's operational and organizational flexibilities were on a much higher scale. It always thought of destroying its own business model for getting better results.

  Cisco, however, remained stuck in its own rigid frame and developed a sense of 'narcism'–looking at the mirror and praising itself, all the time.
- GE developed an excellent relationship with its partners, whereas Cisco offended the old companies like AT&T, losing flexibility in gaining from a good relationship later.
- GE's manufacturing flexibility utilized the advantages of each country to push products in the market. Contract manufacturing was not the way at GE and GE invested heavily in technology improvements.

  Cisco on the other hand, relied on outsourcing model for production and in a fast changing technological environment, it could not maintain its lead. It missed many areas of emerging technology.
- GE's magic in the financial market is still strong. In terms of MVA (market value added), the difference between the total capital investors have put in to a company and the money they can take out, GE's MVA is $312 billion, against Cisco's $116 billion (approximately), as per Fortune dated December 10, 2001.

  The above highlights are only a sample, which can be extended further, on the basis of materials on the flexibility practices followed by the two companies as already discussed above.

Conclusion

From the above study of General Electric and Cisco, there is no doubt that flexibility practices developed as an organizational philosophy help achieve better results and higher long-term growth. It allows the company to deal with market uncertainties in a more effective and robust manner, with the least penalty in time, effort, cost and performance.

As the business environment gets tougher, companies wishing to join the league of world-class companies would be well advised to embrace a flexible systems approach in dealing with various uncertainties.

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Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in a practical situation on the following points:
   - Flexibility in terms of ***"options"***
   - Flexibility in terms of ***"change mechanisms"***
   - Flexbility in terms of ***"freedom of choice"*** to participating actors.
2. Identify and describe the types of flexibilities that are relevant for your own organization? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational system on following continua (Please tick mark in the appropriate box(es)).

Strategic Flexibility

Conglomerate ☐☐☐☐☐ Focused Company

Operations Flexibility

Balanced ☐☐☐☐☐ Outsourcing

Growth Option

Organic ☐☐☐☐☐ Mergers & Acquisitions

Contingency

Market Realities ☐☐☐☐☐ Forecasting

Renewal

Shifting Paradigm ☐☐☐☐☐ Linear Path

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Flexibility Practices"* relevant to your organization.

Reflecting Applicability in Real Life

1. How can you identify important flexibility practices and position and trends in your own context ?
2. What strategic flexibilities you need to create growth engines such as GE and Cisco ?

Indo-Japan Symposium on

Technology and Innovation Management for Competitiveness in Convergence Era

November 6, 2002

Venue: India Habitat Centre, Lodhi Road, New Delhi - 110 003

Organized by MOSAI & AIEJ

In collaboration with

Dept. of Management Studies (IIT Delhi) & **Global Institute of Flexible Systems Management (GIFT)**

Introduction

Competitiveness is a multi-dimensional concept with relevance at many levels. Stagnant/ declining competitiveness of India and Japan (as evaluated by the Global Competitiveness report) is a matter of concern to all stakeholders. Technology, innovation and management will play crucial role in enhancing competitiveness. This seminar aims to provide opportunities for learning from Indian and Japanese professionals.

Objectives

The key objective of the symposium is to provide the participants insights into conceptual and practical aspects of the role of technology and innovation management for technology capability building and competitiveness. Sharing and interpreting experiences of diverse participants will help in understanding the thinking, approach and performance for each country.

For Whom

Academicians involved in research and teaching about the subjects and professionals involved in formulating and implementing competitive strategies/ managers/ learners of competitiveness.

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- Competitiveness: concept and linkages
- Dynamics of competitiveness in IT industry
- Issues in Technology & Innovation management
- Technology capability building
- Indo-Japan collaborations: Prospects and Challenges Benefits of participation
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Manufacturing Flexibility in a Filter Manufacturing Enterprise–A Case Study

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Abstract

Flexibility has become a key factor in the successful and profitable operation of business enterprises. Globalization of markets, rapid technological developments and intense competition has made it imperative for all manufacturing enterprises to be responsive to changes. Therefore, flexibility is needed. At the same time, a high productivity is desired in the face of resource crunch and severe competition. This paper presents a case study of Purolator India Limited, Parwanoo, India and is a part of exhaustive survey covering aspects related to flexibility. The relationships between various types of flexibility and productivity have been established. The values of different types of flexibility have been found at various intervals of time for the enterprise. Various types of productivity have been calculated for the corresponding time intervals. The trends of flexibility and productivity have been determined. An approach has been suggested for managing flexibility in future. A hierarchy of flexibility, listing the order in which various types of flexibility should be focused in future, is also given. SAP (situation-actor-process) analysis has been carried out leading to identification of learning issues and conclusions.

Keywords: manufacturing flexibility, productivity, SAP analysis

Introduction

In the era of liberalization and globalization, achieving high quality and low cost is not enough. In the face of fierce competition, organizations are looking for flexibility to quickly adopt to environmental changes and thus gain an advantage over their competitors (Leana and Barry, 2000). Flexibility will enable them to respond to customers' needs quickly, provide a broad product range or introduce new products to the range effortlessly. Flexibility is a multi-faceted concept with different connotations (Sushil, 1999). Strategic, organizational, financial, information systems and manufacturing flexibility have been identified as the cornerstones of enterprise flexibility (Sushil, 2000). Flexibility is the ability of a system to respond or react to a change with little penalty in time, effort or cost (Upton, 1994). According to Buzacott (1982), the change may be internal (equipment breakdown, workers' absenteeism etc.) or external (change in product design, demand and product mix). Flexibility is also the ability to do things differently or do something else should the need arise (Bahrami, 1992). According to Upton (1995), flexibility is about increasing range, increasing mobility or achieving uniform performance across a specified range. Flexibility is the ability of a system to take different forms. Flexibility is the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts (Sushil, 1997). On the one hand, flexibility means being agile and versatile, while on the other, it means being robust and resilient so as to withstand shocks when negatively affected by changes. There are various types of flexibilities. Browne et al (1984) provided a comprehensive classification of flexibility by describing eight types of flexibilities – machine flexibility, process flexibility, product flexibility, routing flexibility, volume flexibility, expansion flexibility, process sequence flexibility, and production flexibility.

To accommodate flexibility, various companies are experimenting with novel organizational structures and management processes. Some of the prevalent developments include de-layering, team-based network, alliances and partnerships.

Besides flexibility, proper utilization of resources is essential due to unprecedented competition coupled with acute resource crisis. Enhancement in productivity is the key to success. One of the method of improving productivity is to measure productivity level and subsequently take corrective action. Productivity can be measured either as total productivity or partial productivity, i.e. material productivity, labor productivity, energy productivity, and equipment productivity. The paper presents an approach for managing flexibility in Purolator India Limited, Parwanoo, a filter manufacturing firm, keeping productivity improvement in mind.

Methodology for Measurement of Flexibility and Productivity

For measuring flexibility, various parameters contributing towards a particular type of flexibility are identified. A paired comparison of these parameters has been carried out to find out their weight by drawing a position matrix. Further, questions have been framed related to these parameters in a specially designed questionnaire to know the response of the filter manufacturing firm to these parameters. Information has also been collected through personnel discussions with persons at different levels in the company to know the levels of flexibility at different times. Various types of flexibilities have been measured on 0-1 scale as explained in Appendix I. The trends in various types of flexibilities have been measured by comparing their values with the values of the last year and with that of five years back. At the same time, productivity values (partial as well as total) of the filter manufacturing firm have been found out for the corresponding periods by finding actual output and various types of inputs in monetary terms. The trend of various types of productivities has also been determined. Correlation have been established between flexibilities and productivities. Based on the past trends and existing levels of flexibilities and keeping in mind the correlation between flexibilities and productivities, an approach has been suggested for managing flexibility in future. A hierarchy of flexibilities, listing in the order in which various types of flexibilities should be focused in future, is also given.

Flexibility is also the ability to do things differently or do something else should the need arise.

Relationship Between Various Types of Flexibility and Productivity

The relationships between different types of flexibility and productivity have been determined by finding out product moment correlation. Data has been collected from 50 enterprises in India regarding levels of flexibilities and values of productivity. The results of the correlation are shown in Table 1. The results depict that routing flexibility is positively and significantly related with material productivity ($r = 0.296$, significant at $p < .05$ level). This may be attributed to the fact that with higher routing flexibility, the work-in-process (WIP) reduces and due to this the deterioration of WIP also decreases, thus increasing material productivity.

Volume flexibility is positively and significantly related with energy productivity ($r = 0.363$, significant at $p < .01$ level). Volume flexibility gives the company the ability to respond in case of over demand and under demand. An increase in volume flexibility increases energy productivity as higher production volume decreases energy required per unit production. Likewise, product flexibility is significantly related with material productivity ($r = 0.325$, significant at $p < .05$ level). Generally product flexibility is mainly introduced by bringing in and using state of the art technology . This leads to less scrap or wastage of materials, thus increasing material productivity.

Table 1. Correlation Matrix Between Various Types of Flexibility and Productivity

Sr. No.	Flexibility	Productivity				
		Material	Energy	Labor	Equipment	Total
1	Routing	0.296*	0.239	-0.237	-0.047	0.078
2	Volume	0.059	0.363**	-0.176	0.017	-0.111
3	Product	0.325*	0.029	-0.093	0.054	0.091
4	Product mix	0.171	0.059	0.051	0.01	0.318*
5	Labor	0.077	0.022	0.149	-0.04	0.287*
6	Design-change	0.177	0.106	0.279*	0.006	0.242
7	Machine	0.081	0.123	0.183	-0.071	0.154
8	Planning	0.285*	0.293*	-0.21	0.104	0.139
9	Communication	0.152	0.154	-0.072	-0.14	0.281*
10	Total	0.305*	0.162	-0.025	0.018	0.288*

* Significant at $p < .05$ level $r = 0.279$
** Significant at $p < .01$ level r 0.361

Product-mix flexibility is significantly and positively related to total productivity ($r = 0.318$, significant at $p < .05$ level). Product-mix flexibility is achieved by reducing set-up times and change-over times for variety of products made, thereby, reducing lead time and waiting time. Thus, most of the time is utilized in actual production operations, resulting in effective use of resources, thus, increasing total productivity.

Labor flexibility is significantly and positively related with total productivity ($r = 0.287$, significant at $p < .05$ level). Labor flexibility is achieved by having people with multiple skills, good education level, and accommodating nature. All these ingredients of labor flexibility would result in better utilization of human resources. This results in the increase of total productivity.

Design-change flexibility is significantly and positively related to labor productivity ($r = 0.279$, significant at $p < .05$ level). This may be attributed to the fact that design change flexibility may result in increase of the skill levels of the workers in producing different types of products. This would result in enhancing labor productivity.

The correlation matrix depicts that machine flexibility is not significantly related with any factor productivity or total productivity.

Planning flexibility is significantly and positively related with material productivity ($r = 0.285$, significant at $p < .05$ level). This may be explained by the fact that firms with

higher planning flexibility generally do not stock large inventories of finished products. This reduces the expenditure on material storage cost and material deterioration, thus, improving material productivity. Planning flexibility is also significantly and positively related with energy productivity ($r = 0.293$, significant at $p < .05$ level). Higher degree of planning flexibility requires the manufacturing system to have better and well-maintained equipment with minimum breakdowns. This type of equipment generally consumes less energy, resulting in high energy productivity.

Communication flexibility is positively and significantly related with total productivity ($r = 0.281$, significant at $p < .05$ level). Communication flexibility helps in taking quick decisions. This is expected to result in better utilization of resources, thereby increasing total productivity.

Total flexibility is positively and significantly related with material productivity ($r = 0.305$) at $p < .05$ level, and with total productivity ($r = 0.288$) at $p < .05$ level. As product flexibility, product-mix flexibility, routing flexibility, labor flexibility, and volume flexibility are the main contributors towards total flexibility, therefore their impact contributes towards the impact of total flexibility on various types of productivity.

Present Status

Purolator India Limited (PIL) was established at Parwanoo (Himachal Pardesh) in 1976, in technical and financial collaboration with Purolator USA, for manufacturing air filters, lubricant oil filters, and fuel filters. The filters are used for applications in diverse fields such as automotive, industry, railways, and aviation.

The total turnover of the company was INR 630 million in 1994–95 and it rose to INR 860 million in 1995–96. The domestic market share of the company went up from 26% in 1994–95 to 29% in 1995–96. The company is also exporting filters to many countries including Germany, Italy, Japan, USA and Spain. The export sales went up by 55% from 1991–92 to 1995–96. The increase in market share has been due to introduction of new types of filters that include filters for trucks, coil type filters, and oil filters for Cielo car and a variety of filters for overseas market.

Table 2 gives the values of various flexibilities of the enterprise for the years 1991–92, 1994–95, and 1995–96 respectively. The percentage changes in these values in 1994–95 and 1995–96 as compared to that in 1991–92 are also shown.

Table 3 shows values of various types of productivity along with percentage changes in the values for the year 1994-95 and 1995-96 as compared to that in 1991-92.

Table 2. Flexibility Values

Sr. No.	Flexibility	1991–92	1994–95	1995–96	% Change 94–95 Vs 91–92	% Change 95–96 Vs 91–92
1.	Routing	0.696	0.782	0.783	12.5	12.57
2	Volume	0.623	0.821	0.931	31.89	49.53
3	Product	0.506	0.525	0.553	3.68	9.23
4	Product mix	0.522	0.759	0.821	45.23	57.19
5	Labor	0.7	0.925	0.925	32.18	32.25
6	Design change	0.514	0.6	0.623	16.63	21.18
7	Machine	0.516	0.344	0.344	-33.26	-33.26
8	Planning	0.384	0.389	0.389	0.1	0.1
9	Communication	0.5	0.6	0.6	20	20
10	Total	0.546	0.687	0.738	25.64	35.11

Table 3. Productivity Values

Sr. No.	Productivity	1991–92	1994–95	1995–96	% Change 94–95 Vs 91–92	% Change 95–96 Vs 91–92
1.	Equipment	78.77	80.19	81.13	1.8	2.99
2.	Labor	16.95	23.56	26.6	38.99	56.93
3.	Material	1.47	1.77	1.71	20.32	15.98
4.	Energy	92.85	90.73	99.6	-2.27	7.27
5.	Total	1.05	1.13	1.107	7.58	4.93

Status and Trends of Flexibility

The changes in flexibilities that have occurred at PIL in the last five years are discussed below:

Routing flexibility: Nearly 75% of the machines employed in the plant are special purpose machines, and the rest are rigid special purpose machines. This factor limits the routing flexibility of the plant. Process change in the plant is a continuous and on-going activity. For example, pack curing of the filters was earlier done through heating by making use of diesel. LPG was then tried as an alternative fuel. Then, electrically heated ovens were tried, which were subsequently replaced by ovens with circulating air motion. The plant has got 7 separate lines for manufacturing filters. In case of machine breakdown, work-in-process can be shifted on other lines, thus contributing to routing flexibility. However, sequencing of operations cannot be changed due to process constraints. Due to these factors, the routing flexibility of the plant increased by 12.5% from 1991-92 to 1994-95 and further by 0.06% in 1995-96.

Volume flexibility: The production levels of the plant have been continuously increasing. The production level was 12 million units in 1991-92. It increased by 16% to 14 million in 1994-95. In 1995-96, the production further increased by 7% to 15 million. To meet these increasing demands, the company has been continuously going in for expansion. The company established separate lines for production of filters for Ashok Leyland Company and MICO company. The company paid lot of attention towards vendor development

to meet increasing production demands. Presently, there are around 35 vendors in Parwanoo supplying various components as compared to only 2 vendors in 1991–92.

The volume flexibility of the plant has increased by 31.89% in 1994–95, and by 49.53% in 1995–96 as compared to 1991–92.

Product flexibility: The company undertakes the development of filters based on the specifications supplied by the customers. The plant has a comprehensive system of designing and developing the filters. Changes in filter design, major as well as minor, take place from time to time but the plant in itself does not come out with revised model of any filter. It is only when a customer comes out with a new vehicle, the filters suiting the customer requirements are made. All these factors led to improvement in product flexibility, which improved by 3.68% and 9.23% in 1994–95 and 1995–96 respectively as compared to that in 1991–92.

Product mix flexibility: As there are many categories of filters being manufactured in the plant, there is lot of product mix flexibility. Fuel filters are made for aviation purpose whereas for industrial and automotive applications air filters, lubricant oil filters and fuel filters are made. At present, the plant is manufacturing around 300 types of filters. Every year, fifteen to twenty new filters are added to the product range to meet the customer needs. The variation in the share of different types of filters has not shown much change in the trends from 1991–92 to 1995–96. The product mix flexibility of the plant has improved by 45.23% and 57.19% respectively in 1994–95 and 1995–96 as compared to 1991–92.

Generally, product flexibility is introduced by bringing in and using state of the art technology. This leads to less scrap or wastage of materials, thus increasing material productivity.

Labor flexibility: The company has trained its workers for carrying out various processes. The workers are provided with necessary tools, testing equipment, and work instructions in order to ensure accurate, efficient, and controlled process. The company has a system of providing comprehensive in-house training to its personnel. Training needs of all the personnel are assessed, and suitable training programs are organized. In this way, all employees develop necessary skills to carry out their assigned tasks, and achieve quality requirements. Training and education is a continuous process and 2% of the sales is devoted to training and education. Around 20% of the workforce is trained to work on more than two machines to meet any situation arising out of worker's absenteeism. The company is focusing at downsizing of workforce as the workforce reduced by around 25 percent from 1991–92 to 1995–96. Based on above factors, the labor flexibility of the plant increased by 32.18% from 1991–92 to 1994–95. In 1995–96, there was only marginal increase in labor flexibility.

Design change flexibility: The plant is using computer software for developing new filters and for making design changes. The plant has already stored a data base related to design of a wide range of filters and their components. Design changes are generally made in terms of dimensional parameters to achieve functional qualities. Sometimes, changes are also made in the filter paper, e.g., changing the number of pleats in a filter. The design change flexibility improved by 16.63% in 1994–95, and by 21.18% in 1995–96 over its value in 1991–92.

Machine flexibility: All the machines and equipment in the plant are special purpose machines and are designed to do a specific type of work. Therefore, there is not much machine flexibility. With the setting up of various lines to meet specific requirements of customers, the machine flexibility has further decreased as a particular line is used for manufacturing filters for a particular company. Due to the installation of special purpose machines, the machine flexibility has decreased by 33.26% from 1991–92 to 1995–96.

Planning flexibility: The production planning is done for the plant as well as for the dedicated vendors, who supply complete filters to the plant. The annual master plan is tentative. Based on that, a monthly schedule is made. The monthly schedule can be changed based on customer urgency, and specific orders can be preponed. Similarly the monthly schedules also get postponed if there are some material problems. Finally, daily schedules are made, based on individual customer needs and plant capacity. Every line has got specific capacity.

Planning flexibility has slightly improved by 0.103% due to the installation of more lines in the last five years.

Communication flexibility: The conventional information system leads to only limited communication flexibility. It has improved by around 20% in last five years due to increasing use of computers.

Total flexibility: The value of total flexibility of the plant was 0.546 in 1991–92. It rose to 0.687 in 1994–95, and became 0.738 in 1995–96. Thus, the plant is showing increasing trends in total flexibility change in the last five years. The increase in total flexibility is attributed to increase in volume flexibility, product mix flexibility, labor flexibility, and design change flexibility.

Status and Trends of Productivity

The equipment productivity increased in 1994–95 by 1.80% as compared to that in 1991–92. This is due to installation

of special purpose machines in 1991–92. The trends in 1995–96 are showing a further increase.

The labor productivity is also showing increasing trends. It increased by 38.99% in 1994–95, and 56.93% in 1995–96 as compared to that in 1991–92. Efforts are being made right from the start to eliminate excessive workers on various lines by induction of automatic machines to optimize human resources, and to increase labor productivity. Further, introduction of production based incentives has led to an increase in labor productivity.

The material productivity rose by 20.32% in 1994–95 as compared to that in 1991–92, but fell by 3.6 % in 1995–96 Similarly, changes in energy productivity have shown fluctuating trends. It decreased by 2.27 % in 1994–95 but went up by 7.27 % in 1995–96 as compared to that in 1991–92.

Due to different inputs at different times, the total productivity first went up by 7.58% in 1994–95 as compared to that in 1991–92, but then fell by 2.46% in next year. Seeing the above trends, the plant should focus on increasing energy productivity and total productivity in the coming years.

Future Order of Flexibility Acquisition

The future order of flexibility acquisition for the company has been determined keeping in mind the relationships between various types of flexibility and productivity. The market trends and present flexibility levels of the company have also been taken into account. From the trends of various types of flexibility in the last five years, as shown in Figure 1, it is clear that volume flexibility, product mix flexibility, labor flexibility, and design change flexibility of the company have increased significantly. This is justified as the production levels of the company have risen by around 3 million filters in the last 5 years with a corresponding increase in the turnover by around INR 500 million. Every year, fifteen to twenty new filter types are introduced, thus, justifying the need for product mix flexibility and design change flexibility. On the productivity front, energy productivity of the plant declined by 2.27% from 1991–92 to 1994–95, but it improved in 1995–96. The material productivity and total productivity of the plant decreased by 3.6 and 2.46%, respectively in 1995–96.

Due to the increasing demand of filters of various types, the plant should continue to improve its product mix flexibility and volume flexibility. Figure 1 shows the future approach that needs to be adopted by the plant to manage flexibility.

The plant should focus on planning flexibility in the future. This can be made possible by using computers for production planning and scheduling. It may also contribute towards routing flexibility and communication flexibility.

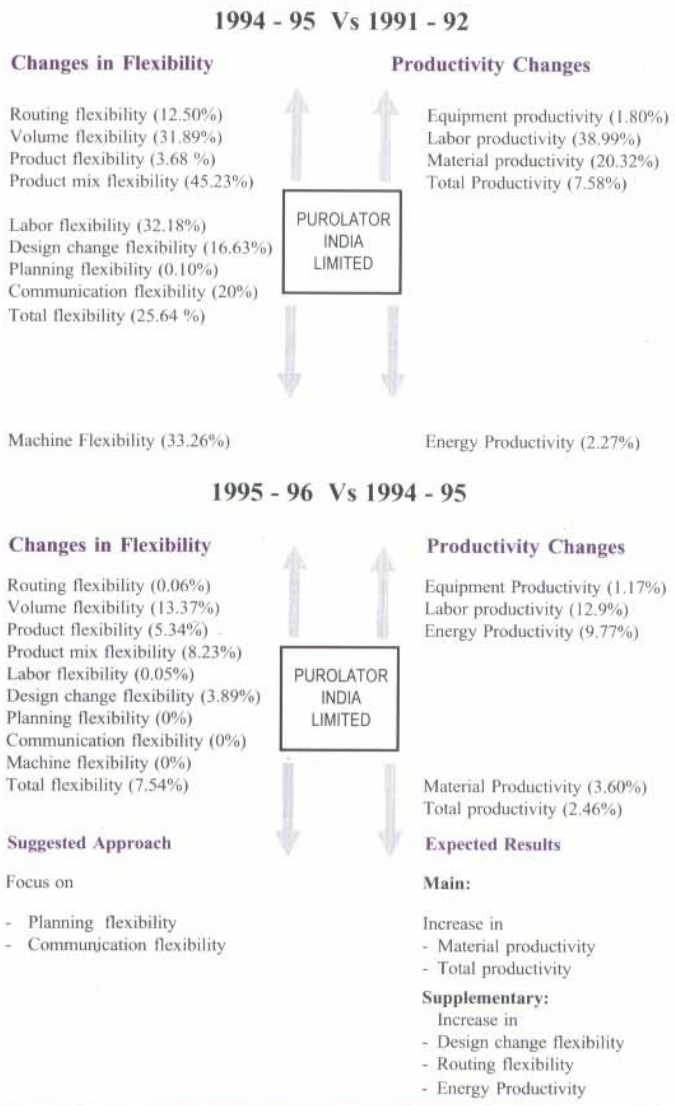

Figure 1 : Trends in Flexibility and Productivity and Suggested Approach for Increasing Productivity

Planning flexibility may help improve material productivity and energy productivity, which had shown declining trends.

The plant should also concentrate on increasing communication flexibility. Higher communication flexibility may contribute towards design change flexibility as both are correlated. In addition, it may lead to an increase in total productivity, which was showing downward trends in 1995-96. It is proposed that, in the future, the plant should focus on various types of flexibilities in the following order:

(i) Product-mix Flexibility

(ii) Volume Flexibility

(iii) Planning Flexibility

(iv) Communication Flexibility

(v) Design change Flexibility

(vi) Labor Flexibility

(vii) Routing Flexibility

(viii) Product Flexibility

(ix) Machine Flexibility

SAP Analysis

SAP (situation-actor-process) analysis has been carried out to determine the approach adopted by the enterprise for managing flexibility. SAP analysis (Sushil, 1994, 1997) is a method of analyzing a case study. In SAP analysis, the case has been described through three basic components (situation, actor and process) that define the dynamic interplay of reality. From the analysis, learning issues have been explored.

Situation

- PIL, Parwanoo established in collaboration with Purolator USA.
- PIL is an ISO 9002 certified company.
- The demand for filters increasing from various customers including foreign countries.

Actor

- Ex-President of PIL
- General Manager (Exports) as a visionary leader.
- Managers and executives of the company as a dedicated lot.
- Employees of the plant as the heart and soul of the firm.
- Vendors of the plant as a source of new ideas.

Process

- Focusing on vendor development and alliances with other enterprises. Developing sub-contractors who are completely dedicated to the plant.
- Setting up different lines to meet specific requirements of customers.
- Increasing the number of shifts from one to three for increasing volume flexibility.
- Introducing automation in the plant to increase production levels.
- Introducing various productivity improvement schemes with workers' participation.

Learning Issues

- Volume flexibility can be increased through sub-contracting, vendor development, and by having alliances with other industrial firms.
- Production based incentive schemes to workers also help in achieving higher volume flexibility.
- Special purpose machines, and automatic machines, help in increasing volume flexibility.
- The ability to expand continuously leads to increased volume flexibility.

Concluding Remarks

Flexibility is a polymorphous phenomenon. Flexibility is visualized as a way that will enable to meet customers' demands quickly, provide a broad product range or introduce new products to the range easily. There are various types of flexibility, namely, routing, volume, product, product-mix, labor, design change, machine, planning, communication and total flexibility. A particular type of flexibility can be measured by identifying various parameters contributing towards that flexibility, determining the weight of various parameters contributing to it and the response of an enterprise to these parameters. The paper highlights the fact that it is possible to plan for flexibility keeping productivity in mind. However, the type of flexibility to be acquired will also depend on the present levels of flexibility, cost aspects and management view towards acquiring flexibility. For that, detailed cost-benefit analysis has to be carried out.

The future order of flexibility acquisition for the company has been determined keeping in mind the relationships between various types of flexibility and productivity.

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APPENDIX 1

Various types of flexibility of the company have been measured based weight of various parameters contributing to a specific type of flexibility and the response of the company to various questions based on these parameters. For example- routing flexibility has been worked out from the response of the company to the questions, set on the following aspects:

a) Type of machine tools and tooling installed

b) Purpose for which CNC machines have been acquired

c) Ability of the manufacturing system to incorporate continuous improvement in productivity, quality and reduction of cost.

d) Number of major changes made in process design in the past.

e) Number of minor changes made in process design in the past.

f) Amount of buffer stocks of materials kept on machines to accommodate breakdown.

g) Ease or difficulty level with which shift of operation from one machine to another in case of machine breakdown is done.

h) Extent to which sequencing of operations can be changed in case of breakdown of machinery.

i) Effort and cost needed to reschedule in case of a breakdown.

j) Rescheduling time required in case of a breakdown.

k) Extent to which managers cooperate towards any change in the process.

l) Extent of line balancing in production area.

m) Type of material handling equipment being used.

To determine relative weights of these parameters, analytic hierarchy process has been employed. Each parameter has been compared with other parameters pairwise. The comparison has been carried out. The comparison was done on a qualitative scale of very low, low, medium, high, and very high as the difference between the importance of two parameters. However the response was written in quantitative terms by converting the qualitative response using the following scale:

Very Low	Low	Medium	High	Very High
1	3	5	7	9

The weight of each parameter towards routing flexibility has been determined by calculating Eigen vector and normalizing it. The contribution of different factors towards routing flexibility in shown in the next table.

Conted...

Weight of Various Factors Contributing to Routing Flexibility

Parameter	a	b	c	d	e	f	g
Weight	.084	.037	.00234	.017	.00606	.00022	.419

Parameter	h	i	j	k	l	m
Weight	.00004	.2629	.169	.0000004	.0000037	.007

The routing flexibility has then been calculated by using the following formula :

$$\text{Routing Flexibility} = \Sigma (W_x \times S_x / 4) \quad (1)$$

where W_x is the weight of xth factor contributing towards routing flexibility and S_x is the score of question based on x^{th} factor.

Similarly, different types of flexibility have been measured by considering various parameters affecting them. Having measured the various types of flexibility, total flexibility (TF) of the company has been measured. Total flexibility (TF) implies the combination of all these components of flexibility. The weight of each component of flexibility towards total flexibility is also found out by paired comparison using AHP. The weight of various types of flexibilities towards total flexibility after normalizing the Eigen vector is given below.

Weight of Various Types of Flexibilities Towards Total Flexibility

Type of Flexibility	Routing	Volume	Product	Product mix	Labour	Design change	Machine	Planning	Communi-cation
Weight	0.034	0.1049	0.2549	0.58	0.0169	0.00712	0.0015	.0002	.00001

The total flexibility is then calculated by taking into account values of components of flexibility and their weights by using the formula

$$\text{Total Flexibility (TF)} = \Sigma (W_x \times S_x) \quad (2)$$

where W_x is the weight of xth flexibility and S_x is the value of xth type of flexibility for a particular company.

Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Manufacturing Flexibility"* on the following points:
   - Flexibility in terms of ***"options"***
   - Flexibility in terms of ***"change mechanisms"***
   - Flexbility in terms of ***"freedom of choice"*** to participating actors.
2. Identify and describe the types of flexibilities that are relevant for your own organizational manufacturing flexibility? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational system on following continua (Please tick mark in the appropriate box(es)).

Product Flexibility

Product range ☐ ☐ ☐ ☐ ☐ Product features

Material Flexibility

Low ☐ ☐ ☐ ☐ ☐ High

Labor Flexibility

Low ☐ ☐ ☐ ☐ ☐ High

Cost Flexibility

Low ☐ ☐ ☐ ☐ ☐ High

Focus of Manufacturing Flexibility

Present ☐ ☐ ☐ ☐ ☐ Future

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Manufacturing Flexibility"* relevant to your organization.

Reflecting Applicability in Real Life

1. How can we increase labor flexibility? What will be role of learning and motivation for that?
2. Based on approach given in the paper develop a strategy to increase productivity.

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Dynamic Decision-Making and Military Communications Systems in the Information Age

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Abstract

The art of making timely, accurate and dynamic decisions has been the most critical aspect of military leadership, since the decisions taken by military leaders at all levels most often have direct impact on human lives, national assets and at times survival of the nations. Traditionally, militaries world over have well defined (and at times rigid) hierarchical, organizational structure. Decision-making process in such organizations generally remains manual, leader oriented, rigid, simple and at times slow. Given the inherent organisational strength, integrity and courage of military leaders and sincerity of purpose across the organisation the process has so far been somewhat successful albeit at higher costs. However, the ground realities today have vastly changed. These changes are in the field of:

(a) New concepts of national and individual security, which has enlarged the scope and domain of armed forces.

(b) Revolutionary progress in software technology, networked information system.

(c) Growing convergence between IT, communication and content.

All this makes it incumbent on the modern armies to review their decision-making process. An attempt has been made in this paper to present an overview of decision-making process in defence structure using the modern tools of IT, identify the trends in the military information systems and highlight the necessity of their convergence. The objective of the paper is thus to examine dynamic decision-making process in modern armed forces and focus on the necessity of convergence between IT enabled decision-making tools, networked military information systems in the backdrop of varying combat environment.

Keywords: dynamic decision-making, military communication systems

The Process of Dynamic Decision-Making

The process of decision-making in armed forces generally follows two models. Firstly, the top down approach. This follows downward along the hierarchical route. Most of the major decisions are taken at the highest levels of command. The orders are then fed to the lower levels for deciding on the nitty gritties and specific functional details. More often than not even the functional aspects are micro managed by the higher Command and Control (C2) nodes. In the second model, which is commonly known as the bottom up approach, the environmental inputs and at times the decision alternatives travel from the lower C2 nodes to the higher nodes. The inputs and the alternatives are evaluated at the higher nodes. The selected option is then passed down to the functional node for execution. In both these models, the power to decide (more often than not even the minor functional details) rests with the highest tactical C2 node with tacit consent from the strategic level. Thus, at the functional level the most preferred option may not be available for execution. Many a time there may be a wide perception differences between the body of troops and headquarters involved in executing the task and those involved in planning. Nevertheless both the methods of decision-making have their own justifications and advantages. Firstly the top-down approach. The capabilities of decision-making are much more enhanced at higher decision nodes than those at the lower rungs of decision-making, since the knowledge base at higher nodes is bigger. Besides, intelligence available and that which can be procured, the facility of corroboration and evaluation, clarity of the overall picture including own and adversary's resources/intentions are much better here. Hence, the decisions taken at higher decision nodes is likely to be more accurate and mature. In the bottom-up approach, the closer proximity of the lower echelons to the combat situations is exploited in gathering inputs. Also, while allowing the lower nodes to generate decision alternatives their involvement in the decision-making process is ensured. This also facilitates a more willing participation in the execution of the plan. The disadvantages of both the approaches are quite evident hence need not be mentioned. But both these systems as they are being applied today have some inherent shortcomings.

(a) Meaningful and important decisions are based on the final judgement of the highest commanders at tactical and many a time operational levels. The ground realities and the fast changing combat environment are more clearly visible to the commanders and troops at functional levels. This anomaly may lead to unrealistically optimistic plans or may miss fleeting opportunities during combat. There may be a case to combine 'the functional eyes with the operational brain'.

(b) The entire process is too cumbersome and time consuming. It may serve the purpose before battle is

joined. But would soon collapse in the fluid combat environment, especially where highly mobile forces are pitted against each other.

(c) The national and strategic means of gathering information do not provide timely input to the functional levels of command. By the time such inputs are available the ground situation generally changes. It may become a case of 'too much but too late'.

(d) The process of converting information in to intelligence takes place at command and control nodes at higher levels of hierarchy. In the absence of real time and continuous input from the functional levels, proper corroboration and integration may be lacking.

(e) The decision alternatives are generally generated by manual means by senior or trained staff officers. This has its own limitations. It is quite likely that some important alternatives may be ignored to keep the whole process simple (or manageable).

(f) The modern decision-making processes employ a number of quantitative techniques. These involve mathematical knowledge. There is always a general aversion to computation or quantification of decision parameters. In an attempt to follow 'keep it simple stupid' approach, it may end up in 'keep it simple for the stupid approach'. Use of computers for the purpose can be of great help.

(g) The evaluation of decisions "pay off and penalties" is also done manually. Obviously the whole process is based on 'ease of handling approach' than on 'minimum error approach'. Techniques like game theory, linear programming, assignment and transportation models can be easily used with the help of computers (to keep the usage simple even in case of large number of variables).

The decision–making process must be based on the real time inputs from the environment.

The above discussion does bring out the need for modifying our decision-making process. In this paper, we will bring out some of the tools of IT available for the purpose. The requirements of a modern decision-making process as emerged from the above discussion are:

(a) The decision-making process must be based on the real time inputs from the environment. While most of the operational and strategic decisions may be based on the sound judgement (without ignoring the hard facts and accurate inputs) functional level decisions must be derived from inputs obtained from various sensors.

(b) There is a need to use automated tools (of IT) to cut down time and degree of difficulty in decision-making. This is especially applicable to contact battle in the combat zone and sensor to shooter decision loop. Time is the essence of the decision cycle loop in the forward zone.

(c) The inputs from the strategic means of obtaining information must be made available to the desired functional levels in time. If need be suitable gateways must be incorporated which can be easily accessed for 'pulling' the desired information.

(d) Suitable architecture of integration and diffusion must be incorporated to convert information into intelligence.

(e) The evaluation of decision alternatives must be done through automated decision support systems.

Command and Control

In the prevalent military doctrines reference to command and control is generally made as command and control warfare (C2W). Thus as per the Indian Naval doctrine on Information Warfare (IW) C2W has been defined as synergistic application of operation security, deception, psychological operations, physical destruction supported by intelligence on so on in order to deny information and influence/degrade/destroy the command and control capabilities of the adversary. Since command and control has not been explicitly defined, we may infer by default that command and control capabilities may be the means of communication from the commander to his force. Stephen J. Andriole and Stanley M. Halpin (1989) bring out the same notion held in the Pentagon. As per them, the usual reply from most officials on the definition of command and control covers a long discourse on the latest communication systems deployed in Europe.

Here again, the means of communication are being mistaken as command and control. Frank Barnaby in his book the automated battlefield enumerates the command and control functions as monitoring own, enemy strengths and resources, and specific conflict situations, asses warning signals, military capabilities, choose options. Lastly, negotiate and terminate conflict. Out of all this, choosing options from a set of options worked out or represented, can be grouped as the command function, whereas all other functions are control functions at various levels of staff support. A number of control functions overlap with the command functions. These are related to assessment and planning. Obviously, these control functions are performed at higher levels of staff support. Command and control is thus a process by which decision-makers select among competing options to achieve strategic and tactical objective. Command, broadly stated, is the determination of what to do, while control is the ongoing management of the execution of the command (Lehner). Hence, it can be inferred that command is primarily a decision-making function, whereas control function deal with all those functions that enable the execution of decision.

The command and control as such will have to be a distributed system especially in a hostile environment, where the military has to function. The levels and extent of distribution will depend on the external and internal dynamics of the organization and environment. The distributed command and control nodes are linked by communication network. A schematic layout of the distributive network topology is given in Figure 1. The pictorial representation maintains a hierarchical topology with gateways, which provide hierarchy level jump facility for pulling the requisite information. A pull model is more appropriate as against push model to avoid information overload at the lower levels of C2 nodes. The opening of the gateways can be controlled through secured key systems so that access control is exercised for sensitive information being pulled from the strategic or national means of information gathering. The speed, capacities and security coverage of various linkages will be as per their respective requirements. Thus, at national and strategic defence levels optical fibre and EHF satellite media will be more suitable.

Suitable architecture of integration and diffusion must be incorporated to convert information in to intelligence.

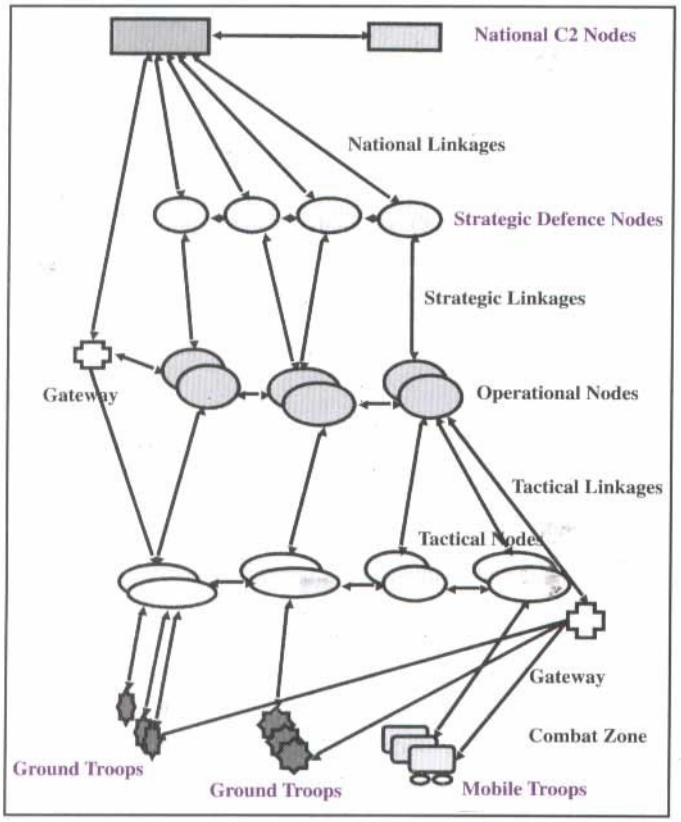

Figure 1 : C2 Nodes and Communication Architecture

Command, Dynamics and Facilitating Technologies

The various methods of information decision support system include qualitative, quantitative, information science and hybrid methods. The qualitative and quantitative methods are the older systems of management. These deal with subjective and structured quantitative assessments, extrapolative, stochastic, operation research and causal models. The information science methods deal with the information management and artificial intelligence models. Though the mathematical techniques involving the earlier methods and models can also be automated, the information method give more logical models for automation.

Cognitive Systems Engineering

Cognitive engineering entails the design and development of computer-based information systems consistent with the way humans store, retrieve, display and process information (Andriole and Addmen). It is not engineering discipline since it seeks to apply the knowledge of human cognitive information processing to larger systems. It also identifies the substantive inference and decision-making requirements with corresponding suitable display systems to facilitate meeting these requirements. The inference making requirements include assessment of events and conditions, likely outcomes and identification of high probability crisis situation. Techniques for discriminating between false alarm and real threat inter-group and intra-group communication and heuristic for adaptive monitoring. These requirements will need distilled displays of threat, geographical vulnerability, comparative cases and 'what- if' conditional displays. The decision-making requirements should encompass generation and evaluation of options, assessment of operational constraints, 'what- if' conditional analysis, calculations of decision option outcomes, historical precedents and intergroup and intra-group communication. The displays to support the decision-making requirements should bring out the cost-benefit ratio, alternative options, option-rank order, communication network, and decision options outcome. These and other functions, tasks are representative of activities that define command and control. In a military environment, the initial inputs will include the operational constraints and the processed knowledge base from the staff and lower commanders/troops. Thus the first step would be matching the initial options with constraints. The cognitive decision alternatives can be generated with the help of what-if conditional expert system. The selected options can be then displayed in a number of easy-to-comprehend ways. The senior staff echelon can rank the options in order of priority. The commander selects an option and orders execution. During the execution stage, the sensors are once again tasked to monitor the effect of the selected option. The same is fed to the decision-making nodes for reinforcing/modifying or rejecting the option even during the execution stage. This chain of cognitive decision-making is depicted in the schematic diagram given in Figure 2.

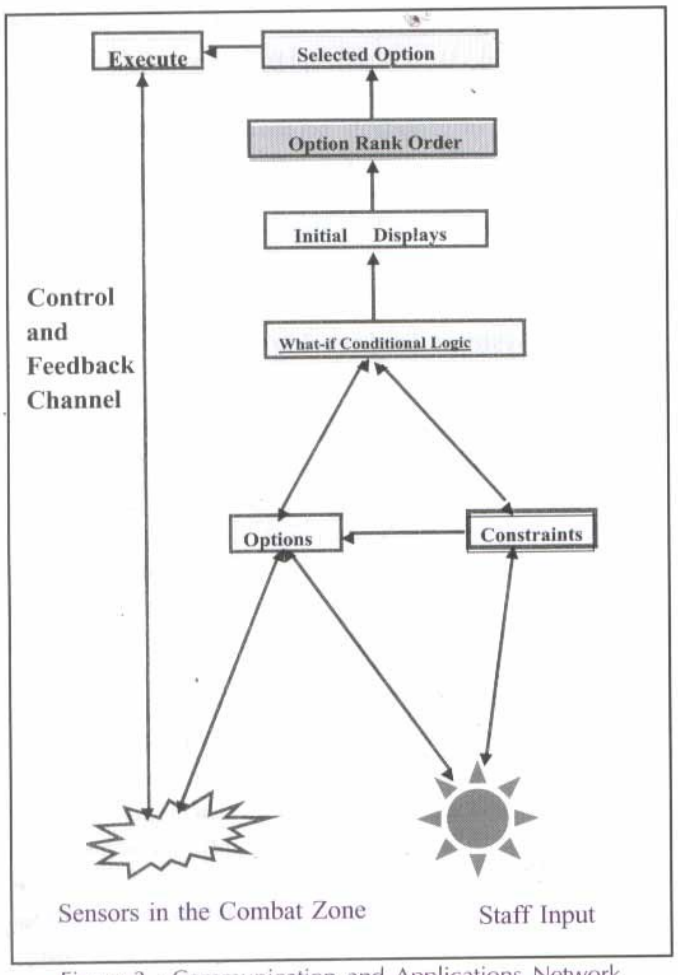

Figure 2 : Communication and Applications Network Cognitive System Engineering

Expert Systems for Command Functions

Expert systems techniques are based on a number of 'if–then' conditional fields stored in the system. The problem solving process goes through the entire range of 'if-then' conditional statements. Each statement is solved or derived by a known expert system. In the command and control application areas the process can be divided into, understanding of sensor reading or data that is processing and fusing raw data into descriptive information. Secondly, situation understanding which entails inferring environmental description from information observable. Lastly, the planning and control functions which involve designing actions to satisfy goals of controlling or affecting the environment. There has been considerable hype in the possibilities of application of expert system in real-life problem solving or decision-making. However, this field of artificial intelligence (AI) has some stringent requirements and issues to be addressed before the system can be made to function in operational environment. The first requirement is to obtain a very sharp focus on the problem domain needs. Before we apply the technical tool, we should be absolutely clear about what we want to achieve. Secondly, AI application is never the best option for all problems. Hence, some very easy or very abstract problems need to be solved by other techniques. In some cases the if- then condition, which the computer has to go through, may run into several volumes to give inconclusive solution. Lastly, the use of expert system technique itself requires considerable amount of expertise.

As we make the user techniques simple and easy, man– machine interface requirement and hence the cost of the system increases manifold. It also needs to be remembered that so far the transition from laboratory expert systems to the operational one is difficult. The major issues governing the fielding of an operational expert system are lack of expert knowledge base, setting up of realistic project goals, identifying the functional environment of the system, functional specification, systems concept and development. The scope and decision of knowledge base for an operational expert system are extremely demanding. A large number of ambiguities and inaccuracies exist in such a knowledge base. These are reflected in the accuracy or validity of the system. Secondly, the project goals are based on a technology push model. The tendency is to set goals as per what the technology has in terms of latest state of art and not as per the operational requirement. In fact, so long the problem solution of the expert system is satisfactory, the type of technology used is of no-big concern. Also too many complicated user interfaces may not be necessary. The functional environment of an operational expert system is entirely different from that of a laboratory prototype. These need to be borne in mind. The specification of the system need to be as per the operational environment and not upon their amenability to AI technology solutions. The system design and development must be based on the systems concepts as against the stand-alone concept.

Data Fusion Technology for Decision Support System

The sequence of decision-making as proposed by Wohl goes through four basic stages. These are stimulus (initial input with associated uncertainties), formation of hypothesis, perception alternatives due to uncertainties in correlated sensor data, options (these are response alternatives pertaining to each hypothesis) and finally the selected response. The final step creates new stimulus transmitted through the feedback channel, which generates new hypothesis and so on. The expert system reasoning functions employ a variety of categories of knowledge to combine multi-sensor data. It uses the structural model, behavioural model, heuristic inference rules or numerical algorithms. The structural model uses the target attributes against the background data of types of target and activities. The behaviour model uses the temporal, spatial and group specific behaviour pattern of the target or the activity. During the heuristic inference rules 'if–then' conditional statements are processed by the computer to arrive at inference templates. These inference

templates are then quantified by using numerical algorithms. The quantification process follows the events with the degree of uncertainties and not the events of chance. Hence, direct application of Bayes' probability function cannot be used. Instead Demster Shafer presentation uses the probability interval to describe sensor data (Fortman, Barshalom and Scheffe, 1980). Based on the DFS and the corresponding DSS two types of decisions are arrived at. Firstly, the hard decision option in which the system generates a definite statement pertaining to the target. In the second case, soft decision statement is generated which includes a presentation of uncertainty. In case of high-risk situation, which generally pertains to combat at fast pace, such as engagement of enemy aircraft, missile, tank and so on, the system must generate hard decision statement. In case of soft decision suitable algorithm need to be used to quantify the degree of uncertainty so that execution can be carried out accordingly. In both the cases, i.e. hard or soft decision statements the techniques of knowledge management will be used to varied degree.

Artificial Intelligence (AI) in Command and Control Functions

The AI based on expert systems are computer-based consultants that provide advice to users in the real world complex problem domains. The expert system is basically a set of rules, known as production rules, or knowledge base which interacts with the users input or queries. The system can be interfaced with any other system or database with the help of an intelligent interface system. In a stand-alone mode, stand-alone expert system (SES) the system functions on its own database whereas in the intelligent expert system (IES) it takes input from other systems databases. Obviously for the military use it is the IES which has vast potential. However, this difference between the two makes the design problem more acute. The design problem fall into three categories, software development, knowledge engineering and user interface development. The problems of software development are in the field of desire of computation speeds, which are required to be extremely high to go through a large number of rules and the choice of processing language. The LISP language presently used for AI purposes is not potent enough to handle complex problem domains. There is a need to switch over to a standard language, which is independent of hardware changes. Ada is one such language. Besides, Ada is also being used for a large number of other projects in the military. The difficulties in the field of knowledge engineering pertain to firstly identifying the human expert who will create the initial production-rules base because the AI system mimics the heuristic used by the human expert in problem solving. Such human experts are not easily available, especially for complex military problems. In certain cases the IES application may be developed for a new system for which there are no human experts. Hence, without human expert to mimic, the system cannot be validated.

Even then the system will be just an aid for the decision-making process. The experience and the judgmental discriminatory powers of the commander will be the most important factors for timely and correct decisions.

Lastly, is the problem of human engineering. The basic snag in this case is the difficulty of justification of the advice or the decision. Firstly, the diverse nature of the community using the system need more elaborate and convincing explanation by the system than what is provided. Most of the users are not familiar with the heuristic used by the expert for embedding the production rules. The expert system based AI is quite suited to problem with no competitive agents. Thus, designing AI systems to command and execute fire support in a tactical situation is much easier than that for supporting a manoeuvre planning. This is due to the fact that decision-making at senior level usually involves a process that calls upon the decision-maker's broad experience and knowledge base. In the case of manoeuvre planning, a particular option itself may be a complete concept of operation that involves many factors, sequence considerations, levels of details etc.

Sensor Integration vs Data Fusion

In multi-sensor data fusion, a combination of inputs from more than one sensor takes place into one or more representational forms. The primary reason for the fusion is to restrict the bandwidth requirements for transmission of the information beyond the fusion node. In case of multi-sensor integration, it is the synergistic use of the information provided by the sensory device to assisting accomplishment of tasks by the system. In multi-sensor integration network, there may be data fusion at one or more nodes of the network. In fact, multi-sensor network will involve activation of a given sensor based on the input received from another sensor, thus facilitating sensor selection as part of the system function. The advantages of fusion and integration pertains to the cost, timeliness, complimentarily and redundancy of the information. The cost factor entails the savings affected by use of sensor network for obtaining a given type and quality of information as compared to that for the same while using single sensor. The factor of timeliness is achieved by the actual speed of operation and parallelism in processing. The factor of complimentarily enables the system to perceive features in the environment, which cannot be perceived using a single sensor.

Neural Networks

These are massively parallel interconnected networks of simple, usually adaptive, elements and their hierarchical

organization, that are intended to interact with the objects of the real world in the same way as the biological systems do (Brassey). Current research in neural networks is providing a common paradigm for the interchange of ideas between neuroscience and robotics. A multi-sensor integrated system designed on the neural network has a capability of learning from the sensor input (failures increase negative stimulus and success positive stimulus). These associated inputs from the environment are dynamically updated as the network learning experience. The neural network based multi-sensor system is able to reconfigure itself adaptively as per the sensor failure. This is exactly the way the neurones of the brain cells function. The multi-sensor integrated neural networks pick up a complete pattern of data as a single input for decision-making. This increases the speed of functioning of the network. However, the network cannot explain its decision, as is the case with the expert system based decision support system (DSS). Hence, the expert system based DSS can be paired with the neural network based multi-sensor integrated network to analyze the decision data. Also it is necessary to recognize the basic difference between the multi-sensor integration in non-military and military environment. In a non-military use the sensor function in a benevolent environment, hence the event recognition even with a single sensor system can be based on a simple probabilistic mathematics of zero sum approach of the game theory (gain of one equal to loss of other hence the sum is zero). This is not the case in a malevolent military environment. The effects of deliberate spoofing by the adversary makes the use of multi-sensor integration or fusion a basic necessity in a military environment. Also in a typical modern military NATO simulation about 25 to 50 decisions by the minute are required to be taken by the system from fifty thousand to hundred thousand reports from 156 separate sensor platforms concerning as many as one thousand targets (Luo). This is particularly applicable for radar systems (say of the AWACS) which track about 400 targets simultaneously in an intense EW environment. In a dynamic system required to support the manoeuvre battle knowledge management systems, which include all the above mentioned techniques will have to be used to cope up with the complexities of the decision-making process. Even then the system will be just an aid for the decision-making process. The experience and the judgmental discriminatory powers of the commander will be the most important factors for timely and correct decisions.

Remote Ground Sensors (RGS) and EW Systems (EWS)

The functioning of various systems in battlefield environment is depicted in Figure 3. In the forward most contact zone, the information is picked up through the attended and unattended remote ground sensors, Electronic Warfare systems. Through the data fusion system the battle input is transmitted to the Command and Control Node. Also the DFS

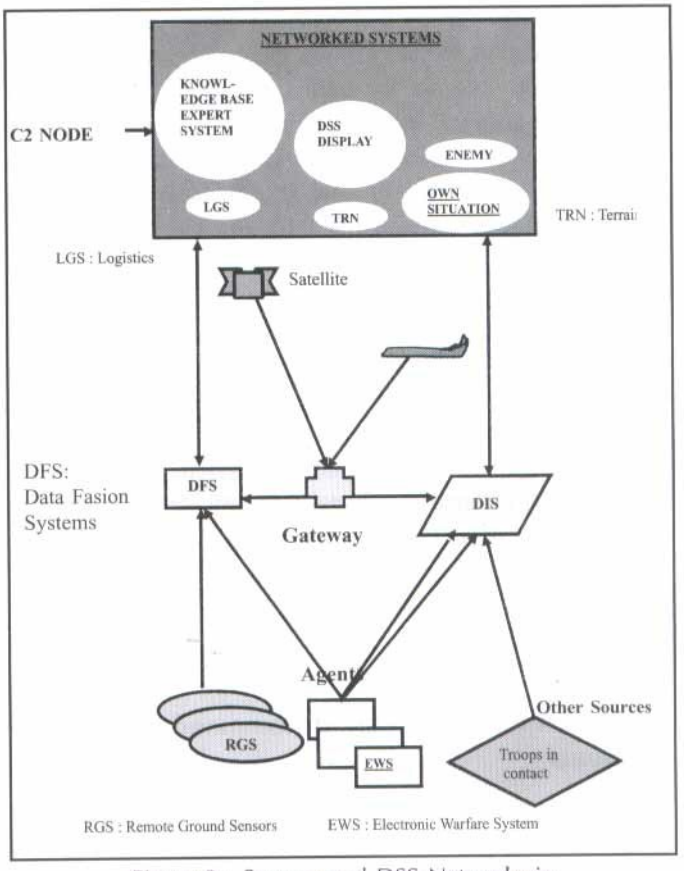

Figure 3 : Sensors and DSS Networks in The Tactical Combat Zone

can access input direct from the tactical or strategic means for action or transmission to the C2 Node. Similarly, the DIS obtains input from the systems as shown. At the C2 node all the techniques of DSS to include the expert system, AI, neural networks can be used to 'use' the input for decision-making. It is here that the Knowledge Management methods will ensure effective utilization of all the means.

IT Support for Training in Command and Control Function of Tactical Planning

The direct use of the DSS software is supported by sensor is for simple tactical problem is quite effective and easy. These problems include the linear sensor and shooter systems or even slightly higher order fire support system for ground, air or naval battle. However, for problems related to decisions in complex manoeuvre or strategic tactical plans at Army group and Corps levels the DSS software are no substitute to the experience and knowledge base of the commanders. However, the planning and decision-making capabilities of commander need to be constantly enhanced and honed. The concept of tactical planning (TACPLAN), and interactive tactical valuation (INTACVAL), IT modules were developed in the US Army war college to achieve the objective of training the Corps Commanders in decision-making (Andriole, Black et al). The modules are based on a dynamic knowledge base supported by a number of graphic, quantitative, qualitative and analytic displays which can be

activated by a keyboard, mouse or joystick. The digitised map displays assist the commanders in deploying the forces. The expert system based knowledge base evaluates the plans and offers advice and suggestions. The knowledge base which includes consultant rules, facts and descriptions, doctrines, terrain parameters and imperatives also lead the commander in understanding the nature of the problem, characteristics of the area, definitive combat power and formulate operational concept of operation and the plan. Based on the plans, policy decisions are issued. The system then generates guidance advice, which can be accepted or rejected.

Software and Hardware Standardization

The operating system and application program object codes of the software are written for a particular hardware. Generally, there is no standardization in writing these object codes. As the hardware is changed, the operating systems also undergo changes. In the commercial market, the sizeable consumer population can always force the manufactures for low-cost conversion cost from one hardware to another. The military consumer does not have this leverage. Also the military users need different types of software. Suitable operating system for military use should address the radar displays, map digitisation displays, weapon and system controller and sensor-input devices. Thus, for military systems standardized software needs to be developed which can be ported in any hardware. Using the Ada language, which is not only independent of hardware but also generates its own code, can do this. With consistent use of this language, engineering approach to software writing can be developed. Also the monumental cost of writing complicated software can be spread over large number of user components and time.

The primary reason for the free availability of funds for the purpose has been the dual nature of the technology being used and participation of the private sector.

Communication and Information Systems

The modern tools of decision-making and generic architecture of military command, control and communication systems have been examined so far. There is a need to have a closer look at the military information systems before attempting a fusion or convergence of these two systems. Communications are the backbone of any combat force so much so that many a time the command and control functions are considered synonym to communication–though these are distinct activities. Communications provide the channels for a number of managerial and command and control activities in general. The convergence of communication with computation or processing, network technologies, multimedia (exploited by entertainment industry in the civilian sphere) has brought in an integrated and interactive systems approach so far as the military information systems are concerned. A detail survey of available literature on military information systems of major military powers has been done to evolve three models – US, NATO and major powers of developing world. Firstly, let us consider the demands on the military communication systems in general. These are listed below:

(a) The system must follow modern network architecture.

(b) Various networks supporting different force structures need to be interoperable.

(c) The capacity of the channels must be adequate to transmit information inputs related to multimedia imageries (for intelligence), command and control data, guidance of weapon systems, detecting tracking and acquiring ground/air /surface targets.

(d) The transmission format and the media used for the purpose must facilitate ease of achieving end to end security. At the same time, the system must ensure integrity and availability of the data.

(e) The channel and packet switches must be fast to maintain a tight decision cycle loop, especially in the sensor to shooter and contact battle environment.

(f) The entire architecture must be reliable (avoid catastrophic failure), secure, flexible, responsive, adequately fast (transmission speeds) and have sufficient capacity.

(g) The changeover from the peace or no- war no- peace environment in Information Operations is likely to be undeclared phenomena. Hence, the peace time and wartime communication systems must have similar capabilities and configurations. The situational awareness of the entire force must be always current and all the participants must have the same common relevant picture so that change over to hostilities is fast enough.

Some important and common features of military communications world over are:

(a) Adoption of systems approach as against individual linkages or even networks.

(b) Fusion of communication and computation into networks. The differentiation between computers and communications has been blurred. Communication has become synonymous to network.

(c) Modern militaries are giving higher priorities to data transmission as against voice.

(d) Growing use of sensor, imageries have placed phenomenal demands on the speeds and capacity of the channel. Hence, the trends towards higher ends of

frequency spectrum, from UHF to SHF, EHF and even millimetres waves and lasers. This in turn has placed additional demands on the circuit elements and directional narrow beam transmission.

(e) As a rule, the transmission rates are far higher than the processing speeds. Besides, the increments in transmission rates too are faster than the processing speeds. The software engineers are finding it difficult to cope up with the communication engineers.

(f) Reducing defence budget and excessive costs of military standard communication equipment have forced the defence planners to opt for commercial off-the-shelf (COTS) equipment.

(g) Besides buying the COTS equipment modern militaries are being supported by large, commercial industries in static as well as mobile communication. The economic infrastructure in general and health of microelectronics, IT industry in particular have become indicators of prowess in communication and information system of the concerned militaries.

Notwithstanding the hype that both China and India have vast resource of skilled IT work force in their respective countries the contribution of this force for developing advanced communication and information systems have not been discernible in the armed forces.

(h) Increased penetration of IT in CIS has not resulted in the reduction of personnel. On the contrary, demand on more skilled and trained personnel has increased.

Distinctive Models of Military Communications Systems

A literature survey of the technologies used for military information systems brings out three distinct models. The most advanced, i.e. US Model of military communications systems and aid to decision-making in the military environment (presumably the Russian systems would be almost similar), the Western European systems (NATO), and the systems being used by the military powers of the developing nations, i.e. China, India and Pakistan.

US Model

The US undoubtedly spends the maximum on the military communications information and decision aid systems among all the developed nations of the world. Moreover, the improvement, modernization programs, which are a constant feature of the US defence policy, keep the US forces many decades ahead of the rivals. Being a democratic country there have been frequent pressure on the DoD to curtail the defence expenditure. This has curtailed the force level and to some extent the force structure but has not affected the communications, information and the decision support systems. The primary reason for the free availability of funds for the purpose has been the dual nature of the technology being used and participation of the private sector. The salient aspects of the US model are:

(a) The systems are extremely robust–even in the event of a full-scale nuclear war minimum required systems will survive since these are nuclear hardened. However, of late the requirement of nuclear hardening is being given a low priority and even done away with to save cost and obtain higher capacities. The present thought process does not perceive any nation daring to pose nuclear challenge to the US.

(b) Involvement of the commercial sector in developing, fielding and to a limited extent operating the military information systems is on the increase. This move itself has resulted in four to five times reductions in cost. At the same time, the efficiency and effectiveness has doubled and in some case quadrupled.

(c) There has been tremendous emphasis on integration and interoperability of systems. This trend has been fallout of the Gulf War. The TriTac essentially ensures design and development of systems which can inter operate across the full spectrum of force hierarchy as well as with the friendly forces of the NATO. Development of JTIDS and MIDS for NATO as well as the US forces ensure integration of ground, air and naval forces. Similarly modifications in the E3C Sentry, JSTARS and E2C Hawkeye are directed at enabling these platforms to support ground, air and surface forces.

(d) The use of higher ends of electromagnetic spectrum has been on the increase. Most notably the frequencies used by the communication satellites have moved into the EHF range from the erstwhile UHF and SHF range. This has facilitated much larger capacities, survivability in the EW environment, reduction in the component and equipment sizes and also technological lead. Use of LASER in the space based systems and millimetre wave for the terrestrial systems also affords similar advantages.

(e) The use of channel bandwidth for data and imagery (multimedia) is on the increase as against voice communications. This not only optimizes the channel utilization but also packs more information content in the communications.

(f) Use of communication networks to provide information about the location of own forces through the EPRLS facilitates instantaneous situational awareness with regard to location of own forces in the combat zone. This is of great importance in mobile warfare.

(g) Expert Systems and Cognitive Engineering based decision support systems are being used at tactical and operational levels. Artificial Intelligence and Neural Networks based systems are not yet introduced in the service except for some limited purpose. Once the last mentioned systems are introduced the accuracy as well as speed of decision-making will be enhanced manifolds.

(h) With the existing set up of military communication and information systems, the change over from the peace time deployment to war or operations other than war will be smooth and rapid. The US Military communications and information systems facilitates a very rapid global projection of sizeable force.

Western Europe (NATO)

The fact that the US and the Western European military communications information systems inter operate and at times complement each other underlines their high technology content and efficacy. In fact, the US as well as a number of other NATO countries are contracting the British Skynet Satellite project. The common features between the US and the other NATO countries military information systems include the emphasis on military communications and information systems as a whole, integration and interoperability, involvement of the commercial sector (this is especially so in the case of UK), ease of smooth change over from peace time to war or operations other than war deployment (both Australia and Germany provide the lead in this respect). The deficiencies when compared to the US systems are as under:

(a) Lack of survivability in a full-scale nuclear war. Since the contingency is highly improbable this may not be a serious handicap.

(b) The multiplicity, extent, capacities of the systems in the case of the Western European Countries are much limited as compared to those of the US.

(c) No substitute of the EPRLS is available with the NATO countries. Hence, they will have to depend on the GPS or get the system from the US. This increases their dependency on the US–a fact not appreciated by the NATO allies. France is planning their own GPS constellation.

(d) As regards the use of decision support systems it can be assumed that similar methods are being used by all the NATO allies since the forces of different countries train together.

The Developing World – China, India and Pakistan

As per the available literature the major military powers of the developing world have shown more involvement in the procurement/development of ordnance as against the communications and information systems. One of the reasons for this comparative neglect can be the existing major deficiencies in the quantity and quality of the ordnance available with these countries. Another reason being the relative lack of quality hardware and software for the advanced communication and information systems. Notwithstanding the hype that both China and India have vast resource of skilled IT work force in their respective countries the contribution of this force for developing advanced communication and information systems have not been discernible in the armed forces. In spite of major investments in optical fibre cable routes, communication satellites and to some extent the EW systems the glaring deficiencies in the CIS of these countries are as under:

The educational background, penetration of IT in the organisation, the extent of organisational knowledge base, the capacity of the force for quick and smooth change and a host of socio-economic aspect would dictate the ease with which the given armed forces can use the automated tools of decision-making.

(a) Lack of requisite integration and inter operability of systems. The lessons of the Gulf war have not yet been incorporated in their militaries.

(b) Poor communication support to the functional elements of the armed forces.

(c) Inadequate use of high-grade software in the CIS.

(d) Grossly inadequate capacities of the communication channels especially of the satellite and space wave communication systems.

(e) Excessive dependence on voice communications compared to data. Hence sub optimal use of the limited channel capacities.

(f) Lack of requisite knowledge base and skills to use the high tech CIS.

(g) The CIS of the developing countries do not have the survivability in a nuclear exchange.

(h) Most of the EW systems of these countries are of foreign origin which have their own vulnerabilities to the hostile IW environment.

(j) The involvement of private sector in the military CIS in both India and Pakistan is minimal. China has taken the lead in this respect but the results so far have not been very impressive.

Convergence of Decision-Making Tools and Military Information Systems

The discussions above bring out the inevitable necessity of incorporating the modern IT based decision-making tools for solving military problems. Another aspect, which stands out,

is the close linkage between the decision-making tools and the military information systems being used by the modern armies. In fact, the boundaries between the two are superficial. Both the systems converge into a system of system approach. Let us first have a look at the decision-making tools and their applicability to the third world armies. The use of these techniques to a very large extent depends on the human resource at all the levels of military hierarchies. The educational background, penetration of IT in the organization, the extent of organizational knowledge base, the capacity of the force for quick and smooth change and a host of socio-economic aspect would dictate the ease with which the given armed forces can use the automated tools of decision-making. Besides the techniques have to be used in a given combat environment, which for the third world armies are quite different from their first world counter part. Nevertheless a recommended road map for the third world armed forces to induct the IT enabled decision support systems so as to shorten the decision cycles in any given combat situation would involve the following:

(a) Since the third world armed forces are not wired to the extent their first world counter parts are emphasis has to be laid on training the leadership to use a mix of experience based, manual, and quantitative decision making processes. It must be remembered that in very near future automated decision-making tools will be available. These will have to be exploited.

(b) The strategic and operational level leadership must be trained in quantitative and IT based decision making processes in a network environment considering the wide spectrum and large number of parameters involved.

(c) Though the IT based decision-making tools may not be very realistic considering the fluid battlefield conditions, these do help as guidelines as well as remove personal bias. Hence, these tools must be used at least the staff must use these tools to help the commanders in arriving at the correct decisions.

The capital and human resource investment incurred by the US in military CIS are beyond the economic means of even the other developed countries of NATO. Hence, it is very much beyond the developing nations to plan for that order of investment in the military CIS. However, the central importance of CIS in the IW environment cannot be ignored even by the developing countries. The recommended course for modernization of military CIS for the developing countries is as under:

(a) Since the CIS is an ideal example of dual use technology for military as well as civilian purpose, the field should be open to the private sector to the maximum possible extent. This would ensure that cost of fielding the systems is reduced manifolds where as the efficacy of the systems is multiplied. This has been the experience of US as well as UK.

(b) Greater reliance on data communications as against voice would enhance the effectiveness of channel utilization at no additional cost.

(c) Integration and inter operability are key factors in the military CIS. These factors cannot be ignored by even the developing countries. It is important to note that both these factors are function of co-ordination and a co-operative environment. Their implementation does not require major investment of capital. The military CIS must adopt a network configuration. Bigger the network better would be the capability to handle and process information. However, the security requirements will be more demanding in a bigger network as compared to a smaller network.

(d) Nuclear hardening of CIS systems has not been found to be cost effective. Neither is the threat realistic. However, hardening of CIS equipment against non-nuclear Electro Magnetic Pulse (EMP) is more important. Since the electrical flux generated by a non-nuclear EMP is much less than the nuclear EMP, the hardening of the equipment can be achieved at much lower cost.

(e) Integration of the GPS technology in the CIS would pay rich dividends at marginal cost. Situational awareness is a key factor in the IW environment. If a commander knows the location of his troops in the battlefield instantaneously as soon as they establish communication his situational awareness would be faster and accurate. A system like the EPRLS (of the US) can even help the subordinate commanders to achieve the same level of situational awareness.

(f) A CIS, which is in constant use, is also the one, which continuously updated. Besides, the users become adept at exploiting the full potential of the system. Generally, the military CIS has two distinct architecture, equipment profile and scales, one for the peace time use and the other for military operations. This brings in the time lag in change over from peacetime deployment environment to active operational environment. Some differences in the two set ups are likely to remain. However, lesser the gap between the two easier and faster will be the change over. The German Heros 1 and 2 and the Australian DISCON systems are good examples of minimal differences in the peace and war time military CIS.

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Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Decision Flexibility"* on the following points:
   - Flexibility in terms of ***"options"***
   - Flexibility in terms of ***"change mechanisms"***
   - Flexbility in terms of ***"freedom of choice"*** to participating actors.
2. Identify and describe the types of flexibilities that are relevant for your own organizational decision flexibility? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational system on following continua (Please tick mark in the appropriate box(es)).

Decision cycles

Short ☐☐☐☐☐ Long

Decision Processes

Centralized ☐☐☐☐☐ Decentralized

Role of ICT in Decision Making

Marginal ☐☐☐☐☐ Critical

Security in your Information Systems

Low ☐☐☐☐☐ High

Overall Quality of Decisions

Low ☐☐☐☐☐ High

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Desion Flexibility"* relevant to your organization.

Reflecting Applicability in Real Life

1. Evalvate the overall quality of decisions and decision-making processes to identify key areas of improvement.
2. Review the investments in information and communication technologies in your organization and their impact on decision-making.

Conference Announcement

ISSS 2003 CONFERENCE

Theme:

CONSCIOUS EVOLUTION OF HUMANITY: USING SYSTEMS THINKING TO CONSTRUCT THE AGORAS OF THE GLOBAL VILLAGE

The conference theme has been chosen to focus attention on: (a) the challenge phasing humanity in transforming from "evolutionary consciousness" to "conscious evolution," and (b) the role systems thinking must play in constructing the 21st Century Agoras in the context of the phenomenon of globalization.

Globalization is being described by many as an emerging new system of world order, following the end of the Cold War order in 1989. Systems thinking must rise to the challenge of engaging human beings in a boundary-spanning dialogue across disciplines and civilizations in order to guide the conscious evolution of this new world order.

Dialogue is essential for understanding cultures and subcultures in the emerging global village. Thus, the ability to engage in dialogue becomes one of the most fundamental and most needed human capabilities. Dialogue becomes a central component of any model of conscious evolution. Dialogue was practiced very effectively in the Agoras of Ancient Greece, such as the Athenian Agora. The Agoras were public spaces for people to congregate and deliberate on their issues. If we want to democratize the emerging global village, we must provide people with the opportunity to engage in meaningful dialogue in the Agoras of the 21st Century.

The ISSS (www.ISSS.org) has long advocated "transdisciplinarity." This was indeed the common feature of the four aims of the Society for General System Research (the forerunner of ISSS) as stated by its founders in 1954. Concepts, laws and models developed in particular fields were to be investigated to see if they could be properly transferred to emerging phenomena which were less well conceptualized. The challenges of the 21st Century, associated with conscious evolution and globalization, demand the identification and general transmission of such concepts, laws and models in whatever field they were originally developed in order to enhance humanity's capacity to design the 21st Century Agoras. Systems thinking remains the best hope for this to be achieved.

Conference Objectives:

1) To work towards making ISSS a living model of a Society capable of appreciating and practicing "conscious evolution;"
2) To explore and identify the role of systems thinking in the context of the emerging phenomenon of globalization;
3) To identify action steps in the pathway of constructing the agoras of the global village;
4) To enhance the praxis of boundary-spanning dialogue across disciplines and civilizations.

Conference Location : Iraklion, Crete, Greece.

Conference Dates : July 7-11, 2003.

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Short Communication

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Cybernetics of Development

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The Problem

Development has multiple dimensions

Development is now the concern of almost every nation and society. But managers of societal systems are continuously taken by surprise by the turn of events at various levels: Recessions in economies, ethnic upheavals, near- hijacking of global assets by few powerful individuals, growing fear of loss of standard of living for some wealthy nations, possible increase in the poverty levels of some nations etc.

Can we consciously intervene in this change process and determine the course of events in the direction of what we call development?

What is Development

Development, according to Websters Dictionary, means many things. Among them three of the definitions are relevant to social development. They are:

Development can mean a process of natural growth

to move from original position (as in chess) to one providing more opportunity for effective movement; to cause to grow and differentiate along lines natural to its kind; to go through a process of natural growth, differentiation or evolution by successive changes

The problem of development is, therefore, to understand the original configuration and context of a system, to identify thereon the lines of natural growth, differentiation and evolution and finally to delineate the process of successive changes in the movement towards a natural or preferred destination.

Soceital System in Focus

Purusharthas provide a most comprehensive statement of individual needs

Human society operates in a broad four dimensional space, described by {economy x technology x science x society}. Among these, economy changes at great speed, while society changes slowly. We refer to the present day society as technology-driven economic system. And so, as a society it is almost dragged along with slow changing social parameters. Latter are governed by individual and group behaviors. But, at the root of the group behavior is individual behavior governed by some basic urges, needs and purposes. One of the most comprehensive statements of individual needs is the four Purusharthas of Indian social philosophy (Maslow's hierarchy essentially talks of achievement hierarchy). These integrate the (technology x economy) duo also into the individual behavior. So, one can try to understand the lines of development movement by an analysis of purusharthas.

Four Purusharthas

Four key purusharthas are: Dharma, Artha, Kama, Moksha

Individual has four important concerns in life: *Dharma, Artha, Kama, Moksha.*

Dharma: Social and moral code that binds society together.

Artha: Material concerns like money and other physical needs.

Kama: Emotive needs like sex, art, music, culture, ambitions, affections etc.

(*Artha* and *Kama:* These involve technology and economy in a big way)

Moksha: Liberation from limits of established truth and exceeding it into a mystic level.

Broadly, the components of each of the above can be stated as follows:

Dharma

i) Social laws and ethics for control and regulation of group behavior

ii) Code of ethics controlling and regulating individual behavior in harmony with social good.

Artha

i) Individual material needs like money, food, clothing, shelter etc.

ii) Social wealth to supply community needs: like GNP, PCI, QLI, Productivity technology, level of self steering ability.

Kama

Emotive life, culture,art, literature,sex, institutions like family.

Moksha

Liberation from the limits of discovered truth and catering to mystic needs. Level of scientific inquiry, fundamental science, philosophical debate, ritual practices to commune with the mystic etc.

Purusharthas can be grouped into meaningtul expressions of scientific laws and traditions

The above components can be grouped into meaningful expressions of scientific laws and traditions.

Viability tradition: Social resilience, (i.e.) ability to tolerate and endure social shocks and bouncing back capability.

(Cybernetic) Law of requisite variety:

Quality of governance (reflects the control and regulating apparatus ethical practices)

Law of requisite hierarchy:

Productivity: (Reflects the productive forces)
Self steering ability (ability to steer itself in a given direction)

Equity: (Indicator of economic and social justice)
GNP, PCI, QLI (reflects money matters etc.)

Cultural Tradition:

Philosophical debate (reflects education, research, media, academia etc and ethics.)

The above can be taken as the measures of development. While designing a plan for development, these must be borne in mind as the lines along which development should take place.

Description of Society as a System

Cybernetics provide tools to address complex problems of development

A society is a large complex system structured through people and technology structures devised by them and organized through various relational subsystems like legislative laws, economic relations and spiritual motivations. So, the organization of a society is a set of relations between the constituent people and their mutual concerns. Scoiety can, therefore, be described–mostly qualitatively–through the theory of relations and broadly by the mathematics of complexity. Cybernetics is an important part of this armory. It contains theory of relations and science of change. Mathematics of complexity basically deals with study of substance and form, that is mathematics of relationships and patterns. It is the most appropriate tool of systems thinking/ approach, in which there is a shift of emphasis from objects to relationships and from quantity to quality. Mathematically the shift is from linear to relentlessly non-linear behavior, from order to disorder from stability to instability and from equilibrium to non- equilibrium conditions. Philosophically this implies a shift from 'being to becoming'. Feedback is an important feature of the behavior of systems.

Large complex systems display many new behaviors during their existence in time: self organization, self similarity, order through chaos etc. Mathematics of complexity attempts to deal with these aspects. We know that present day societies are complex. This aspect cannot be

ignored in designing our development scenarios. To elaborate on the natural behavior of a complex system some of the characteristics can be cited here.

1. Self organizing behavior implies:
   a) Spontaneous emergence of new structures.
   b) Systems are open and are far equilibrium.
   c) Presence of multiple feedback loops driving change.
2. Self-similarity Characteristic implies that every part of the system looks like the whole.
3. Order-through-chaos implies that seemingly random behavior leads to orderly patterns through a process of bifurcations, symmetry breaks and a series of dissipative structures.

Some key characteristics of Dissipative structures:

- Sensitivity to small changes in the environment
- Relevance of previous history at critical points
- Uncertainty and unpredictability of the future
- Display a mix of chance and determinism in the behavior
- They are the basic structures of all living systems including human beings
- Display points of instability at which new structures and forms of order can emerge

In fact the present 'so called' war on terrorism is such a critical point in the global system.

We shall try to understand the present context applying the above system concepts.

Present Contexts

Recent events such as Sept. 11, has all the necessary features of 'Chaos'

September 11, 2001 incidents seem to have had a striking effect on the world scenario. What happened in New York has created ripples all over the world, in various governments and religious groups. This is like a long range correlation. Nobody knew what was happening and whole scenario became chaotic. Friends became foes and vise versa. A volatile coalition of governments was formed against a faceless enemy. A terrorist attack was interpreted as war by Islamic groups against anti Islamic groups. Thus this has all the necessary features of "chaos". It is possible to represent this as a sequence of bifurcations and symmetry breaks, with some parameter relating two successive social states described by a function of societal values.

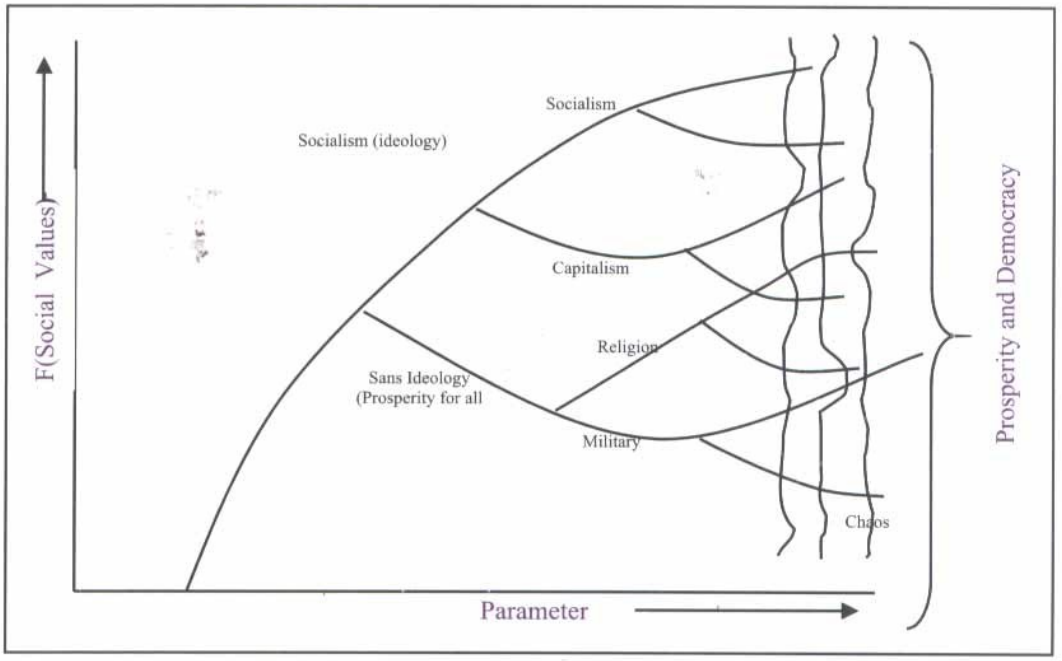

Figure 1 : A Qualitative 'Chaos' Representation Present Scenario

One does not know where this will stabilize. But one thing is clear that extraneous values, like fundamentalism in anything will vanish from the world scene. The second feature of the present situation is globalization in trade, in political dealings and in cultural impacts. Conflicts between the "so called" three worlds, first, second and third worlds–developing and developed, and various other amorphous regional groupings based on trade security and geo politics – are coming to the surface. Where will development lead this scenario of the present? And how does one plan for any preferred scenario?

Growth Lines

One-sided emphasis on development measures such as consumerism-led quality of life has many ills.

If development measures are those described earlier, we should look for their change over the years. We have been generally planning for the quality of life (QLI) parameter. American consumerism has laid too much emphasis on this. Others are following this since it is the most tangible one and requires least persuasion to make individuals work for increasing their monetary riches. But such a one-sided emphasis leaves many holes in the social fabric. A comprehensive plan alone will ensure a stable, safe and equitable society.

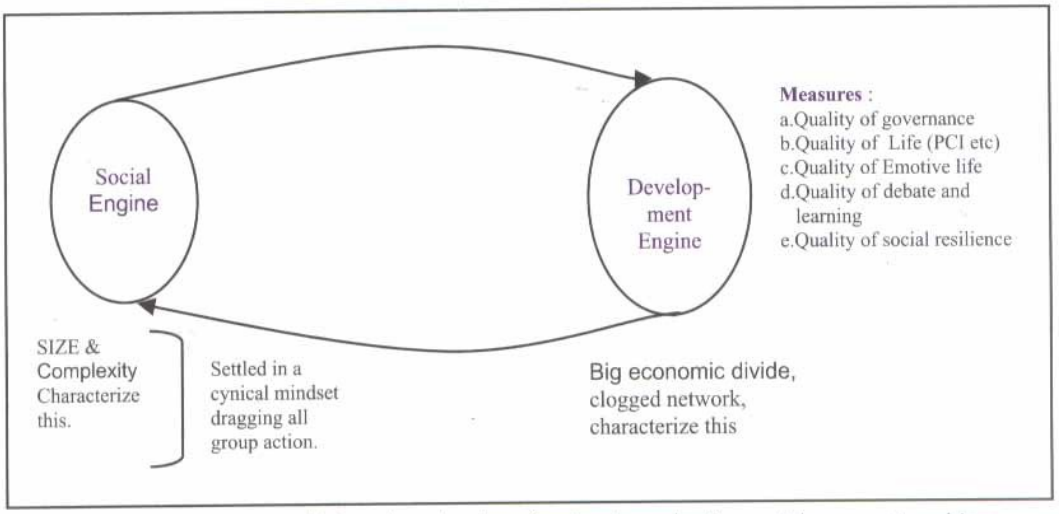

Figure 2 : One engine driving the other in a feedback mode. It may take years to achieve perfect rhythm. Challenge is to achieve this with right communication networks.

Society need to be well rounded

A well rounded society alone can provide a social machine that can drive a homogenous development machine.

Configuration of the Present Social Machine

This elaborate configuration has to operate within a globalised economy. Globalisation is a phenomenon of the present information age. This cannot be avoided by any government or group or society. The effect of it however can be regulated or contained within the powers, capabilities and demands of ideological moorings. This can be broadly portrayed by the accepted nebulous formations and influences shown in the Figure 3.

First world, second world, third world (Now second world) is not existing.

First world leader is like an emperor. His nation or state is 04 dominant. Its interests of others.

Social Machine and Development

The societal system described above can be called the social machine which is the one that drives the development engine characterized by the five development measures. The attempt of the social machine should be to change these measures in a direction that will mean an integrated prosperous life (Samyak jeevatham). The configuration of this is shown in Fig. 4.

Quality of governance is very poor.

If one studies the measures as of today, the most important one, the quality of governance is highly fragmented, weak and poor. It has only the ability to maintain the status quo with

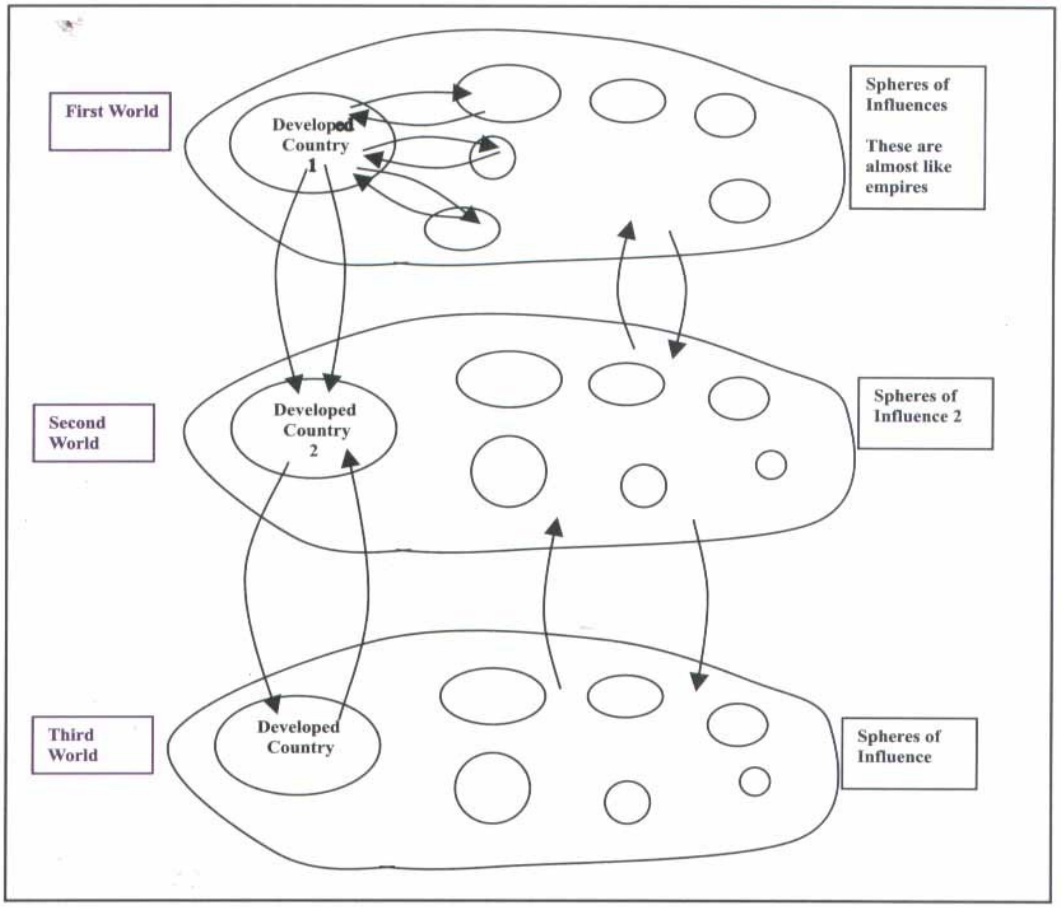

Figure 3 : Spheres of influences: Several spheres of influence and groups
Economic grouping : G7 G44, WTO etc. ASEAN developing and developed ASEAN capitalist, socialist . Political groupings. Military groups: now not so much of importance. Former colonies groups: common wealth.

difficulty. It is not strong either to take the society in the development direction or to withstand the pressures of peoples' ambitions. The lower end of the state machinery is highly addicted to devious ways of making money from every situation. Exploitation of every loophole in a rule and opportunity for their personal advantage has become a norm of an efficient bureaucrat. The legislative bodies have not yet learnt to discharge their functions for the benefit of ensuring proper governance and promotion of social good. They have become battle grounds for personal and party survival. Judiciary too has not acquitted itself with any glory with a laissez fair dispensation mode of justice. The millions of unresolved disputes in courts of various kinds are a pointer to this state of affairs. Even writ petitions take too long to defeating the very purpose of such a legal instrument. With all this, a reasonable semblance of democratic behavior and governance is being maintained since independence. This itself is a creditable thing.

There is urgent need to reform and revolutionize the machinery for policy making and implementation

So the first priority of the social machine is to drive this measure to a proper level. This implies that the available machinery for policy making and implementation of accepted policies should be reformed and revolutionized to support the proper running of the development engine.

The lower end of society should receive right kind of attention

The next measure is quality of life as measured by PCI, GDP Growth etc. In some sense these are improving but not at the pace required for the real big take off. As the cybernetics of economy diagram indicates, the divide between macro and micro levels is so great now, that the lower end, which is suffering from quality of governance in a big way, is dragging the over all growth rate. This end should receive the right kind of attention for the overall measure to touch the critical threshold value and take off in an accelerated way. Broadly the govt. should act as a facilitator for the change of the macro end and the macro economic groups must help the government to play that role. On the other hand government should act as a change agent

for the micro-group and actively promote the entrepreneurial behavior at this end. These are two distinctive roles. Our planning and implementation strategies should reflect this.

Innovate to improve the quality of emotive life

The third measure, the quality of emotive life, is heavily dependant on the culture and tradition of the society. At present, most of our literature art, philosophy and music are highly imitative of the momentarily successful West. Those who want to preserve tradition are adopting a fundamentalist stance, while those who want to move with the times are mostly imitating without any innovation. They are unable to stand on the base and shoulders of the rich and the powerful culture and tradition of our society.

Quality of debate and learning is very low, partly due to media that has become ad-marts

The fourth measure, quality of debate and learning, is at appalling low level. Except in some specified areas of science and engineering, there is not much of science or engineering that is original. Media in most of the countries is biased. There is not much to recommend the media even in developed countries like US, even though considerable amount of printing takes place . Most of the newspapers and TV media are ad- marts. Most of the literature can be called as books of the hour. The cause for this may be the culture of consumerism, which leaves little time for any serious reading or thinking. So packaging of news and entertainment has become the norm of all media presentations.

The fifth parameter quality of social resilience is an interesting measure. This explains to a certain extent the difference between the most developed, developed, the best developing and the least developing nations. The most developed countries, like US, Sweden and some a small number of nations, have been setting their own norms of social behavior conducive to individual initiatives and definitions of prosperity. For US it meant a democratic consumerism. For Sweden it meant massive social welfare and allowing even hedonistic behavior. For countries like UK, France and Europe with more history and tradition, the norms of behavior and definitions of wealth were based on the renaissance tradition and colonial hangovers. For Greece, Italy and Spain their long history and Mediterranean neighbors influenced their growth patterns. For countries like India tradition and colonial rule were heavy-loading factors on the way for development. China and Russia got into an ideological experiment to get over their traditional moorings in defining their movements towards development. Even so, tradition was a heavy base which they could not shake off. Both have got back to their original path.

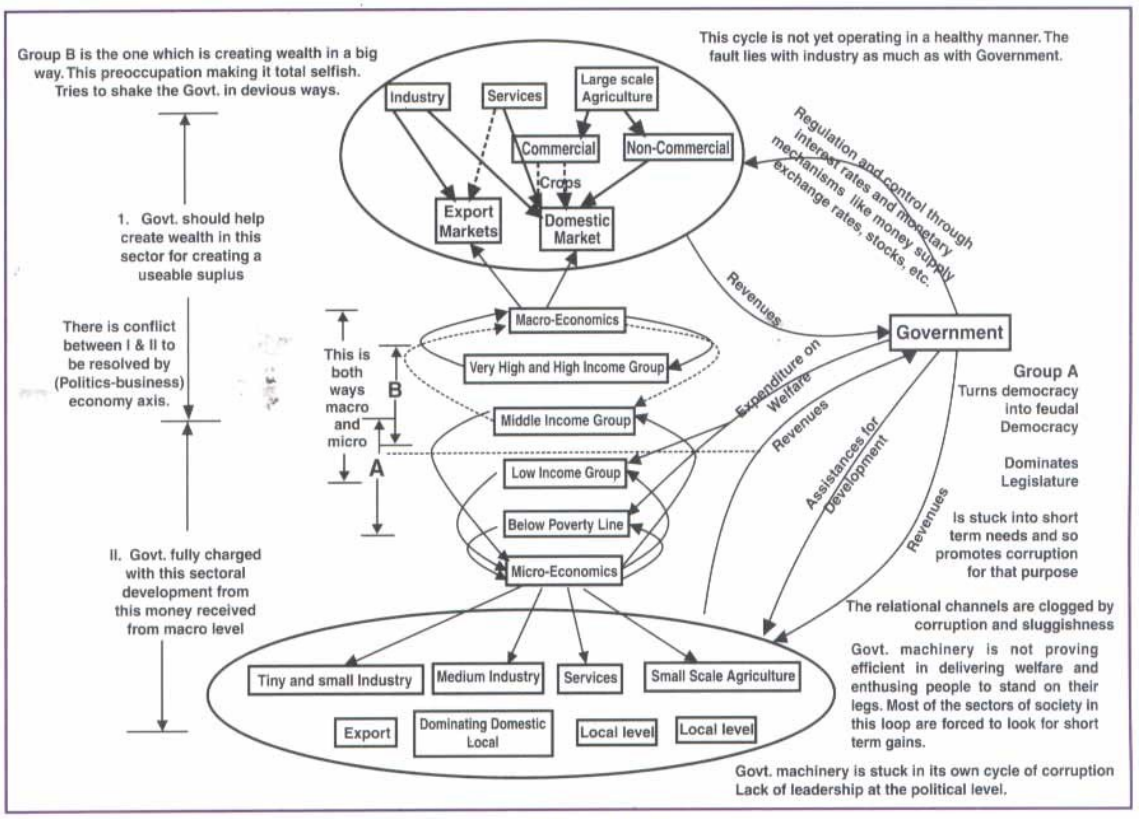

Figure 4 : Cyberneties of Social Machine

Conclusion

ath to development requires deep understanding

is possible to ride the twists and turns on road to development through levotion and Commitment

These are the twists and turns and linkages on the road to development of the complex social systems of the present. If these are ignored, what is natural will be sidelined. It will return again and again to influence the movement. To understand all these aspects of development configuration and planning inclusively is not easy. But without a comprehensive understanding of these issues, the path to development will become rough and rugged. However, one thing can be said: if the planners and implementers work with a conscious commitment to ride on these rough roads with a sense of devotion to public good, the twists and turns and pits can be managed as we do now on our roads. In a developing country one has to give more than what he receives – a kind of partial *Niskama Karma.*

Reflecting Applicability in Real Life

- Review the engine driving development and identify changes required for balanced development.
- Suggest way to enhance quality of debate and learning in an era when mechanisms (e.g. Media, ad-marts) are biased.

About GIFT

GIFT (Global Institute of Flexible Systems Management) is a professional society to enhance *"flexibility"* in business and management.

Mission

To evolve and enrich the flexible systems management paradigm for the new millennium.

Vision

Evolving as a global forum for interaction of all interested professionals and organisations in a truly flexible mode so as to help them create more options, faster change mechanisms and greater freedom of choice in their own settings.

Schools

The Institute comprises of various schools, which are autonomous bodies, dealing with contemporary areas at the cutting edge contributing to the flexible systems management paradigm. At any point of time, each member can opt for an association with any two of the following schools in the respective thrust areas:

* GIFT School of Global Management
* GIFT School of Technology and Innovation Management
* GIFT School of Information Technology & Knowledge Management
* GIFT School of E-Governance
* GIFT School of Learning Organisation and Strategic Transformation
* GIFT School of Quality, Productivity and Wastivity Management
* GIFT School of Environment Management and sustainable Development
* GIFT School of Human Values and Management Ethos

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- Book Series on Flexible Systems Management
- Quarterly Journal - *"Global Journal of Flexible Systems Management"* giftjourn@l
- Newsletter - "Flexibility"

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The membership fees for different types of members, unless changed/revised by the Governing Council from time to time, will be as given under:

	With in India	Overseas
Student (Annual)	**Rs. 500.00**	**US$ 25.00**
Annual	**Rs. 1,000.00**	**US$ 50.00**
Life	**Rs. 10,000.00**	**US$ 500.00**
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