Relating flexibility of information systems to different planning process styles, information systems architecture and strategy of the organization

Somen Dey
Department of Industrial and Management Engineering
Indian Institute of Technology Kanpur,
Kanpur, India
somen@iitk.ac.in

R.R.K. Sharma
Department of Industrial and Management Engineering
Indian Institute of Technology Kanpur,
Kanpur, India
rrks@iitk.ac.in

Abstract

Information systems (IS) are one of the most important parts of manufacturing and service organizations infrastructure. To maintain the competitive edge in the current scenario of uncertain and dynamic environments, it is essential to implement flexible IS within the organization to become responsive. They must be implemented in an appropriate way to support function and enable necessary processes and allow value creation. The different IS architectures must suit and support the strategic decision making styles of the organizations. In this paper we develop different propositions relating flexibility of IS to different cognitive process planning styles (i.e. bold, incremental or rational) considering the elements of environmental uncertainty, different IS architectures and strategy of the organizations.

Keywords
Information systems (IS), IS architectures, Service-oriented architecture (SOA), Object-oriented architecture (OOA), Process planning styles

1. Introduction

Information systems (IS) forms the nucleus of any organization. It is used for storage and retrieval of the valuable data pertaining to the different operations/activities of organizations. Information needs should be effectively fulfilled by the IS as demanded by all partners of a supply chain at the correct time when needed, for proper coordination, integration and becoming responsive to the changing environment. Flexibility of IS is of prime concern which should match with the process planning styles adopted for taking strategic decisions in an organization. This papers presents a comprehensive literature review on process planning styles (i.e. bold, incremental or rational) and IS flexibility and presents theoretical research propositions on how different cognitive styles of process planning influences IS flexibility. The two different IS architectures i.e. service-oriented architecture (SOA) and object-oriented architecture (OOA) has been discussed and propositions are formulated to investigate the flexibility aspects in both types. Finally a comprehensive literature review on organizational strategy has been drawn and propositions are made relating organizational strategy and IS architecture.

2. Literature Review
2.1 Literature Review on Cognitive Styles of Process Planning

Process planning involves decision making by organizations or individuals, which is basically influenced by the cognitive styles deeply rooted within the culture of organizations or individuals. A cognitive style is a psychological dimension that represents consistencies in how someone acquires and processes information (Ausburn and Ausburn, 1978; Messick, 1984). A lot of theory regarding the decision making styles is available in the existing literature. Mckenney and Keen (1974) recognized styles pertaining to the dimensions of information gathering and information evaluation. The information gathering dimension differentiates receptive, data sensitive or analytic individuals from perceptive, data filtering or intuitive individuals. The information evaluation dimension differentiates systematic or analytic or structured decision makers from holistic trial and error or intuitive individuals. By combining all these, the authors proposed four cognitive styles of decision making namely systematic-perceptives, systematic-receptives, intuitive-perceptives and intuitive-receptives. Bass' (1983) work on organizational decision making treats individuals as "constraints" on this phenomena and emphasized on the role of personality, competence and styles in making choices and doing things. A comprehensive framework on decision making styles was given by Mitroff (1983) and Haley and Stumpff (1989). Both these work were based on Jungian classification of cognitive personality types (1923). The Jung's model suggested that people acquire information using two types of perception models i.e. sensing (S) and intuition (N) whereas they process information in two modes, i.e. thinking (T) and feeling (F). The sensation-oriented information acquirer prefers structured problems which involve routine and detail. These people look for specific data and see themselves as realists concerned with immediate problems. The intuitive oriented prefers unstructured problems, seeks holistic information that describes possibilities and use more general data. The thinking oriented people stress on logic and formal methods of reasoning whereas feeling dominated people individuate and emphasize effective personal decision making. Jung combined all these and defined four personality types i.e. sensation-thinking (ST), intuition-thinking (NT), sensation-feeling (ST) and intuition-feeling (NF). Behling, Gifford and Tolliver (1980) found intuitives to be more risk prone than sensors in a betting situation. Henderson and Nutt (1980) found that sensation-thinking (ST) styles were associated with a greater degree of risk aversion than sensation-feeling (SF) styles. Hunt et al. (1989) examined the relationship between decision maker's characteristics i.e. cognitive style and decision processes and strategies. Their research concentrated on sharply contrasting "Analytics" and "Intuitives". Analytics are people who gather detail information whereas Intuitives focus on patterns. While evaluating information, analytics define quality of solution in terms of the method whereas intuitives defend a solution in terms of fit. Sharma et al. (2001) related the decision making styles or personality traits given by Jung to the strategy making process (SMP) and environmental uncertainty. The authors selected three major styles of SMPs i.e. rational, interaction or incremental and bold or assertive based on their review of existing literature. Rational decisions are taken through careful analysis of problems and opportunities, scanning of markets, methodical planning based on past information to support the decisions. Incremental decisions are based on taking small steps for planning a part of a large problem and then taking successive incremental planning and decision making steps as decision maker penetrates further deep into the problem. The bold style of decision making is characterized by taking uncertain, strong and bold steps altogether by decision maker based on his intuitions. The uncertain conditions prevailing in the environment sometimes makes it necessary for individuals/organization to take a bold approach in process planning. Agarwal and Wooley (2013) studied the effects of member's cognitive styles on team processes and errors in task execution. The authors highlighted two prominent styles common among individuals i.e. object visualization and spatial visualization. Object visualizers process information holistically and globally while spatial visualizers process information analytically using a modular approach i.e. part by part. The study showed that teams consisting of individuals with high spatial visualization were more process focused or process oriented than teams with object visualization.

2.2 Literature Review on Information Systems (IS) flexibility

Information systems (IS) departments are the backbone of any organizational structure and constantly reflects the volatile and strategic business requirements of an organization. Most of the past studies and research on IS flexibility mainly focused on two concepts i.e. IS infrastructure or information technology (IT) flexibility (Duncan, 1995; Prahalad and Krishnan, 2002; Sambaimurthy et al. 2003) and IS capability to respond or match to changing market and business environments, organizational needs and enhancing the change capability of organizations, bringing them more closer to customers (Mensah, 1989; Levy and Powell, 1998; Ives and Mason, 1990; Robey and Boudreau, 1996; Kanellis et al. 1999; Duclos et al. 2003; Palaisamy and Sushil, 2003). Duncan (1995) proposed three components of IT infrastructure flexibility i.e. technological components, flexibility characteristics and indicators. The technological components consists of platform technology, network and telecommunication technologies and core data processing applications. The indicators provides a measure of individual component's flexibility namely component

characteristics, resource management practice and IT capabilities. Flexibility characteristics were measured by compatibility, connectivity and modularity. Byrd and Turner (2000) gives an additional component of human IT infrastructure to measure IT flexibility. Duclos et al. (2003) defines IS flexibility as "the ability to align information systems architectures and systems with the changing needs of the organization as it responds to customer demands". Ramaraj (2010) developed four conceptual models depicting the relationships between IS flexibility and IS requirements, users and environment. Gunasekaran and Ngai (2004) gave a framework for the development of IS/IT for an effective, flexible and agile supply chain management (SCM). They identified six major issues in the framework i.e. strategic planning of IT in SCM, implementation of IT, knowledge and IT management, infrastructure, e-commerce, virtual enterprise. Strategic planning of IT adoption in SCM is generally done by top management keeping in view with the long term business plan, global competitiveness, agility, cost, outsourcing, strategic partnerships i.e. mergers and acquisitions. Implementation of IT demands support from top management, cross functional teams with IT skills and deployment of business process reengineering (BPR) and quality function deployment (QFD) tools. Knowledge and IT management provides a backbone for application of IT in SCM. This involves imparting IT training and education, core competency training, cross functional training, job rotation, empowerment, rewards and incentives, empowerment and investment in knowledge capital, e-learning and e-training. Infrastructure such as internet connectivity, enterprise resource planning (ERP), software and hardware availability plays a significant role. Palanisamy and Foshay (2013) studied the impact of user's internal flexibility, participation and usage on IS flexibility. Their research model demonstrated that personal characteristics of IS users play a significant role in influencing IS planning, development and overall flexibility.

2.3 Literature Review on Environmental Uncertainty

The environmental dynamism and uncertainty primarily governs the decision making approaches and strategy of individuals or organizations. In this context it is important to study the essential dimensions of environmental uncertainty. Environmental uncertainty can be studied with respect to the following three basic dimensions as evident from the existing literature i.e. dynamism, heterogeneity and hostility (Duncan, 1972; Choe, 2003; Miller and Friesen, 1980, 1982, 1983; Teo and King, 1997; Dess and Beard, 1984). Dynamism can attributed in terms of changeability (of products, services or technology) and unpredictability (of competitors actions and demand fluctuations). Heterogeneity represents the diversity of external factors present in the environment such as diversity in customers purchasing habits, in the nature of competitions and in nature of product lines. Hostility can be assessed in terms of scarcity of required resources and competition in the external environment. Past researches have generally defined hostility in terms of threats posed by labor scarcity, price competition, product quality competition and product differentiation (Newkrik and Lederer, 2006).

2.4 Literature Review on IS Architectures

The major challenge for organizations in the current scenario is the need for integration of information systems. Today enterprises heavily depend on the IS which are responsible for running all business processes (Cummins, 2002). IT systems must be capable to adapt to changing requirements of fast paced and competitive business. The IT infrastructure must be simpler and manageable. This requires a well-defined architecture and overall architectural approach which supports flexibility throughout the enterprise wide processes and applications, unable information and resource sharing (Anaya, 2005). The concept of service oriented architecture (SOA) is widely accepted software architecture approach which fulfils the design and implementation of flexible IS systems and facilitates the change of business processes quickly. SOA can be defined as an architectural style that supports service orientation and service orientation is a way of thinking in terms of services and service based development and outcome of services (Alwadain et. Al, 2015). Erol et al. (2009), developed a theoretical model which identified attributes of SOA which supports the enterprise flexibility. The authors measured enterprise flexibility in terms of agility, efficiency and adaptability. Table 1 describes the theoretical framework.

Table 1: SOA and Creating Enterprise Flexibility (Erol et al. 2009)

Attributes of Service Oriented Architecture (SOA)	Business Outcome	Enterprise Flexibility = f(Agility, Efficiency, Adaptability)		
		Agility	Efficiency	Adaptability
SOA enables the development of applications as reusable and modular business services.	Applications which are developed as reusable and modular services make them easy to be integrated, changed and maintained.	Agility is obtained as a result of timely response to the changing business requirements.	Reusable services provide cost savings.	Applications which are developed reusable and modular services can easily be changed to support emerging business needs and requirements.
SOA as an application architecture promotes loose-coupling. Loose coupling is an attribute of systems, referring to an approach of designing interfaces to reduce interdependencies across modules or components.	This approach minimizes the interdependencies between applications. Adding new applications or modules or replacing modules and changing operations within individual business processes do not impact the other modules or applications.	The risk of unanticipated changes due to a change in another business application will be minimized. This will enable faster modifications to business application resulting in agility.	Due to minimized risk and time of change, efficiency will obtained.	Enterprise will respond to changing business requirement maximizing its adaptability. Adaptability, efficiency and agility will result in higher enterprise flexibility.
SOA enables reusability of existing applications.	Rather than developing applications from scratch, companies can utilize existing functionality & create new solutions by assembling component applications from existing and new technology	This attribute enables rapid deployment of new solutions.	Use of existing functionality provides cost savings	Enterprise can respond to changing business needs, resulting in higher enterprise flexibility.
SOA promotes development and use of standards based services. Standard based services leverage the integration of new and existing applications and enterprise integration.	Use of standards provides interoperability between applications and systems, regardless of their technology or location. As a result, lower cost and shorter time-to-market will be obtained	Shorter development and integration of applications will increase the agility.	Lower cost of application development and deployment due to support of universal standards will increase the efficiency.	Shorter time to market, shorter integration times will enable the faster response to emerging business requirements. Obtained agility & efficiency will result in higher enterprise flexibility.

SOA requires use of self-contained services. Having self-contained services means the state of each service does not depend upon the state of another service.	SOA speeds time through parallel development. Since each service is self-contained and does not depend upon the state of another service, sub-systems can be developed independently.	This provides faster development or modification of sub-systems. Agility increases.	Through the use of resources optimally, efficiency is increased.	Faster and efficient response to new business requirements increases the adaptability of the enterprise, resulting in higher enterprise flexibility.
SOA requires the use of wrapping applications with well-defined interfaces. This process tums applications can be turned into a set of services. The wrapping process creates an abstraction layer that hides all the complex details of the applications.	As a result the services can be integrated with any other application easily. The integration of the applications will not depend on the language, operating system, or database the application uses	Easy integration of applications enables faster response to business changes. New applications can be implemented and integrated rapidly into existing systems without interoperability problems	This will help to economic use of existing and legacy systems. The economic life of legacy systems will be longer which will provide cost savings	Ease of integration with new and existing systems will increase the ability of enterprises to respond to new business requirements efficiently and rapidly. Higher enterprise flexibility will be obtained.

Another important approach in information systems development is the object oriented architecture (OOA). Object oriented modelling is a well-known approach to design complex software system where the system is not a single hierarchy (Acheson, (2010). In OOA, the basic working entities are the objects which are derived from their respective classes. A class is a blue print or prototype from which objects are created. Objects are composed of attributes which describe the related characteristics of the objects and functions or methods which describe the object's behavior. Objects communicate with each other through functions or methods. It seen as a new approach for designing efficient information systems and provides a valuable technology for designing a decentralized production planning approach by structuring manufacturing activities in various autonomous organizational units. The inheritance feature helps in deriving new class from an existing parent class and thus supports code reusability. Object oriented constructs supports a distributed design because of information hiding and data encapsulation of objects. Modularization facilitates customizations of the system and adaptability to changing conditions (Rohloff, 1993).

2.5 Literature Review on Organizational Strategy

A lot of studies have been accomplished to classify organizations based on their strategic orientations. Two prominent research work on strategic classification of organizations are particularly significant owing to the huge citations of the work. The first typology was given by Miles and Snow (1978), where the authors classified the organizations into four groups based on their strategic orientation i.e. Prospector, Defender, Analyser and Reactor. Organizations that follows a prospector strategy are highly innovative firms that are constantly seeking out new markets and new opportunities and are oriented towards growth and risk taking. An organization that follows a defender strategy concentrates on protecting its current markets, maintaining stable growth, and serving its current customers. These organizations are basically mass producers. An organization that follows an analyser strategy both maintains market share and seeks to be innovative, although usually not as innovative as an organization that uses a prospector strategy. Organizations with reactor strategy has no consistent strategic approach; they drift with environmental events, reacting to but failing to anticipate or influence those events. Miller and Roth (1994) added another significant category of strategic group to the literature named as innovators. Innovator type organizations continuously innovate and bring cutting edge technologies to the market place.

3. Theoretical Framework
Propositions on the relationship among process planning styles, environmental uncertainty, IS flexibility, IS architectures and strategy of the organizations

We begin by examining propositions related to a number of relationships between process planning styles as identified from the literature and the information systems (IS) flexibility. The study aims to investigate how flexibility of IS results with different process planning styles. We also develop a set of propositions to investigate the degree of flexibility of two different IS architectures i.e. service-oriented architecture (SOA) and object-oriented architecture (OOA). Finally, we develop a set of propositions that reflect the relationships among organizational strategies and IS architectures.

3.1 Relationships between process planning styles and environmental uncertainty and IS flexibility

The three major process planning styles that we consider here are bold, rational and incremental as evident by the discussion of literature (Sharma et al. 2001). We propose that the flexibility of information system (IS) is certainly influenced by the cognitive styles of planning and taking decisions. Environmental uncertainty also affects the IS flexibility. Our framework considers five factors on environmental uncertainty i.e. marketing, suppliers, government policies, technology and competitors. These factors will be examined on five dimensions of uncertainty i.e. dynamism (in terms of changeability and unpredictability), hostility (in terms of scarcity and competition) and heterogeneity (Duncan, 1972; Choe, 2003; Miller and Friesen, 1980, 1982, 1983; Teo and King, 1997; Dess and Beard, 1984).

Hence, from the discussion of literature review, the following prepositions are concluded.

P₁: *The bold style of decision making is based on a more unified information system (IS) which collects and updates the information in database quickly and in a timely fashion, because of the danger of getting outdated.*

P₂: *The rational style of decision making depends on a more comprehensive, detailed and accurate data to be provided by information systems (IS), which should help individual/organizations to take rational decisions based on high certainty and low risk of failure.*

P₃: *The incremental style of decision making requires information systems (IS) which can continuous validate and update subsequent results into the systems. The updated results should pave the way for next stage of planning. The incremental style is likely to result in acquisition of hardware and software platforms that are incompatible.*

P₄: *The elements of environmental uncertainty plays a significant role in deciding the nature and flexibility aspects of the information systems (IS).*

3.2 Relating organizational strategy with the IS architectures and investigation of flexibility of service-oriented architectures (SOA) and object-oriented architecture (OOA)

Organizations operate according to their pursued strategy. We consider three different types of strategic groups from the existing literature i.e. defenders or cost leaders, prospectors or differentiators and innovators (Miles and Snow, 1978; Miller and Roth, 1994). The defender type organization go for mass production, prospectors produce different variants of a product in lots as per customer's demand and requirements while innovators bring cutting edge technologies to the market place. We argue that the pursued organizational strategy should be supplemented by the IS architectures adopted by the organizations. This will enhance the operational capabilities of the organizations and support their strategic orientation and needs. Two prominent IS architectures have been discussed in the literature review i.e. service-oriented architecture (SOA) and object-oriented architectures (OOA). SOA works with interoperable services and business functionalities. It supports loose coupling, reusability, stateless communications, on demand activation/eviction of services, reduces resource contention, stops services when no longer required, improves service access time and works with multiple instances of the services. In terms of scalability, SOA supports collaborative automation, flexible and reconfigurable, distributed,

autonomous, intelligent and reusable. OOA utilizes interacting objects. Objects are the working entities derived from their respective classes. Objects are characterized with attributes and methods or functions. Objects communicate with each other through functions. In terms of scalability, there is no limitations on the number of objects created. OOA supports tight coupling, immense planning required, ensures reusability and reduces complexity. Some prominent features of OOA includes abstraction, inheritance, encapsulation, polymorphism and data hiding.

Hence we propose the following:

P₅: *The prospector or differentiators type of organizations are more compatible with service-oriented IS architectures to support their strategic objectives and functions under high environmental uncertainty whereas the innovator type of organizations are compatible with service-oriented architecture to support their strategic objectives under very high environmental uncertainty.*

4. Conclusion

In this paper, we carried out an extensive literature review of different process planning cognitive styles**,** information systems flexibility, various IS architectures and strategy of organizations. Based on the literature review, we proposed various theoretical propositions and develop a research framework which needs further detailed investigation. These propositions will be validated and empirical investigated through exhaustive data collection in form of administered questionnaires to obtain responses from different organizations.

References

Ausburn, L. J., & Ausburn, F. B. (1978). Cognitive styles: Some information and implications for instructional design. *Educational Communications and Technology Journal*, 26, 337–354.

Messick, S. (1984). The nature of cognitive styles: Problems and promise in educational practice. Educational Psychologist, 19, 59–74.

Mckenny, J. and Keen, P. (1974). How managers' minds work. *Harvard Business Review, 52, 79-90*.

Bass, B.M. (1983). *Organizational decision making.* Homewood, IL: Irwin.

Mintroff, I.I. (1983). Archetypal social systems and analysis: On the deeper structure of human systems. *Academy of Management Review*, 8, 387-397.

Haley, Usha C.V. and Stumpff, Stephen A. (1989). Cognitive trails in strategic decision making: Linking theories of personalities and cognition. *Journal of Management Studies*, 25(5), 477-497.

Jung, C.G. (1923). *Psychological types: or the psychology of individuation*.

Behling, O., Gifford, W.E. and Tolliver, J.M. (1980). Effects of grouping on decision making under risk. *Decision Sciences*, 11, 272-283.

Henderson, J.C. and Nutt, P.C. (1980). The influence of decision style on decision making behaviour. *Management Science*, 26, 371-386.

Hunt, R.G., Krzystofiak, F.J., Meindl, J.R. and Yousry, A.M. (1989). Cognitive Style and Decision-making, *Organizational behaviour and human decision processes*, 44(3), 436-453.

Sharma, R.R.K., Sharma, N.K. and Baitha, N. (2001). Influence of environmental uncertainty and cognitive style of entrepreneurs on chosen process of strategy making: A preliminary survey. *Journal of Technical and Vocational Education*, 18, 34-46.

Aggarwal, I. and Woolley, W.A. (2013). Do you see what i see? The effect of members' cognitive styles on team processes and errors in task execution. *Organizational Behaviour and Human Decision Processes*, 122(1), 92-99.

Duncan, N.B. (1995). Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure. *Journal of Management Information Systems*, 12(3), 187-225.

Prahalad, C.K. and Krishnan, M.S. (2002). The dynamic synchronization of strategy and information technology. *MIT Sloan Management Review*, 43(4), 24-33.

Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003). Shaping agility through digital options: Reconceptualising the role of information technology in contemporary firms. *MIS Quarterly*, 27(2), 237-263.

Mensah (1989). Evaluating information systems projects: A perspective on cost benefit analysis. *Information Systems*, 14(3), 205-217.

Levy, M. and Powell, P. (1998). SME flexibility and the role of information systems. *Small Business Economics*, 11(2), 183-196.

Ives, B. and Marson (1990). Can information technology revitalize your customer service? *Academy of Management Executive*, 4(4), 52-69.

Robey, D. and M.C. Boudreau (1999). Accounting for the contradictory organizational and consequences of information technology: Theoretical directions and methodological implications. *Information Systems Research*, 10(2), 167-185.

Kanellis, P. and Paul, R.J. (2005). User behaving badly: Phenomena and paradoxes from an investigation into information systems misfit. *Journal of Organizational and End User Computing*, 17(2), 64-91.

Duclos, L.K., Vokurka, R.J. and Lummus, R.R. (2003). A conceptual model of supply chain flexibility. *International Management and Data Systems*, 103(5-6), 446-457.

Palanisamy, R. and Sushil (2003). Achieving organizational flexibility and competitive advantage through information systems flexibility: A path analytic study. *Journal of Information and Management*, 2(3), 261-277.

Byrd, T.A. and Turner, E.D. (2001). An exploratory analysis of the value of the skills of IT personnel: Their relationships to IS infrastructure and competitive advantage. *Decision Sciences*, 32(1), 21-54.

Ramaraj, P. (2010). Information systems flexibility in organizations: Conceptual models and research issues. *Global Journal of Flexible Systems Management*, 11(1-2), 1-12.

Gunasekaran, A. and Ngai, E.W.T. (2004). Information systems in supply chain integration and management. European *Journal of Operation Research*, 159(2), 265-295.

Palanisamy, R. and Foshay, N. (2013). Impact of user's internal flexibility and participation on usage and information's system flexibility. *Global Journal of Flexible Systems Management*, 14(4), 195-209.

Duncan, R.B. (1972). Characteristics of organizational environments and perceived environment uncertainty. *Administrative Science Quarterly*, 17, 313-327.

Choe, J. (2003). The effect of environmental uncertainty and strategic applications of IS on a firm's performance. *Information Management*, 40 (4). 257-268.

Miller, D. and Friesen, P. (1980). Archetypes of organizational transition. *Administrative Science Quarterly*, 25(2), 268-299.

Miller, D. and Friesen, P. (1982). Innovation in conservation and entrepreneurial firms: Two models in strategic momentum. *Strategic Management Journal*, 3(1), 1-25.

Miller, D. and Friesen, P. (1983). Strategy making and environment: the third link. *Strategic Management Journal*, 4(3), 221-235.

Teo, T.S. and King, W.R. (1997). Integration between business planning and information systems planning: An evolutionary-contingency perspective. *Journal of Management Information Systems*, 14(1), 185-214.

Dess, G. G. and Beard, D.W. (1984). Dimensions of organizational task environment. *Administrative Science Quarterly*. 29(1), 52-73.

Newkrik, H.E. and Lederer, A.L. (2006). Incremental and comprehensive planning in an uncertain environment. *IEEE Transactions on Engineering Management*, 53(3), 380-394.

Cummins, F.A. (2002). *Enterprise integration: An architecture for enterprise application and systems integration.* John Wiley and Sons Inc.

Anaya, V.O.A. (2005). *How enterprise architecture can support integration*. IHIS'05 Bremen Germany

Alwadain, A., Fielt, E., Korthaus, A. and Rosemann, M. (2015). Empirical insights into the development of a service-oriented enterprise architecture. *Data and Knowledge Engineering*, (in press)

Erol, O., Sauser, B.J., and Boardman, J.T. (2009). Creating enterprise flexibility through service oriented architecture. *Global Journal of Flexible Systems Management*, 10(1), 11-16.

Acheson, P. (2010). Methodology for object-oriented system architecture development. *Systems Conference 4th Annual IEEE*, 5-8.

Rohloff, M. (1993). Decentralized production planning and design of a production management system based on an object-oriented architecture. *International Journal of Production Economics*, 30-31, 365-383.

Lai, L.S. (2000). An integration of systems science methods and object oriented analysis for determining organizational information requirements. *Systems Research and Behavioral Science*, 17, 205-228.

Miles, R.E. and Snow, C.C. (1978). Organizational, Strategy, Structure and Process. *Academy of Management Review*, 546-562.

Miller, G.M. and Roth, A.V. (1994). A Taxonomy of Manufacturing Strategies, *Management Sciences*, 40(3), 285-304.

Biography

Somen Dey is currently pursuing his Ph.D in the Department of Industrial and Management Engineering, IIT Kanpur, India. He obtained his B.Tech (hons) degree in Production and Industrial Engineering from NIT Jamshedpur and Master of Engineering (M.E.) degree in Production Engineering from Jadavpur University, Kolkata. His primary research interests includes optimization of manufacturing systems, manufacturing strategy and supply chain management.

Prof (Dr.) R.R.K. Sharma is the Professor and Head of Department of Industrial and Management Engineering, Indian Institute of Technology, Kanpur, India. He has written 140 research papers in international journals and conferences.