NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE
(NAAC Accredited)
(Approved by AICTE, Affiliated to APJ Abdul Kalam Technological University, Kerala)

DEPARTMENT OF MECHATRONICS ENGINEERING

COURSE MATERIAL

MR 464 AGILE MANUFACTURING SYSTEMS

VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

1) The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.

2) The department is committed to impart the awareness to meet the current challenges in technology.

3) Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society

PROGRAMME EDUCATIONAL OBJECTIVES

I. Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

II. Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

III. Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

IV. Graduates shall have ability to acquire scientific and engineering fundamentals necessary

for higher studies and research.

PROGRAM OUTCOME (PO'S)

Engineering Graduates will be able to:

PO 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and

norms of the engineering practice.

PO 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME(PSO'S)

PSO 1: Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO 2: Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

COURSE OUTCOME

After the completion of the course the student will be able to

CO 1	Understand the basic concepts of agile manufacturing.
CO 2	Acquire knowledge about the conceptual and theoretical basis for the design and implementation of Advanced Manufacturing Systems
CO 3	Design and evaluate the performance of agile manufacturing systems.
CO 4	Describe about the traditional problems in work place
CO 5	Understand the concepts of skill and knowledge enhancing technologies
CO 6	Acquire knowledge on design of manufacturing enterprise

CO VS PO'S AND PSO'S MAPPING

CO	PO1	PO2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS0 1	PSO 2
CO 1	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 2	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 3	2	-		-	-	-	-	-	-	-	2	2	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 6	2	-	-	-	-	-	-	-	-	-	2	2	-	-

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

SYLLABUS

Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Need for agile Manufacturing -Competitive environment of the future- the business case for agile manufacturing conceptual framework for agile manufacturing	7	15%
II	Four Core Concepts: strategy driven approach- integrating organization- people technology interdisciplinary design methodology	7	15%
	FIRST INTERNAL EXAMINATION		
III	Agile Manufacturing and Change Management: The change implications- post failures in advanced manufacturing- changes	7	15%
	on the way- traditional management accounting- paradigm- investment appraisal- product costing - performance- Measurement and control systems		
IV	Control technological and Design paradigms - traditional problems in workplace- organizational issues -role of technology	7	15%
	SECOND INTERNAL EXAMINATION		
V	Agile Manufacturing Enterprise Design: Agile manufacturing – enterprise design -system concepts as the basic manufacturing theory-joint technical & organizational design as a model for the design of agile manufacturing enterprise-- enterprise design process -insights into design processes	7	20%
VI	Skill & Knowledge Enhancing Technologies For Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling -technology design strategic- Design Concepts- Historical Overview- Lessons- Problems and Future Development	7	20%
	END SEMESTER EXAM		

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS
8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS
5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS
4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

QUESTION BANK

MODULE I				
Q:NO:	**QUESTIONS**	**CO**	**KL**	**REMARKS**
1.	List the advantages of agile manufacturing	CO1	K2	
2.	Discuss the need for agile manufacturing	CO1	K2	
3.	Explain in detail about the ways to implement agile manufacturing in a company	CO1	K2	
4.	Why do we need to be agile? Discuss the role of agile manufacturing in 21st century.	CO1	K4	
5.	Discuss the concept of agile manufacturing	CO1	K2	
6.	What are the potential benefits of agile manufacturing	CO1	K2	
7.	Explain the conceptual framework for agile manufacturing	CO1	K1	
8.	Compare agile manufacturing with lean manufacturing	CO1	K1	
9.	Discuss the advantages of agile manufacturing over mass production	CO1	K2	
10.	Investigate the concept of agility and flexibility	CO1	K4	
11.	Differentiate agile manufacturing with lean production	CO1	K1	
12.	Discuss the role of agile manufacturing in a company	CO1	K2	
MODULE II				
1.	Explain the keys to agility and flexibility	CO2	K1	
2.	Describe about the interdisciplinary design in agile manufacturing	CO2	K1	
3.	Describe the four concepts of agile manufacturing	CO2	K1	
4.	Explain the nuts and bolts of agile manufacturing	CO2	K2	
5.	Write the importance of interdisciplinary design methodology	CO2	K1	
6.	How agile manufacturing helps in organizational integrity	CO2	K4	

7.	Describe in detail about the concepts of agile manufacturing and explain how it helps a company to be competent	CO2	K1	
8.	Discuss in detail about the 4 concepts of agile manufacturing environment.	CO2	K2	
9.	What are the key steps followed by a company to be agile	CO2	K1	
10.	Explain about interdisciplinary design methodology	CO2	K2	
11.	What are the nuts and bolts of agile manufacturing	CO2	K1	
12.	Elucidate the basic principles of agile manufacturing	CO2	K2	
	MODULE III			
1.	Discuss the five implications for change management in agile environment	CO3	K2	
2.	List post failures in advanced manufacturing	CO3	K1	
3.	Explain the changes that happened in the industry due to agile manufacturing	CO3	K2	
4.	Explain the product costing. Discuss the problems with product costing.	CO3	K2	
5.	How does organizational structure affect performance measurement	CO3	K2	
6.	How to conduct program evaluation.	CO3	K2	
7.	Explain about traditional management accounting	CO3	K2	
8.	Explain investment appraisal. Discuss investment appraisal technique	CO3	K2	
9.	Discuss the change implication in agile manufacturing and change management	CO3	K2	
10.	What are the key elements of the strategic management process	CO3	K1	
11.	Explain the changes that arises in the manufacturing industry due to agile manufacturing	CO3	K2	
12.	Explain the project, programme, portfolio of investment appraisal. Discuss the techniques for it.	CO3	K2	
	MODULE IV			
1	Dosi's concept of technological paradigms	CO4	K1	

2	Design paradigms of agile manufacturing	CO4	K6	
3	VR-based holonic design and operations environment: the overall methodology	CO4	K2	
4	10 drawbacks to traditional organizational culture	CO4	K2	
5	What is agile methodology?	CO4	K1	
6	How agile development boosts quality	CO4	K2	
7	How agile manufacturing adapts to organizational change quickly	CO4	K2	
8	Role of technology in agile manufacturing	CO4	K1	
9	How agile manufacturing enables diffusion of knowledge and cross-training across organization	CO4	K2	
10	Organizational issues related with agile manufacturing	CO4	K2	
	MODULE V			
1	Meaning of Agile Manufacturing	CO5	K1	
2	Key Enablers of Agile Manufacturing	CO5	K1	
3	Discuss about Operation management of virtual companies in AM requires	CO5	K2	
4	Automation and Information Technology in Agile Manufacturing	CO5	K2	
5	Discuss about Enterprise design / enterprise design process	CO5	K2	
6	How to design an enterprise?	CO5	K1	
7	Insights into design processes	CO5	K1	
8	Discuss about system concepts as the basic manufacturing theory	CO5	K2	
9	Organizational design as a model for the design of agile manufacturing enterprise	CO5	K6	
10	Case study related to organizational design	CO5	K2	

MODULE VI				
1	Needs of skill development	CO6	K1	
2	Knowledge enhancing techniques	CO6	K2	
3	Differentiate Knowledge vs Skill	CO6	K4	
4	Technology design strategic - design concepts	CO6	K6	
5	Design concept in agile manufacturing	CO6	K6	
6	Historical overview-lessons-problems and future development	CO6	K2	
7	Problems of agile manufacturing	CO6	K2	
8	Discuss about future development associated with agile manufacturing	CO6	K2	
9	Agile enterprise characters and strategies	CO6	K2	
10	Role of virtual enterprise in agile manufacturing	CO6	K1	

APPENDIX 1		
CONTENT BEYOND THE SYLLABUS		
S:NO;	**TOPIC**	
1	Big Bang vs Phased adoption in ERP	

MODULE 1

INTRODUCTION TO AGILE MANUFACTURING

❖ AGILE MANUFACTURING

What is agile manufacturing? It is basically a modern approach or strategy used by manufacturers to respond quickly to the changing customers' needs and market demands. There are multiple factors that enable you to become an agile manufacturer – modular and customer-focused product design, Information Technology, corporate partners and knowledge culture.

Agile manufacturing enables the organization to respond to the market demands in a jiffy, and that too without compromising on the quality. Consumers appreciate the speed and so do your business! Without compromising on the quality of products, an agile manufacturing plan guarantees fast delivery services and promptness. There has to be an intuitive agile manufacturing plan which should focus on the rapid moment for creating and executing idea while gauging what is right for the business and what isn't.

How is agile manufacturing different from other practices?

1. **Modular, customer-focused product design**

Agile manufacturing plan encourages quicker modification and adaptability. When products are designed in the modular pattern, variations are done easily. It brings together different pieces of materials to simplify changing designs and deliver products with an unprecedented level of speed and personalization.

2. **Information technology**

Organizations, whether large scale or SMBs aim to improve external and internal business communication. Proper IT infrastructure drives agile manufacturing and ensures that employees are updated with every managerial decision and technological advancement.

3. **Corporate partners**

Not every business model aims to build good relationships with the partner companies. Agile manufacturing plans lay emphasis on maintaining short-term partnerships and co-operative projects. However, it is always suggested to examine your corporate relationships prior to implementing any new plan.

4. **Knowledge culture**

Training is the key to agile manufacturing. It ensures that the right amount of knowledge is cascaded to the suitable person because everyone is the organization should seamlessly

understand the rapid changes and adaptation through which the business is going. Appropriate training should be evenly provided to all the concerned people in order to succeed in agile manufacturing.

Characteristics of agile manufacturing to manage change are as under: Recognition: The first step to manage change is to identify that it is happening and proactively engage in change management. They can conduct a company-wide knowledge audit.

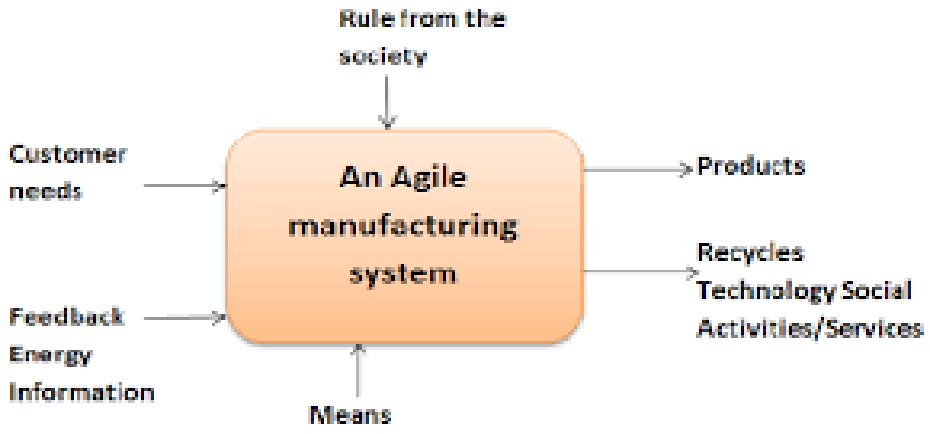
Focus on the customer: Company must focus on improving the customer's experience instead of allowing change to control business. Customers want solutions that comprise both products and services, product flexibility and variability to meet their demands, and a quick response to questions that relate to pricing and support.

Leveraging resources: An agile enterprise can also be recognized by its ability to effectively exploit its resources and share knowledge. Part of change management is to identify underutilized, unused or non-existent resources and take better advantage of them or bring them on board.

Cooperating to compete: Lastly, agile manufacturers change the way that they interact with their business partners so that they can compete more effectively through cooperation. They know that they do not dictate market demands, they listens to their customers, find core competence, make partnerships and share knowledge when it is necessary to provide the customer with a solution.

- Agile manufacturing systems can be conceptually thought of as being an integrated whole of complex interacting sub-systems, organized in such a way as to endeavor towards a common set of goals. Due to the inherent complexities and agility associated with the modern manufacturing systems, modeling these complex interacting subsystems using common analytical and mathematical approaches has proved to be very difficult. An agile manufacturing system is a multi-objective seeking system. At the top level, an agile manufacturing system takes in the customer needs, feedback (responses), and part of society's total energy information (in raw materials, human power, resources, etc.), then transforms them in such a way as to produce the outputs (products) more efficiently.

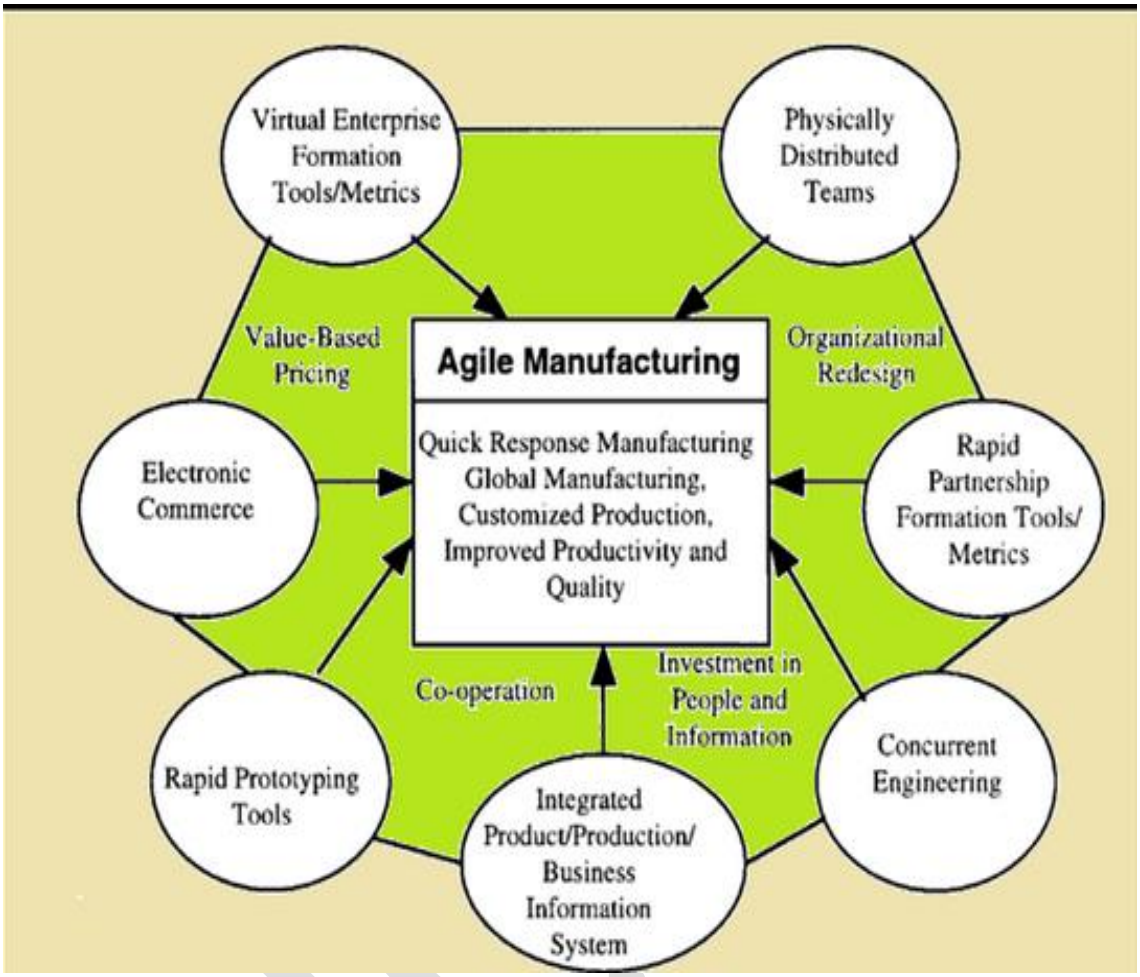
Functional scheme of an Agile manufacturing system



In Agile manufacturing system, according to dynamic customer request, along with the feedback from system, the product conceptual design is done and there is a great need for product innovation. Subsequently the product is configured and parameterized. Product manufacturability is considered and tested with simulation tools. In most advanced Agile manufacturing environment, completely and semi-autonomous systems are used. In order to ensure that the Agile manufacturing process is under good control, it is necessary to monitor the process, obtain process and product information, diagnose the problems and control the process

Abundant of management reports signify that Agility enables enterprises to succeed in an environment of continuous and unexpected change. Researchers have approached the management of agile manufacturing from a various viewpoints using a wide range of tools. The enablers of agile manufacturing include virtual enterprise, formation tools/metrics, physically distributed teams and manufacturing, rapid partnership formation tools/metrics, concurrent engineering, integrated product/production/business information system, rapid prototyping tools and electronic commerce.

Enablers of agile manufacturing



In above figure, a conceptual model has been presented to illustrate the enablers of agile manufacturing. To realize agility in manufacturing, physically distributed firms need to be incorporated and managed efficiently so that the system is able to adjust to varying market conditions. It can be understood from the conceptual model that different enablers of agile manufacturing are overlying each other. Therefore, all the enablers should be integrated to achieve good integration.

Agile manufacturing is a new, post-mass-production system to develop and distribute goods and services. Agile manufacturing necessitates resources that are beyond the reach of a single company. It is imperative for firms to share resources and technologies. The competitive ability of an enterprise depends on its ability to establish good relationships, and thus cooperation seems to be the key to possibly complementary relationships.

Copious studies have demonstrated that agile production, the next phase in manufacturing, is the eventual requirement for global level manufacturing performance. Agility involves fundamental change in an organization's approach to cycle-time reduction. Agility involves cost and that cost must be feasible over the long run for a truly agile organization so that working capital is not

eroded over the long run. The agile organization also changes constantly with time, becoming accustomed to change itself. Sturdiness, the ability to anticipate change and provide a well-ordered completion cycle is another metric of agility. Lastly, the scope of change must be capable of wide swings with little resistance. Scope is a measurement of the accommodation to magnitude of change. Agile organizations not only are aware of their normal coverings of production capability, but also exploit on change that goes beyond these normal scopes. Agile organizations go further than expecting a number of contingencies. The system itself can be disassembled and recreated as required. Therefore, agility goes beyond lean into arena of robustness and challenge. Agile manufacturing also consider the human condition by encouraging creativity from employees, while at the same time increasing the standard of living of society as a whole and the free time of those employed.

Advantages of Agile Manufacturing:

Agile manufacturing has more benefits to organization. Supporters of agile model, Terrence Schmoyer, executive director of the Agile Manufacturing Enterprise Forum, stated that Agile manufacturing provides the ability to flourish and prosper in a competitive environment of continuous and unanticipated change and to respond rapidly to fluctuating markets. Other benefits of agile manufacturing include:

1. Proactively response to customer needs leads to a successful organization.
2. Highly flexible to changing environments and able to respond to environmental changes.
3. Organizations gain capability to reorganize them self very quickly.
4. Agile manufacturing can easily deal with contingencies which cannot be predicted.
5. Very low inventories and costs involved with inventories are also reduced.
6. Low lead time and flexible manufacturing quantities.
7. Encourages creativity in employees thus leading to high job satisfaction.
8. Superior product quality can be maintained.

Disadvantages of Agile manufacturing:

1. Mass markets are fragmented into niche markets therefore difficult to accomplish economies of scale.
2. Giant organizations have difficulty to adopt agile manufacturing as the constant changes prevent any fixed organization structure.
3. High cost is involved in embracing agile production.
4. Highly trained employees are needed which requires a lot of monetary and time investment.
5. Major issue is the cooperation between competitor companies, which are almost impossible in Indian background.
6. Main strength of organization lies in its human capital so much that abrasion could seriously weaken its future growth.

   Today, agile manufacturing is gaining more attention from both the academic and industrial groups. Widespread programmes are being conducted on related issues to spread agile manufacturing concepts, to build agile enterprise prototypes, and eventually

to realize an agile industry.

To summarize, Agile manufacturing systems are developed as a solution to a people with a changeable and dynamic demand, and with a high degree of mass customization in its products. The notion of agility was evolved in 1991 when an industry group observed that the growing rate of change in business environment was rapidly overtaking the ability of outmoded manufacturing organizations to adapt. Agile manufacturing is a technique for manufacturing which combine organization, people and technology into an integrated and synchronized entirely. It is a phrase applied to an organization that has created the processes, tools, and training to allow it to respond speedily to customer needs and market changes while still controlling costs and quality. It is the approach that many enterprises are using as a solution to the new market opportunities.

❖ NEED FOR AGILE MANUFACTURING

Agile manufacturing is a vision of manufacturing that is a development from the concept of Lean production Agile stresses the importance of being highly responsive to meet the `total needs' of the exact customers.

The agile manufacturing system should be able to produce a variety of components in a short time period. To achieve Agile Manufacturing status, companies primarily need implement agile design processes. Agile product development system is capable of addressing frequent iterations of multiple design options early in the process, based on continuous testing and highly sophisticated customer driven design changes. Agile manufacturing suggests certain future directions for the further evolution of the lean enterprise system to help enterprises develop capabilities to thrive in fast-changing and uncertain environmental conditions.

The agile manufacturing enterprise can be defined along four dimensions:

1. value-based pricing strategies that enrich customers;
2. co-operation that enhances competitiveness;
3. organizational mastery of change and uncertainty; and
4. Investments that leverage the impact of people and information.

Agility has four underlying principles:

1. delivering value to the customers
2. being ready for change
3. valuing human knowledge and skills
4. Forming virtual partnerships.

Need for Agile manufacturing in the manufacturing industry

1. Enrich the customer
2. Have a flexible that allows rapid reconfiguration of resources
3. Cooperate internally and with other companies in order to enhance competitiveness

4. Nurture an entrepreneurial culture that leverages the impact of people and information
5. Agile teams are multifunctional in order to combine the knowledge and skills necessary to enrich the customer
6. Agile teams are co-operative both within and between companies, to enable the intra- and extra-firm cooperation needed to enhance competitiveness
7. Agile teams are virtual, which allow the company to combine resources (people and information) as needed in order to pursue entrepreneurial goals

The need for Agile manufacturing in a company

1. Customer-integrated process for designing, manufacturing, marketing, and supporting all products and services.
2. Decision making at functional knowledge points not in centralized management "silos"
3. Stable unit costs, no matter what the volume
4. Flexible Manufacturing-ability to increase or decrease production volumes at will.
5. Easy access to integrated data whether it is customer-driven, supplier-driven, or product and process-driven
6. Modular production facilities that can be organized into ever-changing manufacturing nodes.
7. Data that is rapidly changed into information that is used to expand knowledge.
8. Mass customized product versus mass produced product.

Why do we need to be agile

- Global Competition is intensifying.
- Mass markets are fragmenting into niche markets.
- Cooperation among companies is becoming necessary, including companies who are in direct competition with each other.
- Customers are expecting:
    - Low volume products
    - High quality products
    - Custom products
- Very short product life-cycles, development time, and production lead times are required.
- Customers want to treated as individuals

❖ COMPETITIVE ENVIRONMENT OF THE FUTURE

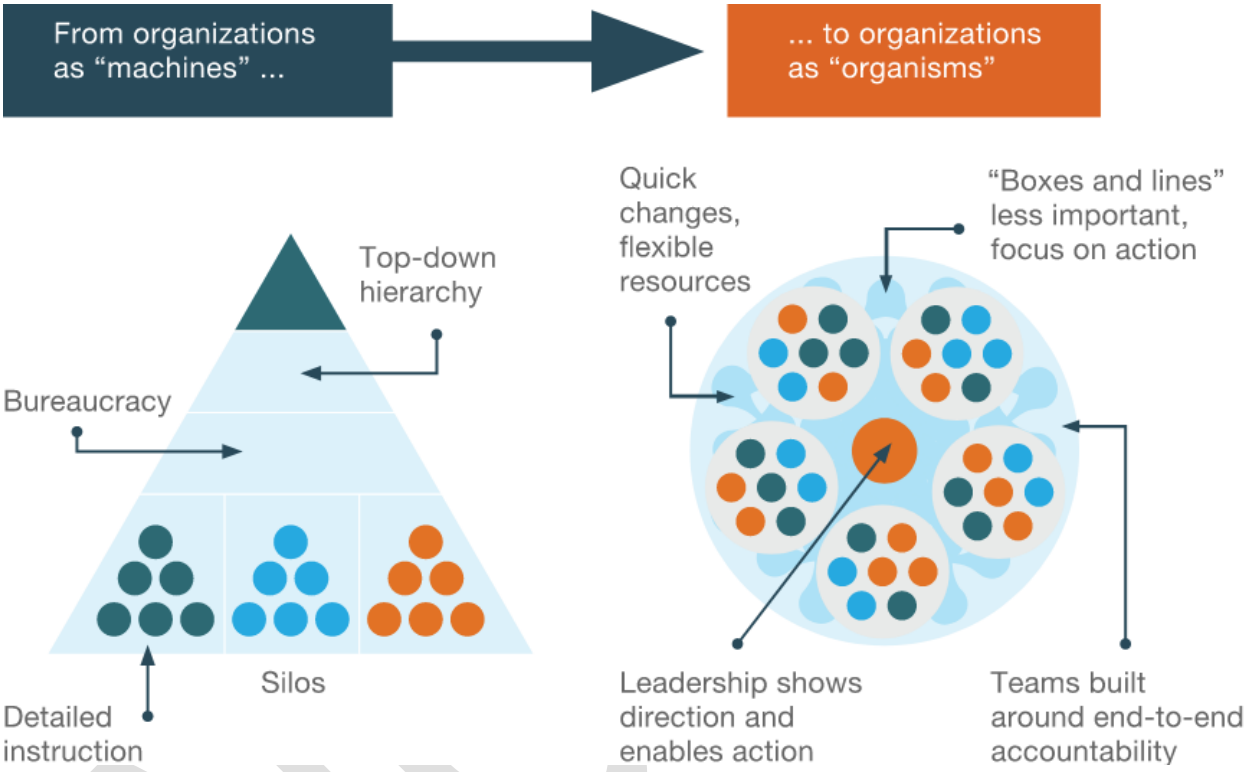
The new paradigm: Organizations as living organisms

The trends described above are dramatically changing how organizations and employees work. What, then, will be the dominant organizational paradigm for the next 100 years? How will companies balance stability and dynamism? Moreover, which companies will dominate their market and attract the best talent?

Our article "Agility: It rhymes with stability" describes the paradigm that achieves this balance and the paradox that truly agile organizations master—they are both stable and dynamic at the same time. They design stable backbone elements that evolve slowly and support dynamic capabilities that can adapt quickly to new challenges and opportunities. A smartphone serves as a

helpful analogy; the physical device acts as a stable platform for myriad dynamic applications, providing each user with a unique and useful tool. Finally, agile organizations mobilize quickly, are nimble, empowered to act, and make it easy to act. In short, they respond like a living organism

The agile organization is dawning as the new dominant organizational paradigm. Rather than organization as machine, the agile organization is a living organism.



When pressure is applied, the agile organization reacts by being more than just robust; performance actually improves as more pressure is exerted. Research shows that agile organizations have a 70 percent chance of being in the top quartile of organizational health, the best indicator of long-term performance. Moreover, such companies simultaneously achieve greater customer centricity, faster time to market, higher revenue growth, lower costs, and a more engaged workforce:

- A global electronics enterprise delivered ff250 million in EBITDA, and 20 percent share price increase over three years by adopting an agile operating model with its education-to-employment teams.
- A global bank reduced its cost base by about 30 percent while significantly improving employee engagement, customer satisfaction, and time to market.
- A basic-materials company fostered continuous improvement among manual workers, leading to a 25 percent increase in effectiveness and a 60 percent decrease in injuries.

As a result agility, while still in its early days, is catching fire. This was confirmed in a recent

McKinsey Quarterly survey report of 2,500 business leaders. According to the results, few companies have achieved organization-wide agility but many have already started pursuing it in performance units. For instance, nearly one-quarter of performance units are agile. The remaining performance units in companies lack dynamism, stability, or both.

However, while less than ten percent of respondents have completed an agility transformation at the company or performance-unit level, most companies have much higher aspirations for the future. Three-quarters of respondents say organizational agility is a top or top-three priority, and nearly 40 percent are currently conducting an organizational-agility transformation. High tech, telecom, financial services, and media and entertainment appear to be leading the pack with the greatest number of organizations undertaking agility transformations. More than half of the respondents who have not begun agile transformations say they have plans in the works to begin one. Finally, respondents in all sectors believe that more of their employees should undertake agile ways of working (on average, respondents believe 68 percent of their companies' employees should be working in agile ways, compared with the 44 percent of employees who currently do).

There are five fundamental "trademarks" of agile organizations based on our recent experience and research. Companies that aspire to build an agile organization can set their sights on these trademarks as concrete markers of their progress. For each trademark, we have also identified an emerging set of "agility practices"—the practical actions we have observed organizations taking on their path to agility

There are five trademarks of agile organizations

	Trademark		Organizational-agility practices[1]
Strategy	North Star embodied across the organization		• Shared purpose and vision • Sensing and seizing opportunities • Flexible resource allocation • Actionable strategic guidance
Structure	Network of empowered teams		• Clear, flat structure • Clear accountable roles • Hands-on governance • Robust communities of practice

Process	Rapid decision and learning cycles		• Rapid iteration and experimentation • Standardized ways of working • Performance orientation • Information transparency • Continuous learning • Action-oriented decision making
People	Dynamic people model that ignites passion		• Cohesive community • Shared and servant leadership • Entrepreneurial drive • Role mobility
Technology	Next-generation enabling technology		• Evolving technology architecture, systems, and tools • Next-generation technology development and delivery practices

The 5 trademarks include 23 practices for organizational agility; 18 are based on survey research. Five additional practices are included that have emerged from recent experiences with large global companies transforming into agile organizations.

➢ THE BUSINESS CASE FOR AGILE MANUFACTURING

Changes in the business environment are leading firms to adopt a new production model termed agile manufacturing. Agile manufacturing, a recently popularized concept, has been advocated as the 21st century manufacturing paradigm. It is seen as the winning strategy to be adopted by manufacturers bracing themselves for dramatic performance enhancements to become national and international leaders in an increasingly competitive market of fast changing customer requirements. Responding to changes, and taking advantage of them through strategic utilization of managerial and manufacturing methods and tools, is the pivotal concepts of agile manufacturing.

Case Studies

➢ United Colours of Benetton

Benetton is a world leader in designing, manufacturing and marketing of different casual clothing for men, women and children. The Benetton enterprise is considered as agile and is based on various characteristics like external production, indirect retail network, indirect sales and centralized management. Agility was achieved by a combination of fast information feedback between customer and producer, by keeping inventory to a minimum level, organisation of cut and sew and dye departments to work in a rapid manner, and small lot cycles to reduce cycle time. This means that shops are always full of items that are currently selling and in fashion.

Manufacturing is characterised by a made to order production plan where a single job usually contains only one style of clothing with varying colours and sizes to meet different orders from many customers. The use of IT and other technologies also gives a major boost to the agility needed in this type of production. It helps in creating an integration between design and production departments, and between the manufacture and marketplace. IT also helps in production to provide control on all external manufacturing units and a close look can be given on the distribution of the finished products around the world.

To achieve the right customer service level, store managers have to commit 80% of orders 7 months in advance of the season stock. These are produced and delivered on a 20 day order cycle time. By doing a monthly stock rotation and having a daily entry of orders and feedback inline with market demands, helps in adjusting production immediately and so have the right item collections in shops every month.

- **CARPETNET Virtual Supply Chain**

Carpet manufacture and supply using traditional methods has a cumulative total lead-time of sixteen weeks. This involves the five processes of making the fibre, pinning yarn, tufting the carpet, dyeing the product, and finally back shear. All of this takes place in separate processes before warehouse stock piling. A total of five truck movements are also required to make fibre process to the retail store. However, end-customers were expecting delivery and installation right after a style and colour were selected. In practice, this may be interpreted as laying the product ordered within seven days of placing the order itself. Thus, the problem was to shorten this long process supply chain to fit within the one week time window.

The fibre manufacturer decided to re-engineer the total value stream to create a Demand Driven Logistics System (DDLS). This required that manufacture and production be tightly linked, so that the discrete businesses become virtually one entity. Within the new DDLS, information is immediately shared and the manufacturer and the mill start works at the same time. The key enablers here are minimal lot sizes and minimal cycle times, and fully integrated communications all the way both ends of the supply chain.

All in all, a technical breakthrough on the manufacturing process was required. The present process was broken with the sole intention of putting everything back together in a better way with the required results. In this case, the technological breakthrough which was needed and achieved, required the fibre to be dyed uniformly before it was woven as a rug. In order to set up the Virtual Supply Chain (VSC), the fiproduct championfi selected a few carpet mills as potential strategic partners, keeping in mind certain criteria such as trust, attitude and philosophy, competitive position, investment record and improvement potential. Joint Task Forces were then set up between the fibre manufacturer and selected mills. In business terms, the VSC goals were divided according to the fibre manufacturer/mill market share, and geographical penetration. It was determined that some product rationalization was essential. The one-week total cycle time service value stream should be concentrated on just the 10% of the product lines that yielded 52% of the mill's volume. Downtime was reduced by half, and average changeover times reduced from 4 hours to 15 minutes, quality costs reduced, and streamlined material flow engineered throughout the chain. The VSC created an integrated computer networking system,

spanning the entire supply chain, making communications all the more efficient. This is known as CARPETNET, from which the VSC takes its name.

The CARPETNET VSC is an agile system which purpose is covering top selling items and their delivery and installation in the customer's residence within the total allowable time window of one week. In addition to engineering lean deliver processes, synchronizing material and information flows, and providing fast and transparent communications, the whole project was a success due to a huge technological breakthrough. The development of Solution Dyed Nylon production process greatly reduces the total cycle time from a number of days to mere hours. Predicted benefits of the CARPETNET VSC includes reduction in inventory to about half, customer service level may rise from 65% to 99%, quality costs will be reduced to about 30%, and waste is eliminated by making to order with pre-dyed yarn.

- **Dell**

Dell Computer Corporation's recent success is due to its innovative and finely tuned distribution channel for direct sales to customers. This competitiveness is built around the concept of customized agile response. Customers can receive product information, place orders, or get quotes directly and immediately through direct contact, – face-to-face – through carious telephone numbers – ear-to-ear – and over the internet – keyboard-to-server.

The customer contacts the company directly through the methods mentioned earlier, and the sales process is initiated instantly and easily. Usually, Dell representatives promise that the product will arrive within five business days, although the customer often receives the product sooner. The manufacturing factory receives a printout of the order, and manufacturing processes begin within hours. Each computer is customer-built, and all necessary software and hardware testing is carried out in less than a day. Dell also boxes the computer after final inspection and it is sent to a distribution center that ships it in time to arrive with a monitor. The monitor is built ahead of time by a separate supplier.

For these reasons, customer's orders are satisfied by an agile execution-based, direct model driven business operation without any finished inventory. Dell also keeps component inventories to a minimum, and vertical integration helps the company further reduce the costs. Fast feedback from customers enables Dell suppliers to quickly update product mix, and maintain their inventory velocity. This breakthrough on supply strategy was made as Dell shared their goals with suppliers. By shipping as required, hourly or daily, Dell bought more constituents and assemblies from the suppliers faster and paid quicker, so everyone benefited.

❖ CONCEPTUAL FRAMEWORK FOR AGILE MANUFACTURING

A framework for the design of agile manufacturing systems

A framework for the design of AMSs is developed. It can be seen that most of the literature on AM and related issues either deal with strategies or techniques, but not an integrated view of developing an AMS. In this section, an attempt has been made to present an integrated strategic and techniques framework for the design and development of AMSs together with people and

systems issues.

Agile manufacturing can successfully be accomplished using various well-defined agile system architectures. The system architecture for AM may include control, function, process, information, communication, distribution, development, and implementation. Effective and efficient implementation of AMSs requires enterprise level integration. The first step in this direction is to integrate design, process planning and scheduling. A bidding-based approach to the integration of computer-aided design, process planning and real time scheduling can be used for the design and implementation of AMS.

The product is represented in a STEP model with de-tailed design and administrative information including design specifications, batch size, and due dates. Upon arrival at the manufacturing facility, the product is registered in the shop for manager which is essentially a coordinating agent. The shop for manager broadcasts the product's requirements to the machines. The shop contains autonomous machines that have knowledge about their functionality, capabilities, tooling and schedules. Each machine has its own process planner and responds to the product's request in a way that is consistent with its capabilities and capacities. When more than one machine offers certain process(es) for the same requirements, they enter into negotiation. Based on processing time, due date and cost, one of the machines wins the con-tract. The successful machine updates its schedule and advises the product to request raw material for processing. The concept was implemented using a multi-agent system in an object-oriented programming language. The task of decomposition and planning are achieved through contract nets. As discussed earlier, Internet plays a significant role in AMSs.

Based on the literature survey, a conceptual model for the development of AMSs is developed as shown in Fig. 1. As indicated earlier, the model has been developed along four key dimensions including strategies, technology, people and systems. The main objective here is to develop integrated AMSs with the help of suitable strategies and techniques to develop rapid partnership formation, VE and reconfigurability for mass customization. Further details of the model are discussed hereunder.

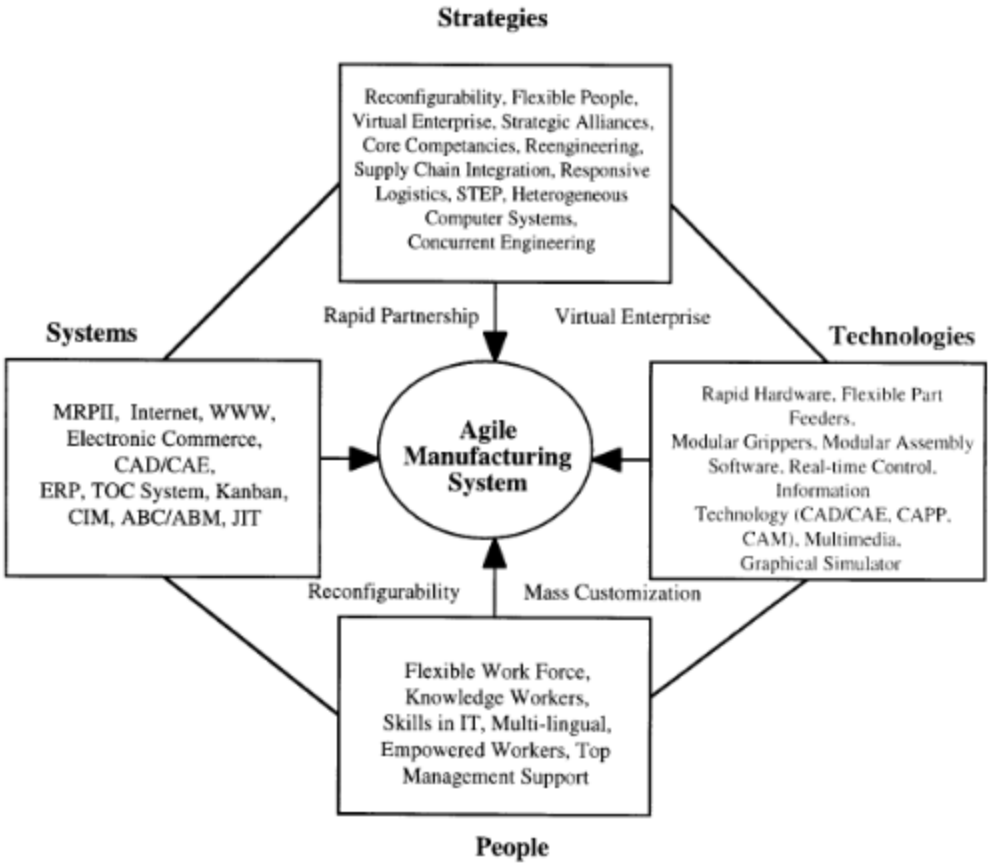


Fig. 1. Development of an agile manufacturing system.

4.1. Strategies

Long-term decisions considering the reconfigurability of the organization with the objective to compete in the global market by mass customization are important to make use of various re-sources available for producing quality goods and services. The following are some of the strategic decision areas that should be considered while developing AMSs: CE, rapid partnership formation, strategic alliances, virtual enterprise, physically distributed manufacturing systems.

Partner selection is one of the most important activities in agile enterprise. Selecting manufacturing partners in AM is an endeavour that is worried with the complexity and dynamic of the market driven by customer needs as well as the inherent subjectivity of the selection process. Traditional vendor selection methodologies do not lend them-selves as a ready solution to these needs of agile environment. The criteria for selecting partners are not only based on the cost and responsive-ness, but should also be based on the quality of goods and services, location of the company, IT skills, and the effectiveness of their supply chain including the flexibility. For instance, CE can be used for new product developments and partner selection based on core competencies. The increased customization, and the subsequent adoption of CE practices driven by the significance of the product time-to-market and compounded by the distributed nature of enterprises, makes it very difficult to accurately estimate the product manufacturing cost and the

cycle time for new products.

Appropriate cost accounting practices and performance measures should be adopted in AM environments. It is not simply based on non-financial performance measures, but also financial performance measures. For example, the partner's performance can be measures by the time to deliver the product and of course the cost as well. The intangible factors are significant in AM environments and are difficult to quantify, such as the in-house information and communication systems. There-fore, there is a need to identify and measure intangibles in agile enterprises. In AM environments, prequalifying partners, evaluating a product design with respect to the capabilities of potential partners, and selecting the optimal set of partners for the manufacture of a certain product are important. A decision support system for design evaluation and partner selection in AM needs to be developed. Therefore, every company must find the right combination of culture, business practices, and technology that are necessary to achieve agility in its organization. After analyzing the strategic options of AM, the strategies such as market forces, partnership formation, VE, rapid product developments are the key strategies to achieve agility in manufacturing.

4.2. Technology

As discussed earlier, strategies of AM with suit-ably supported technologies would enhance the success of achieving/improving agility in organizations. Therefore, key technologies to achieve agility based on the strategies selected are highlighted here. In AMSs, rapid hardware changeover can be made possible by robots, flexible part feeders, flexible fixturing, modular grippers and modular assembly hardware. The flexible feeders rely on belt feeding and binary computer vision for pose estimation. This has a distinct advantage over non-flexible feeding schemes such as bowl feeders which require considerable adjustment to changeover from one part to another. The agile-enabling technologies such as Internet, Multimedia, EDI, Electronic Commerce, flexible manufacturing cells, Robotics and CAD/CAM need to be suitably incorporated within the scope of the VE to achieve agility in manufacturing.

4.3. Systems

In the AM paradigm, where multiple firms co-operate under flexible virtual enterprise structures, there exists a great need for a mechanism to man-age and control information flow among collaborating partners. In response to this pressing need, an AM information system integrating manufacturing databases dispersed at various partner sites needs to be developed. Agile manufacturing requires agile support systems which can be obtained by computer-aided information systems for planning and control activities of manufacturing. Systems such as MRP, ERP, and CAD/CAM and KBS can be used to collect information and make appropriate decisions concerning the effective operations that would support agility in manufacturing organizations. The reason why computerized information systems are recommended for AM is due to the characteristics such as VE, rapid prototyping and physically distributed manufacturing systems.

There is a need for the development and integration of information infrastructure to facilitate

distributed design, planning, manufacturing, and marketing functions in agile enterprise. The purpose of this is to achieve multipath agility in the product development process. Multipath agility provides increased access to alternative resources and information, and achieves improvements in productivity and quality through flexibility of access and utilization of resources, rather than through stepwise improvements in any one task. These concepts will be tested through demonstration case studies in many-to-one and one-to-many design} manufacturing cycles of real products. Nevertheless, integration of current fragmented computer systems, causing over-complexity, is perhaps the biggest challenge the AM enterprise faces. Partner organizations may remain competitive in some markets or return to a competitive relationship with other partners after the dissolution of the VE. Sensitive information and business processes must be protected as part of the overall business process design, so as to enable the type of communication necessary to allow the partners to perform successfully as a single entity. Computerized information systems with suitable protection may help to safeguard sensitive information.

To make a transition to the agile industry, where manufacturing firms cooperate under virtual enterprise structures, there is a need to develop mechanisms for agile partners to cooperate flexibly and dynamically. An individual partner, with its in-formation system, can plug in (out) of the VE sup-ported by a communication network such as the Internet. It is through the integration of these partner information systems that information management is possible in collaborative activities. The conceptual information system for an agile manufacturer consists of two hierarchies, viz. the in-formation hierarchy and the transaction hierarchy. The information hierarchy represents agile in-formation using Object Oriented Methodology (OOM), and the transaction hierarchy models partner transaction management using a Knowledge Based Systems (KBS) accommodating expert rules. Using the Client} Server architecture, an integrated partner information system for improving flexibly and dynamically can be developed.

In agile enterprise where manufacturing partners share product related data to come up with new, customized, and high quality products at minimal lead-times. The principles of group technology (GT) can be used. The information on product design is assumed to be available in the product databases of distributed partners, and can be generated through an existing GT design processor. A software system using object-oriented technology will be useful in implementing the procedure. Agile manufacturing systems can benefit significantly from a database support. An AM database system (AMDS) designed for capturing and manipulating the operational data of a manufacturing cell will be helpful.

Design for agile assembly is accomplished by considering operational issues of assembly systems at the early product design stage. The flexibility required of an AMS must be achieved largely through computer software. The system's control software must be adaptable to new products and to new system components without becoming unreliable or difficult to maintain. This requires designing the software specifically to facilitate future changes. Agile manufacturing can be successfully accomplished using various well-defined system architectures. For example, Jung et al provide a primary sketch of architectural requirements for rapid development of AMSs. This architecture can include control, function, process, information, communication, distribution, development, and implementation.

4.4. People

The most critical problem in agile environment is how to manage and motivate workforce to support the flexibility and responsiveness. Forsythe discusses the human factors in AM. For the development of agile business practices, there needs to be consideration of human factors affecting decision making within fast-paced dynamic environments. When information does not flow, due to technical or human issues, agility is lost. For this reason, elimination of human points of failure in infrastructure support is essential. If users are unwilling or reluctant to accept agile practices and enabling technologies, AM will fail from the inability to overcome the inertia of traditional, often deeply ingrained practices.

Agile manufacturing poses threat to the comfort of managers due to the empowerment of product development teams and the increased openness of information. Concurrent engineering within a fast-paced product development environment favors collaborative work between engineering disciplines. Most of the challenges of human factors posed by the agile environment can be overcome by a series of team meetings during which the team jointly developed the project plan, including objectives, strategies for meeting objectives, a detailed task network, schedule and resource and funding projections. The information technologies alone are not sufficient to achieve the desired communications efficiency and, if anything, the unfamiliarity of the technologies could impede communications efficiency.

To overcome these factors, two strategies can be adopted: (i) various mechanisms can be employed to allow team members to meet face-to-face and establish personal familiarity (e.g. team training and project planning), and (ii) to sustain familiarity throughout the course of the project(through monthly all-hand meetings, weekly lunches, social events).Information may be transmitted via multiple channels depending on urgency, content and distribution through phone, voice-mail, fax, e-mail, and http. The agile workforce should be capable of meeting increasing technological challenges, de-signing their work places, solving quality-related problems and team-to-team learning, improving equipment availability, using mistake-proofing processes, dealing with increased complexity, and finally, helping labor unions harmonize their members and company expectations.

MODULE 2

FOUR CORE CONCEPTS

- Four Core Concepts:

The model of agile manufacturing is built on four core elements. These include *Modular Product Design*, *Information Technology*, *Corporate Partners*, and *Knowledge Culture*.

Modular Product Design

Agile manufacturing tends to create products, which allow modification and variation quickly. This is best achieved by the Modular Product Design approach, which means products are designed in a modular fashion. Modular products are typically built from a number of different pieces, allowing fast and easy variation.

For example, instead of creating the product from a single piece of material, the manufacturer would create smaller pieces that fit together to create the product. If you'd want to change a specific aspect of the product, you wouldn't need to change the whole process. You could simply make design changes to an individual piece, while still changing the overall look or function of the product.

Information Technology

Agile manufacturing also involves the use of information technology, especially in order to improve internal and external communication. This is essentially about dissemination of information throughout the organization to ensure employees are up-to-date and able to respond quickly.

Proper implementation of information technology allows employees to make decisions quicker in terms of product design. Furthermore, it allows a rapid response time to customer queries, as information is disseminated quickly across the different platforms.

Corporate Partners

On the contrary to the traditional model of manufacturing, the agile manufacturing model aims to leverage relationships with other companies. Short-term partnerships and co-operative projects are encouraged, as they can help the company to enter and adjust to new or changing markets quicker.

The company will be better suited to improve time-to-market for products by working closely with companies that are already present in these markets. For example, introduction to a new market can be quicker by using an existing supplier in this market prior to establishing your

presence there.

Knowledge Culture

Finally, agile manufacturing relies heavily on the creation of a knowledge culture. This means agile manufacturers invest in employee training to ensure rapid change and adaptation are understood and supported throughout the organization.

When a company is considering implementing agile manufacturing, creation of knowledge culture will be key to success. Switching to agile manufacturing is not always easy and appropriate training should be provided to support employees during the process.

THE DIFFERENCE BETWEEN LEAN MANUFACTURING AND AGILE MANUFACTURING

When an organization is considering ways to organize its manufacturing process, they can come across another manufacturing concept called lean manufacturing. While both lean and agile manufacturing can help companies lower costs, improve customer service and boost responsiveness, there are certain differences in these methodologies.

Lean manufacturing is focused on minimizing the costs of manufacturing. The focus is therefore on demand-based manufacturing, which aims at eliminating investments in inventory. Lean manufacturing involves improving the effective use of utilities, facilities and materials. The process is driven by the mind-set that it can be constantly improved to make manufacturing more cost efficient. Therefore, lean manufacturing emphasizes improvement and the measurement of performance.

You could view both models through the analogy of a person. One could be a thin person or one could be a fit person. Thin and fit is not the same, but a person can also be thin and fit. Similarly, an organization can be a lean or an agile manufacturer, or the company could become both. However, an agile manufacturing plan doesn't automatically mean it's also lean.

In fact, lean manufacturing is often considered the precursor of agile manufacturing. This is because lean practices can enable agile manufacturing practices. The similarities of these models include:

- **Support of revenue creation and sustainability**
- **Improved competitiveness**

The combination of a lean and an agile manufacturing approach is often referred to as 'leagile' manufacturing. Leagile manufacturing can be achieved by using several different approaches, including:

- Combination of a lean make-to-stock manufacturing approach for products in high demand and make-to-order agile manufacturing approach for other products.

- Creation of a flexible production capacity for responding to demand surges or unexpected customer requirements.
- Implementation of postponement strategies, which allow the base product to be manufactured in advance, with the final assembly and configuration adding the variation and changes needed based on the final customer order.

The key is to understand both approaches and the benefits of using either strategy. Ultimately, the decision of choosing the right manufacturing system depends on your organization's needs, as well as the type of product you are manufacturing. While lean and agile manufacturing can have beneficial synergies to keep in mind, these two approaches are ultimately different in terms of implementation and focus.

THE FOUR STEPS TOWARDS AN AGILE MANUFACTURING PLAN

Implementing agile manufacturing in your organization will require careful planning. The process is by no means easy, but the following steps will ensure you focus on the key issues when considering the agile approach.

1. Research

First, you must conduct extensive research into agile manufacturing. The most important aspects to understand and study include:

- *The cost of agile manufacturing*
- *The processes required for agile manufacturing*
- *The concrete tasks involved in the processes*

You should understand these three aspects in relation to your business. For example, the cost of implementation can vary depending on the industry you operate in and the business model you are using.

One of the ways to get a better understanding of the above points is by examining other businesses. You should try to find organizations similar to your business, which have implemented agile manufacturing in the past.

Furthermore, consider the benefits and downsides to transforming your current manufacturing model into an agile model. We'll discuss the advantages and disadvantages in more detail in the following section. Consider the points in terms of your business and get a better understanding whether the benefits outweigh the costs in your circumstances.

It's essential to understand certain products are more suitable for agile manufacturing than others. Examine your products and ask the following questions:

- *Would this product benefit from better personalization? Is there a potential market for creating*

the product as a modular product model?

- *Do you know of a product that could be developed through agile manufacturing model? What competitive advantages could your business provide to such a product?*

2. Appoint a task force

Implementation of an agile manufacturing plan will take time and you should clearly define the people in charge of managing this change. This not only helps smoothen the process, but it also ensures accountability.

Assemble a task force in charge of creating a plan for agile manufacturing. You can shift job responsibilities within your organization to allow a group of people to focus on the task. Previous knowledge of agile manufacturing can be beneficial, but the key is to support the group and provide them with the necessary resources. Make sure a board member is part of the team, as this change is a strategic shift that will shape the future of your business.

The task force should provide regular updates on the process. The group should have a clear set of objectives it needs to achieve and you want to implement a timetable for the process.

The task force should play an important role in creating the knowledge culture in the company. Whilst you want to narrow down the amount of employees who are in charge or researching the ways to implement agile manufacturing, you want to have everyone in the organization involved in the process. According to the State of Agile Survey, conducted by software provider Version One, "*general resistance to change*" is among the biggest barriers of agile adoption in organisations. Over 40% of respondents felt there's a tendency to resist change within organisations and this can hinder the effectiveness of agile manufacturing.

3. Examine current supplier relations

Since partnerships are the key to agile manufacturing, you should examine your existing partnerships before implementing the new approach. You will find this important for two reasons:

- First, it ensures you *strengthen stable partnerships*, which enhance agile manufacturing.
- Second, it enables you to *locate partnerships that don't work* for your benefit.

You should re-evaluate your existing supplier partnerships to categorise your relationships to the above two groups. You can take advantage of relationships that might be beneficial for agile manufacturing and get rid of the ones, which are not strengthening your organizational capabilities. Do not stick to suppliers that cause problems, especially in terms of responsiveness and speed.

4. Draw a long-term plan

Finally, you should establish a long-term plan for agile manufacturing. The implementation

process will take time and getting agile manufacturing to full speed will be an enormous task.

You should draw a long-term plan together with the task force. This plan should include:

- **Benchmarks** – What are the signs of success for your business? How can you measure the objectives?
- **Milestones** – When should key objectives be accomplished?
- **Contingencies**– What if things go wrong? How to correct mistakes or change direction?

Preparing for eventual obstacles or problems should be an important priority for the team. Major changes to organizational structure, such as the implementation of an agile manufacturing plan, will need to weather the storms, so to speak. It is important to outline possible problems and obstacles beforehand, as well as have a plan for overcoming unexpected situations.

MODULE 3

AGILE MANUFACTURING AND CHANGE MANAGEMENT

❖ AGILE MANUFACTURING AND CHANGE MANAGEMENT: THE CHANGE IMPLICATIONS

Manufacturing companies are now operating in fast-moving commercial environments where unanticipated threats and opportunities are the order of the day. Agile manufacturing in such environments means understanding the environment and being flexible, cost effective and productive with consistent high quality. Each company will respond in a different way to deploy its own agile characteristics. This paper describes research that tackles the problem of identifying what characteristics constitute agile manufacture and proposes a framework for evaluating and developing agile manufacturing. Manufacturing enterprises involve people, organization, technology, processes and information, and no commonly accepted practical reference framework exists to investigate, analyse and evaluate the ability to deal with change.

As change management consultants, we're often asked how Agile and change management fit together. There are a lot of questions about how adding change management to an Agile project management cycle works; there are concerns expressed about whether change management will slow things down, and get in the way of the speed and innovation derived from Agile.

The need for change management is arguably increased in Agile because of its iterative nature, the amount of churn created, and consequently, its impact on climate and readiness. There are implications for change management when an organization adopts Agile that need to be addressed.

What is the same in both approaches is the need to focus on full implementation, not just installation. What is the same is the fact that if you marry a fit for purpose, situational change management approach that's blended with project management protocols, you will help projects be implemented faster and to benefit realization.

5 Implications for Change Management in an Agile Environment

Agile is a project management approach that works by breaking projects into short, iterative cycles called "sprints". At its core, Agile is based on the assumption that circumstances change as a project develops. That's why, in an Agile project, the planning, design, development, and testing cycles are never done. They continue to change as the project takes form.

As with other project management disciplines, Agile project managers focus on doing things technically right by making certain they deliver business changes under time, cost, and quality

(scope) constraints. That's Installation. While you are still working through a life cycle, in Agile, they are doing this in short sprints, rather than saving it all for the end. This has the potential to create ongoing disruption and churn.

These differences create some implications for change management in an Agile world:

1. Because there is less planning time (you are going directly from milestones to script), **change management templates are less useful**
2. There is **less opportunity to formalize and standardize**
3. Because Sponsors and Targets can be exposed to the changes earlier than in the traditional Waterfall approach, there is **more immediate disruption**, and disruption is constant. Since there is a **direct correlation between levels of disruption, and resistance, resistance occurs much earlier, and must be planned for and managed earlier**
4. Given all of the above, **change practitioners must be more adept** and able to make judgment calls rapidly and often, rather than relying on templates and tools
5. Impacts **on Project Managers, IT, and Sponsors must be managed**

The same change management deliverables are needed, although the timing for developing these may be altered in Agile. In the Initiation phase, the foundation of these deliverables should be built:

- **Business Case for Action** to define what the change is
- **From-To Definition** to identify gaps between "is" and "will be"
- **Key Role Mapping** to identify where Sponsors are needed, and who specifically these individuals are by name
- **Readiness Planning** to have strategies and tactics available to manage resistance
- **Communication Planning** by audience, with feedback loops to gather feedback that identifies potential sources of resistance

In both the Agile and Waterfall life cycles change management practitioners must continually ask the same questions to manage risks in real-time, and be prepared to apply situational strategies and tactics for mitigation:

- Is the Definition of the Change still accurate, and are Sponsors and Agents aligned?
- Where is Sponsorship needed?
- Where will we have resistance, and how will we manage it?
- What do we need to communicate, when, and how?
- What reinforcements are needed to drive the change to sustained, full implementation?

❖ POST FAILURES IN ADVANCED MANUFACTURING

Technological challenges

1. Slow production speeds

2. Materials development and inconsistencies in material properties

3. Manual post-processing

Software challenges

4. Limited capabilities in data preparation and design

Quality assurance challenges

5. Part-to-part variation

6. Lack of industry-wide standards

Workforce challenges

7. Lack of understanding and expertise in AM

Financial challenges

8. Making the initial investment

Workflow and integration challenges

9. Disjointed AM ecosystem

10. A lack of digital infrastructure

❖ CHANGES ON THE WAY

As industrial technology grows increasingly pervasive, this wave of automation and digitization is being labelled “Industry 4.0,” as in the fourth industrial revolution.

Industry 4.0, the fourth industrial revolution, is revolutionizing manufacturing by providing

manufacturers with the opportunity to utilize advanced manufacturing capabilities and information technology (IT) throughout the product lifecycle. As a result, manufacturers are benefitting from increased visibility into operations, substantial cost savings, faster production times and the ability to provide excellent customer support.

The only way manufacturers can stay ahead of competitors and win market share in today's quickly morphing environment is to embrace change. Those who wish to thrive and not just survive are leveraging the latest in growth-inducing Industry 4.0 technologies.

The top 10 2019 manufacturing industry 4.0 tech trends according to Hitachi Solutions, which assists manufacturers including Seventh Generation, Maxell, and Ping to leverage the latest technology in order to grow, are:

1. IoT is THE Big Thing

Manufacturers are increasingly leveraging the Internet of Things (IoT), which entails the interconnection of unique devices within an existing Internet infrastructure, to achieve a variety of goals including cost reduction, increased efficiency, improved safety, meeting compliance requirements, and product innovation. IoT's existence is primarily due to three factors: widely available Internet access, smaller sensors, and cloud computing.

Roughly 63% of manufacturers believe that applying IoT to products will increase profitability over the next five years and are set to invest $267 billion in IoT by 2020. They understand that IoT empowers them to make informed strategic decisions by providing crucial, real-time information. Nearly a third (31%) of production processes and equipment and non-production processes and equipment (30%) already incorporate smart device/embedded intelligence according to The MPI Group. Similar percentages of manufacturers have a company strategy implemented or in place to apply IoT technologies to their processes (34%) or to embed IoT technologies into products (32%).

"IoT and predictive analytics are having a major impact on manufacturing, offering exciting new opportunities for connecting operations and transforming business processes," said Michael Strand, Senior Vice President at Hitachi Solutions America. "Innovation is driving business growth, and technology is enabling manufacturers to evolve with an increasingly digital-first business landscape."

2. Predictive Maintenance is Keeping Production on Track

A breakdown in critical equipment is costly to manufacturers both in terms of repairs as well as downtime and loss of productivity. According to Information Technology Intelligence

Consulting, 98% of organizations say a single hour of downtime costs over $100,000. Ensuring that all equipment is functioning optimally therefore remains a key priority for manufacturers, many of whom are turning to predictive maintenance technology to do so.

Widespread adoption of predictive maintenance technologies could reduce companies' maintenance costs by 20%, reduce unplanned outages by 50% and extend machinery life by years according to management consulting firm McKinsey & Company.

Predictive maintenance programs monitor equipment using any number of performance metrics. By automating the data collection process through the use of IoT technology, manufacturers can develop a better understanding of how systems work and when they will fail. The ability to predict when maintenance should be performed saves manufacturers valuable time, money, and resources. Typically, monitoring tests can be conducted while equipment is in operation, which means there is no loss of production due to equipment shutdown.

3. Shifting Focus From B2B to B2B2C

Many manufacturers who traditionally had a B2B business model are shifting to a B2B2C (business-to-business-to-consumer) model due to the many benefits selling directly to consumers provides including:

- **Increased Profit:** You get the full manufacturer's suggested retail price (MSRP) rather than wholesale prices for your products.
- **Faster Time to Market:** You can prototype, test, and get products to market quickly instead of contending with the lengthy traditional retail sales cycle that requires locked-down product development far ahead of order and delivery. This agility gives you a competitive edge.
- **Brand Control:** You own your brand. It won't be diluted or misrepresented by third parties.
- **Price Control:** You can reinforce your MSRP.
- **Better Customer Data:** Selling direct to customers allows you to collect data about them that ultimately results in better products, stronger relationships, and increased sales.

To effectively sell direct to consumers you'll need to select a platform for your e-commerce operations that supports both your B2B and B2C sales platforms. It will have to deliver on order fulfillment and tracking, secure payments, customer service management, and sales and marketing activity tracking while providing a 360° view of all your B2B and B2C customer

interactions.

4. Leveraging Supply Chain for Competitive Advantage

Remaining competitive means delivering more value to your customers than your competitors. While pricing is extremely important, savvy manufacturers will continue to distance themselves from price wars by leveraging new technology that simplifies supply chain management, which in turn delivers many competitive benefits. These benefits include being able to operate your business more efficiently, more visibility and control over inventory, reduction of operational costs, and improved customer satisfaction and retention.

Today's supply chain technology solutions address manufacturing needs in a variety of areas, including:

- Manufacturing Optimization
- Logistics Optimization
- Sales and Operations Planning
- Product Lifecycle Management
- Business Intelligence
- Network and Inventory Optimization
- RFID
- Procurement

A third of over 2,000 industrial companies have digitized their supply chains while nearly three-quarters expect to by 2020, according to PwC.

5. ERP Systems Are Continuing to Streamline Processes

Small to medium sized manufacturing companies are increasingly recognizing that an enterprise resource planning (ERP) system is key to creating a lean and competitive advantage.

ERP systems offer two key benefits:

- They streamline processes by automating all business operations and providing accurate, real-time information.
- By providing accurate, real-time information, administrative and operational costs are reduced. The end result is that manufacturers can proactively manage operations, prevent disruptions and delays, break up information roadblocks and help users make quicker decisions.

The lengthy implementation of traditional ERP systems can be frustrating for manufacturers.

Now, however, you have the option choose a rapid implementation ERP system, which can be up and running much faster and more affordably than traditional ERP systems.

6. Greater Visibility Into Big Data is Helping Manufacturers Achieve More

IoT is transforming almost every surface into a sensor for data collection and providing real-time insights for manufacturers. This ability to collect data from so many sources combined with increasingly powerful cloud computing is finally making big data usable. Manufacturers can slice and dice data in ways that provide them with a comprehensive understanding of their business. This enables them to improve production, optimize operations, and address issues before problems arise.

7. VR and AR Are Continuing to Forge Winning Partnerships Between Man and Machine

Assistive technologies, such as augmented reality (AR) and virtual reality (VR), will continue to create mutually beneficial partnerships between man and machine that positively impact manufacturers.

Due to VR software interfacing seamlessly with computer-aided designs, product developers can use VR to quickly make modifications and additions to products during the product design stage before they go into modeling and manufacturing processes. AR and VR can also decrease inspection time and assist in detecting errors in addition to improving workers' sight line, which enables them to complete tasks faster.

For example, by using AR devices such as electronic glasses or goggles, computer-generated graphics can be placed in a worker's field of vision that provide him with real-time help when it comes to performing a task. AR technology can also be used with cameras and sensors for training. Workers can be shown how to perform a task and use the data feed to correct mistakes, which makes it possible to quickly and effectively train unskilled workers for high-value work.

8. 3D Printing is Making Production Faster and Cheaper

Manufacturers will benefit from faster, less expensive production as a result of 3D printing. It makes rapid prototyping, which is a highly cost-effective way for product designers to test and troubleshoot their products, possible. In addition, it enables manufacturers to produce items on demand instead of having to manufacture and warehouse them.

The expensive and time-consuming process of tooling for manufacturers is already being transformed by 3D printing. Historically the production of molds, jigs and fixtures used in the

mass production of heavy equipment took months, was very expensive and typically involved utilizing tooling companies headquartered overseas. 3D printing makes it possible for tooling to be cost effectively completed on-site, in days, and has already been embraced by the automotive and aerospace manufacturing industries.

9. Continued Reshoring is Leading to an Increase in Made in the U.S.A Products

Reshoring – bringing operations back to United States shores – is becoming increasingly common among manufacturers. There are multiple factors contributing to reshoring. Firstly, the economies in many go-to offshoring countries are doing well, which has led to an increase in wages for their residents. Secondly, in countries where labor remains inexpensive, the infrastructures typically can't support complex manufacturing operations. In addition, transportation costs are rising. The increased use of new software programs that help manufacturers utilize robotics to automate many of the processes that used to require a human, are also contributing to a resurgence in reshoring.

10. Finding Tech-Savvy Employees Will Be Challenging

As manufacturers increasingly rely on technology, their need to hire tech-savvy employees is increasing. The challenge is that there are not enough skilled employees to fill the number of open jobs. To fill the void, manufacturers have to do two things:

- Train existing workers to perform skilled tasks.
- Find ways to make their business appealing to computer coders, app developers, data scientists, 3-D printing specialists, and other highly trained professionals.

To stay Industry 4.0 competitive, manufacturers must commit to doing four things: identifying crucial business needs, investing in technology that will meet them, building organizational capabilities and actively adapting processes and culture so both remain relevant. Choosing inertness over action could lead to your manufacturing business shutting its doors instead of opening new and potentially lucrative ones.

❖ TRADITIONAL MANAGEMENT ACCOUNTING

Management accounting is the function involving gathering and disseminating of integral accounting and statistical data to decision makers. Management accountants facilitate the management with relevant information for making suitable policies, planning and control operations. Johnson and Kaplan argued that the conservative theories of management accounting has become obsolete and have paved way for activity-based costing, economic value adding,

balanced scorecard, beyond budgeting, throughput costing, target costing, and Kaizen costing etc. These findings are based on their study on the American business in context of the evolution of management accounting right from the primitive textile mills to the present-day computer-automated manufacturers. Johnson and Kaplan are of the view that it is imperative for the contemporary organizations to incorporate radical alterations in the means and ways of assessment and management of costs. With escalating technological advancement, dynamic international and national competition, colossal information-processing capacities, it is crucial that managers access the relevant and accurate information as and when required.

Yazdifar and Tsamenyi highlight the primary factors responsible for bringing the change in management accounting practices as information and technology and organizational restructuring.

Evolution of management accounting

The change in management accounting has radically transformed the role of management accountants. Conventionally, management accountants were playing the roles of score keeping, attention directing and problem solving. However, with time, the role of management accountant has transformed to meet the information requirements of the uncertain business environment. Management accountant have now adorned the role of business partners and information analysts enabling them to upgrade from centralized accounting function to partnering with managers in business units (Sulaiman, Ramli and Mitchell, 2008). Cooper and Dart (2009) have advocated a comprehensive role of management accountants which is contemporary and business-eccentric in nature like being an internal business consultant, strategic management consultant or a hybrid accountant. It is rather replaced with a newer function of strategic business advisers which is highly complex and layered profile. However, gradually this function shall also be replaced with more advanced function. Like every aspect of business, management accounting has also undergone the chronological progression which is inevitable. Management accounting too was an advancement of cost accounting and the conventional book keeping practices and enabled better decision making practices. However, it was unable to adopt strategic thinking and other essential qualitative facets of management. Today's intensifying global competition has compelled the evolution of an accounting system which takes into consideration the strategic aspect of decision making.

Role of management accounting

Hoskin, Macve and Stone (2007) has also promoted strategic management accountants and emphasized that it is the need of the modern evolving culture ousting the conventional functionality and also the requisite of strategy implementation which is now regarded as a team effort. This calls for a well –defined strategy which is communication clearly across the

organizational verticals and conjoining it to the drivers of change. Also, fostering a performance centric culture enables integration of all departments towards effectual strategy execution. This has impacted the set of management accounting approaches which are contemporarily focused on desegregating the comprehensions from management accounting and marketing management in the purview of strategic management. The conventional role of management accountants has lost its relevance and has now been re-conceptualized with strategic dimensions. Ax and Bjornenak (2007) argued that the role of management accountants was bound to be modified and upgraded as the information facilitated by the traditional management accounting tools was usually late and that too was highly grouped and misleading by financial reporting making it irrelevant for decision making. Moreover the conventional set of management accounting tools and managers' role did not make provision for communication or strategy implementation.

Sources of change

Sulaiman, Ramli and Mitchell (2008) have identified the sources of changes in the role of management accountants. These can be categorized into the following three categories:

- **External:** Rise in market competition has influenced the consumer behavior significantly which has transformed the market dynamism and companies were compelled to find financial systems which can quantify customer knowledge and lower customer dissatisfaction. Globalization has led to dissemination of the accountancy practices across countries and organizations tend to adopt internationally best practices of accountancy and management. Also, many companies hire external consultants which bring with themselves a set of unique ideas of management accounting tools and techniques (Ajami, Arrington, Mitchell and Norreklit, 2005). Also, variations in financial accounting requirements and regulations across countries also compel the firms to alter their management accounting practices accordingly.
- **Internal operations:** Management accounting is deeply influenced by internal organizational operations and factors unique to the organization like core competencies or work dynamics of the facility as it is intended to be befitting to the prevalent operational surroundings. Likewise, with the induction of contemporary production technologies also steer subsequent change in the product costing practice. Also, the degree of adoption of information technology also has a potent effect on the management accounting aspects. Like e-commerce or accountancy software implementations may call for alterations in management accounting (Terry, 2003). Also, the style of management prevalent in the company and performance practices like Total Quality Management also influences the management accounting practices.
- **Organizational:** Organizational structures also warrant alterations in management accounting. Mergers and acquisitions, organizational restructuring, decentralization, centralization, hierarchical structure, downsizing, outsourcing, corporate governance etc.

all have implications on the management accounting and eventually modify the role of the management accountants accordingly.

Drivers of management accounting

These factors along with the gradual progression of the global business paradigm have influenced management accounting eventually, making it expansive in its horizon. Conventionally, management accountants were concerned with formal, financial and historical information obtained from a financial accounting system. It had a short-term outlook as it facilitates information for internal happenings of the company without any strategic intentions. Even the time frame is fixed like a financial accounting period or calendar time. The management accountants traditionally reviewed the standard cost objects like products or responsibility centers department wise for which drivers were production volume, labor hour and machine hour (Chenhall, 2007). Contrariwise, the present day management accountant explores and supplies informal, non-financial and pro-active information. Apart from internal aspects, management accountant considers and analyzes external factors like customer information, supplier information, competition analysis and society as a whole. They work on a broader perspective with a strategic base. Information is not time bound rather it is subject to management requirements. An array of cost objects are considered like departments, consumers, societal factors, supply chain, brand and marketing function and even industry competition which result in both volume and non-volume drivers.

❖ INVESTMENT APPRAISAL

Investment appraisal is a collection of techniques used to identify the attractiveness of an investment.

The purpose of investment appraisal is to assess the viability of project, programme or portfolio decisions and the value they generate. In the context of a business case, the primary objective of investment appraisal is to place a value on benefits so that the costs are justified.

There are many factors that can form part of an appraisal. These include:

- financial – this is the most commonly assessed factor;
- legal – the value of an investment may be in it enabling an organisation to meet current or future legislation;
- environmental – the impact of the work on the environment is increasingly a factor when considering an investment;
- social – for charitable organisations, return on investment could be measured in terms of ‘quality of life’ or even ‘lives saved’;

- operational – benefits may be expressed in terms of 'increased customer satisfaction', 'higher staff morale' or 'competitive advantage';
- risk – all organisations are subject to business and operational risk. An investment decision may be justified because it reduces risk.

A financial appraisal is the most easily quantifiable approach but it can only be applied to benefits that produce financial returns.

The simplest financial appraisal technique is the payback method. The payback period is the time it takes for net cash inflow to equal the cash investment. This is a relatively crude assessment and is often used simply as an initial screening process.

A better way of comparing alternative investments is the accounting rate of return (ARR) which expresses the 'profit' as a percentage of the costs. However, this has the disadvantage of not taking into account the timing of income and expenditure. This makes a significant difference on all but the shortest and most capital-intensive of projects.

In most cases, discounted cash flow techniques such as net present value (NPV) or internal rate of return (IRR) are appropriate to evaluate the value of benefits and alternative ways of delivering them. NPV calculates the present value of cash flows associated with an investment; the higher the NPV the better. This calculation uses a discount rate to show how the value of money decreases with time. The discount rate that gives an investment a NPV value of zero is called the IRR. NPV and IRR can be compared for a number of options.

Appraisal of capital-intensive projects and programmes should take into account the whole-life costs across the complete product life cycle as there may be significant termination costs. In the case of the public sector, where income is usually zero, it is common practice to identify the option with the lowest whole-life cost as the option that offers the best value for money.

The appraisal on less tangible and non-financial factors is more subjective. In some cases, a financial value may be calculated by applying a series of assumptions. For example, work that improved staff morale may lead to lower staff turnover and reduce recruitment costs. A financial appraisal of this benefit would have to include assumptions about the numerical impact of increased morale on staff turnover and the estimated costs of recruitment.

Where benefits cannot be quantified then scoring methods may be used to compare the subjective value of benefits.

Project

Stand-alone projects will use investment appraisal to compare alternative approaches to

achieving the required benefits. Wherever possible, the project should use techniques that are the organisational, programme or portfolio standard approach.

Where a project is part of a programme, the initial investment appraisal may be performed by the programme management team. That does not exempt the project management team from being familiar with the content of the appraisal or the techniques used to perform it. It will still be responsible for keeping the business case up to date and this will involve repeating the investment calculations to account for changing circumstances.

Where a project is undertaken by a contracting organisation, the financial appraisal is relatively straightforward as it will simply be a comparison of costs with the fee paid by the client, probably using a discounted cash flow technique.

Programme

Programmes are usually defined to bring about organisational change. This inevitably gives rise to a higher proportion of intangible and non-financial benefits being included in the business case. Commercial programmes must be careful not to be overly dependent on non-financial benefits, as anything can be justified through subjective views of value.

The programme management team must set out standards for the appraisal of the component projects and their associated benefits. Consistent and compatible techniques must be used across the programme so that individual project business cases can be aggregated and summarised in the overall programme business case.

Portfolio

In the definition phase of a portfolio there may be many ideas and suggestions for projects and programmes to meet the strategic objectives. The portfolio management team must establish a system for capturing and screening these ideas.

This is where broad-brush techniques such as payback may be used. A criterion may be set that requires payback within the financial planning cycle. Any projects or programmes that do not provide payback in that period are discarded. As the higher-potential ideas are captured, they will be subject to more detailed, analytical techniques.

The prioritisation and balancing phases of the portfolio will rely heavily on how investment appraisal has built the business cases of the component projects and programmes. It is essential that the portfolio management team establishes standard methods and consistent approaches across the portfolio to ensure reliable decision-making. The team should also provide specialist

advice and guidance on the use of appraisal techniques to all project and programme teams.

The portfolio management team must also ensure that investment appraisals consider potential investments in the context of the existing and planned projects and programmes. For example, to identify opportunities for reuse of components and avoid double counting of benefits.

- ## Investment appraisal techniques

There are numerous ways through which a business can carry out investment appraisals, but here are three of the most common techniques:

Payback period

Payback period is the length of time between making an investment and the time at which that investment has broken even.

To calculate the payback period, you'd take the cost of the investment and divide it by the annual cash flow. Investments with shorter payback periods are more desirable because it will take less time for an investor to receive back their capital.

Net present value

Net present value (NPV) is the difference between the current value of cash inflows and the current value of cash outflows over a determined length of time. NPV is used to calculate the estimated profitability of a project and it is a form of capital budgeting which accounts for the time value of money.

The time value of money is the principle that money is worth more in the present than an equivalent amount will be in the future because it has longer to earn interest. Cash inflows and outflows are adjusted according to the principle of the time value of money, taking available interest rates into account.

As a result, NPV determines whether it is more financially prudent to invest in a project, or to accept a different rate of return elsewhere based on projected future returns. To calculate the NPV, you would subtract the current value of invested cash from the current value of the expected cash flows.

If the NPV is positive, then it indicates that a project's predicted earnings or profits are greater than the anticipated costs. If the NPV is negative, then the reverse is true, and the project or investment might not be pursued by the company.

Accounting rate of return

The accounting rate of return (ARR) is a ratio used in capital budgeting to calculate an investment's expected return compared to the initial cost. Unlike NPV, ARR does not account for the time value of money, and if the ARR is equal to or greater than the required rate of return, then the project is deemed to have acceptable levels of profitability.

ARR is presented as a percentage return, meaning that an ARR of 20% means that the project is forecast to return 20p for every 100p invested over a one-year period. To calculate the ARR, you would divide the average return during a given period by the average investment in that same period.

Why is investment appraisal important for traders?

Investment appraisal is important for traders because it is a form of fundamental analysis and, as such, it is capable of showing a trader whether a stock or a company has long-term potential based on the profitability of its future projects and endeavours.

If a company is involved in a number of long-term investment projects, there is also a greater risk that revenues, costs and cashflows might be damaged. This is something that a trader will need to consider before they take a position on a company's shares.

❖ PRODUCT COSTING

**Product costing is the accounting process of determining all business expenses pertaining the creation of company products. These costs can include raw material purchases, worker wages, production transportation costs and retail stocking fees. A company uses these overall costs to plan a variety of business strategies, including setting product prices and developing promotional campaigns. A company also uses product costing to find ways to streamline production costs to maximize profits. For example, choosing raw materials that are more cost-effective can allow a company to increase profit from retail sales by lowering its product creation costs.

**Product costs are the costs directly incurred from the manufacturing process. The three basic categories of product costs are detailed below:

1. Direct material

Direct material costs are the costs of raw materials or parts that go directly into producing products. For example, if Company A is a toy manufacturer, an example of a direct material cost would be the plastic used to make the toys.

2. Direct labor

Direct labor costs are the wages, benefits, and insurance that are paid to employees who are directly involved in manufacturing and producing the goods – for example, workers on the assembly line or those who use the machinery to make the products.

3. Manufacturing overhead

Manufacturing overhead costs include direct factory-related costs that are incurred when producing a product, such as the cost of machinery and the cost to operate the machinery. Manufacturing overhead costs also include some indirect costs, such as the following:

- **Indirect materials:** Indirect materials are materials that are used in the production process but that are not directly traceable to the product. For example, glue, oil, tape, cleaning supplies, etc. are classified as indirect materials.
- **Indirect labor:** Indirect labor is the labor of those who are not directly involved in the production of the products. An example would be security guards, supervisors, and quality assurance workers in the factory. Their wages and benefits would be classified as indirect labor costs.

Example of Product Costs

Company A is a manufacturer of tables. Its product costs may include:

- **Direct material:** The cost of wood used to create the tables.
- **Direct labor:** The cost of wages and benefits for the carpenters to create the tables.
- **Manufacturing overhead (indirect material):** The cost of nails used to hold the tables together.
- **Manufacturing overhead (indirect labor):** The cost of wages and benefits for the security guards to overlook the manufacturing facility
- **Manufacturing overhead (other):** The cost of factory utilities.

Company A produced 1,000 tables. To produce 1,000 tables, the company incurred costs of:

- $12,000 on wood
- $2,000 on wages for carpenters and $500 on wages for security guards to overlook the manufacturing facility
- $100 for a bag of nails to hold the tables together
- $500 for factory rent and utilities

Total product costs: $12,000 (direct material) + $2,000 (direct labor) + $100 (indirect material) +

$500 (indirect labor) + $500 (other costs) = $15,100. As this is the cost to produce 1,000 tables, the company has a per unit cost of $15.10 ($15,100 / 1,000 = $15.10).

**The cost of a product on a unit basis is typically derived by compiling the costs associated with a batch of units that were produced as a group, and dividing by the number of units manufactured. The calculation is:

(Total direct labor + Total direct materials + Consumable supplies + Total allocated overhead) ÷ Total number of units = Product unit cost

Product cost can be recorded as an inventory asset if the product has not yet been sold. It is charged to the cost of goods sold as soon as the product is sold, and appears as an expense on the income statement.

Product cost appears in the financial statements, since it includes the manufacturing overhead that is required by both GAAP and IFRS. However, managers may modify product cost to strip out the overhead component when making short-term production and sale-price decisions. Managers may also prefer to focus on the impact of a product on a bottleneck operation, which means that their main focus is on the direct materials cost of a product and the time it spends in the bottleneck operation.

PROBLEMS WITH PRODUCT COSTING

The modernization of manufacturing techniques and improvements in product shipping has greatly changed the ways businesses calculate product cost. According to eNotes, an education website, manufacturing facilities in the 21st century can assemble products so quickly that there's little need for component inventories. This renders many old methods of calculating product cost irrelevant. Additionally, shifts in manufacturing focus to meet customer needs through production have led to manufacturing lines with small variances in production techniques. These seemingly small differences in production techniques create complicated accounting situations where companies have difficulty determining actual production costs in the short term. Compensating for this lack of clarity requires companies to make long-term projections regarding costs over the life of product lines instead of costs leading up to the sale of products.

PROBLEMS OF MEASUREMENT

In product costing much emphasis is placed on capturing *all* costs, even those that do not immediately spring to mind, one of the reasons why ABC is growing in popularity: it begins with activities and thus by definition encompasses all of a corporation's many involvements. In the production process, measurement is relatively easy even if complex. A complexity arises, for instance, in assigning the capital costs of equipment to individual products that pass through it—

and including the costs of cooling liquids and lubricants used in machining. But raw materials purchasing, for instance, including the costs of developing good relations with suppliers, is difficult to measure in relation to individual products. Warranty service is yet another area that does not immediately spring to mind: it is typically handled long after a sale is completed.

Just how detailed product costing should be will naturally arise in the course of operations—motivated by the types of analysis a business requires to solve its problems or to adjust its pricing. Very detailed product costing has a cost of its own—the justification for which will be the use to which such data are put.

PRODUCT COSTING IN SERVICE OPERATIONS

The "product" of a sales consultancy may be a printed report to a client accompanied by a Microsoft PowerPoint presentation at the client's headquarters. Here the real cost of the product will have little relationship to the costs of the tangible "deliverables." The business is actually selling information and judgments acquired by interviews, focus groups, data searches, reading, analysis, discussions, and consultations some of which may have required extensive travel. In another operation, engaged in evaluating sites for the presence of hazardous waste dumped in the past, the deliverables may again be a report, but the work may have required extensive groundwater sampling based on geological maps of the site and extensive searches of old real estate transactions. In yet a third operation, specializing in carpet cleaning operations, the product is a visit in the course of which equipment is used and labor applied.

In most such situations, product costing takes place in advance of all work actually accomplished. And, typically, good estimating is the difference between turning a profit or booking a loss. But the principles that apply are identical. Both in the services and in the manufacturing environments, accurate costing (hence pricing) will depend on subdividing the work carefully into its many categories, measuring time and purchased materials and services. As in manufacturing some products are rejected for faults, so in service work there is wasted time, false starts, and other experiential factors that must be factored in. In both cases, overhead must be known accurately and applied in proportion to the value of the service bid and supplied.

The chief difference is that service activities almost never repeat exactly. Therefore discoveries made in comparing estimates to actual costs can rarely be applied to future jobs with the same precision and expectation of exact results.

❖ PERFORMANCE MEASUREMENT AND CONTROL SYSTEMS

A performance measurement control system is a tool used by organizations to control the performance and outcomes in business operations. It is designed to help managers make

decisions regarding how business is conducted.

Performance measurement control systems contain several key principles: All work activity must be measured; if an activity cannot be measured, its processes cannot be improved; all measured work should have a predetermined outcome regarding performance.

Purpose

A performance measurement control system is designed to help organizations improve performance issues. Every process of a business' operations is studied through this system to improve the performance. When all activities have improved performance, the organization's profitability should increase.

Process

Analysts (managers) determine what the outcome of each particular activity should be. If an activity cannot be measured, the organization tries to eliminate it. After each activity is measured, it is compared to the desired results. If the activity is not performing up to the desired outcome, changes to the activity are implemented to improve performance.

How to Develop Evaluation Criteria

Evaluations are a normal part of all organizations. For evaluations to be effective, the criteria used during the evaluations must be planned carefully. Key components of evaluation criteria include understanding the program objectives, the effectiveness of the activities used by a company to reach the objectives, the efficiency of the company's outputs, and the impact of the company's activities and the sustainability of the business.

Understand the company's main objectives. In order to evaluate how an organization is performing, there must be something to compare the actual performance to. In evaluations, this often starts with a review of the company's goals. Before the criteria for an evaluation can be developed, the objectives of the organization must be clear to those performing the evaluation.

Determine if the activities are sufficient to meet the organization's objectives. The first piece of the evaluation criteria must be an investigation of the company's core operating activities. These activities should be evaluated to determine whether or not they are being conducted properly. If there are gaps or deficiencies, management can take strategic steps to bridge those gaps to improve the overall process.

Measure effectiveness. The next piece of evaluation criteria is determining how well the activities actually helped the organization meet its goals. This includes determining the likelihood of the company meeting its goals based on the way the company's activities are set up.

Assess the company's efficiency. The next step in determining evaluation criteria is to set up a measurement tool to measure the efficiency of the organization's output. This tool will consist of evaluation techniques that measure if the company is using its resources wisely and in a cost-effective manner. This also means assessing whether the goals were achieved on schedule. These measurements can help management design alternative solutions to make the company's operations more efficient.

Investigate the impact the company has. Another key piece of evaluation criteria is studying the impact of the company. This part of the evaluation investigates the results of the company's operations. It looks into the positive and negative impact the operations have caused. Some of these impacts may be unintended, and so the evaluation would have to determine why they occurred.

Evaluate the sustainability. This criterion is used to determine how changes in the competitive landscape, regulatory environment, economic conditions, customer preferences and the job market influence the company's ability to sustain sales and profit growth.

How to Write a Gap Analysis Report

A gap analysis report seeks to benchmark the performance of an organization against target standards or goals. Any type of organization or business can be effectively analyzed using gap analysis methodology. According to Adams Sixth Sigma, all successful organizations have a process of gathering data and subjecting it to thorough gap analysis. Gap analysis is appropriately utilized when reviewing performance within all facets of an organization. These can include, but are not limited to, information technology, business development, human resources and regulatory compliance.

Instructions

Analyze how performance-related data compares to benchmarks set within each constituent group comprising your organization. Utilize objective numbers whenever possible, and avoid input of subjective assessments into your gap analysis model.

Identify deficiencies in each phase of the business against the promulgated targets. Quantify in

tangible terms the extent of each shortcoming.

Determine if sufficient resources exist within the organization in order to attain the target goals. Study individual performance data in order to ascertain if resource deficiencies relate to either quality or quantity.

Calculate the requisite additional resources needed in order to bring performance up to the organization's stated goals. Outline quality issues within the organization's current resources where applicable.

Seek input from the organization's personnel relating to the conclusions of the gap analysis report. Extrapolate from the data which areas within the organization need focus, and devise a plan of action to close the gap between expected and actual performance.

How Does Organizational Structure Affect Performance Measurement?

Modern businesses have complex structures. Decisions taken by top managers and senior personnel affect the overall performance of the business. Strategic performance measurements are aimed at monitoring the effectiveness of an organization's structures.

Organizational Structure

Organizational structure is seen as the hierarchy through which a group, business or organization of people collaborate to achieve a set of objectives and common goals. The ways these hierarchical structures interact with each other affects the measurement of effectiveness in that organization.

Functional Unit Coordination

In an organization, it is assumed that functional units or departments understand their roles and how these contribute to the organization's overall goals. But, most functional units perform their roles in a way that only reflects their specialization and focuses on their own goals. The personal preferences and agendas of a department’s senior managers influence the performance outcomes of that department.

Organizational Alignment

Organizational structures that are inorganic and less versatile tend to cause miscommunication in the overall strategy of the organization. Miscommunication largely affects the execution of tasks and objectives and the organization's performance measurements. Open, fluid organizational structures have exemplary performance measurements. Second-and third-tier employees have an

understanding of the goals the first-tier functional units have planned to achieve.

How to Improve Process Capability

Process capability is a measurement used to reflect how well a process functions within the normal limits of variability. These limits of variability are the upper and lower control limits. The goal is to have the process occur within the range of variability. When the process occurs outside the range, the process is not capable of producing a consistently high quality product or service.

Examine the process flowchart. Look for areas of duplicate work, extended cycle times or rework. If there are areas of duplication, extended cycle times or rework, work with the stakeholders to remove the unnecessary steps. Speak with stakeholders to help them understand that only those items critical to the customer receiving a quality product or service will remain.

Examine the control charts for outliers and variability. If there are outliers or large swings in variability, work to understand if the variability is due to common causes or special causes. A common cause variation is predictable and present in every process. A special cause variation is due to special or unusual circumstances.

Prioritize improvements and create new control charts to examine the effects of the changes.

How to Set Up a Quality Management System

Quality management will allow an entity to perform efficiently and effectively. Quality management involves leading, planning, staffing, organizing, controlling and motivating others within an organization. Even though the ultimate goal of quality management is to satisfy clients with quality products or services, the quality must be evident in every department of the organization, from the manufacturing department to the custodial services. There are five key components to a quality management system: Key players, purpose-driven communication, top-notch training and motivation, research and improvement.

Building a Quality Management System

Hire key players with proven success in their respective areas of expertise. Each person should feel empowered by being permitted to be a part of the decision-making process.

Establish purpose-driven communication by establishing a vision and mission statement for the organization. Communicate the vision and mission statements from the top of the organization to

the bottom. Make it evident to all members of the organization that these statements should govern their interactions with one another, clients and suppliers.

Provide top-notch training. Each member of the organization should be able to learn how to perform his function through professional development sessions, designated mentors and teams. As the organization changes, the training should be reevaluated and altered accordingly.

Establish a motivation system. This involves evaluating the performance of employees and rewarding them accordingly for their efforts. This will encourage employees who are successful to continue; it will encourage others to strive for improvement.

Perform continuous research and use the data gathered for improvement. The research-based approach will allow the company to use the appropriate statistical method to spot potential problems before they negatively impact the organization. The organization should continuously reinvent itself in response to the needs of the people it serves.

How to Conduct a Program Evaluation

A program evaluation employs social research methods to investigate the implementation and impact of public programs. Government agencies, school systems, nonprofit agencies operating grant-funded programs, public health organizations, and others - all conduct evaluations or contract with evaluation professionals. Program evaluation is rigorous, involving extensive research and analysis, but can reveal important findings that help agencies gauge program impact and improve services.

The Evaluation Process

Decide the purpose of your evaluation. Some program evaluations assess the program's implementation so as to improve service delivery. Others gauge the extent to which the program has achieved its goals. Increasingly, most program evaluation is interested in a program's impact, or its effects beyond the stated goals or objectives. Every public program, after all, has unintended effects, even if it achieves what it sets out to do.

Develop a program evaluation plan. This plan organizes your evaluation, specifies the questions you hope to answer, and the means by which you will try to answer them. During the planning process, you should meet with the program director or manager. During this meeting, find out what data, if any, the program staff has as part of program operations. This will give you a head start in data collection and prevent duplication of effort.

Construct appropriate measures for determining the outcomes of your evaluation. If, for

example, you are evaluating a school program that provides tutoring in mathematics for middle school students, a measure of the program's success would be the performance on standardized math tests by students who participated in tutoring versus the performance of those who did not.

Collect and analyze your data. The program manager may have a set of data already in a spreadsheet, or you can enter data into your own spreadsheet, along with any additional data that you collect. The purpose of your evaluation will determine the type of analysis you should conduct. Analytical techniques in program evaluation range from simple descriptive statistics to linear regression techniques. Your statistical or research methods book can help you determine the most appropriate analysis method.

Report your results. This is usually done in the form of a written report, but in some instances done as a presentation. When writing a report, structure it in such a way that the intended readers (usually the program manager and other decision-makers) can easily find the information that they need.

What Is a Nonconformity Opinion Audit?

The function of an audit is to examine the accounts and activities of a business and establish and verify the accuracy of its records. The auditor provides an independent assessment for the business. A financial audit will articulate an opinion on the financial status of the organization, and determine whether the business complies with generally accepted accounting principles. A performance audit, on the other hand, uses information to evaluate the effectiveness and the economy of an organization. If the organization fails the audit either partially or wholly, the auditor will commonly prepare a nonconformity opinion report. A nonconformity opinion by an auditor can jeopardize the certification of an organization.

Nonconformity

The nonconformity opinion states what requirements the organization has failed to meet during the auditing process. This type of opinion usually indicates some discrepancy found in the systems or records of the organization related to GAAP. The auditor will provide evidence of the nonconformity findings in the form of records, documents, statements and observations. If during the auditing process the auditor discovers any aspect of the system that is nonconforming, he must pass the relevant information to the right personnel within the organization.

Options

After the auditor writes a nonconformity opinion, the organization should attempt to rectify the situation. A firm should attempt to reach a consensus with the auditor regarding the nonconformity. Depending on the severity of the write-up, the organization can often rectify the

problem at minimal cost, without significant complications. Additionally, if the organization feels the auditor made a mistake during the auditing process, it should file an appeal with the auditor and ask for a review of the process and records that led to the nonconformity opinion.

Auditor's Obligation

The job of an auditor is to find any discrepancies within the organization. Most auditors have extensive experience in different types of industries, having either worked in them or gained the experience auditing them. Auditors also have to abide by GAAP rules regarding the reporting of nonconformities. Additionally, auditors must answer to the registrar they work for about the observations made in any nonconformity opinion.

Certifications

During a performance audit, the auditor focuses on efficiency. On the other hand, a financial audit focuses on accuracy. Both types of audits aim to improve the performance of the business and preserve the organization's accreditation or certification. Losing a certification or accreditation can result in fines, work stoppage and financial loss for an organization. The organization should, therefore, always take auditors seriously, and address any nonconformity opinions before they cause damage to the overall operations of the company.

How to Implement a Program Management Plan

A program management plan is used to group multiple independent projects in order to achieve a strategic business outcome. Often in program management a lot of focus is placed on writing the plan document and less focus is placed on implementation. An equal amount of effort needs to be placed on implementing the plan to ensure it is successfully carried out, and that any deviations are recognized and managed accordingly. Generally, it is the responsibility of the program manager or the program management team to take full ownership of the program plan and ensure it is implemented effectively.

Establish chain-of-command. Set a clear chain-of-command with a formalized decision-making process. Make sure the process is simple and can support rapid turn-around times so that implementation does not become stalled. Ensure defined processes are not being circumvented by continually monitoring the situation.

Develop program standards and success indicators. Identify the standards that will be used to measure integration of the various program components. Document standards related to processes, communication, data, reports, templates, and distribution methods to ensure that various projects and tasks that are part of the program are integrated.

Identify an Implementation schedule and status reporting. Document details of key project phases, schedules and milestones. Identify plan participants and project contributors and provide them written documentation of their responsibilities and reporting mechanisms. This will keep the team focused and on task.

Communicate, communicate, communicate. All parties involved in the program management plan need constant communication. The communications should include ongoing initiatives and activities, performance reports, successes and accomplishments, and outlets for feedback, input, and comments.

Evaluate process and then re-evaluate the plan. Regularly collect feedback from participants and assess if the goal is being achieved. As each key project concludes, hold a formal meeting to discuss the process. In the process, celebrate success, identify areas of improvement, and modify resources as needed to optimize performance. If goals are not being achieved, evaluate if they should change.

Develop a training plan. If the outcome of the program management plan results in a new system or process, a formal program should be developed to provide training and resources for all the users and system owners. The plan should outline training, communications and change-management programs.

Signs of Weak Internal Controls

Internal controls are procedures companies develop to safeguard their assets and to produce accurate, reliable financial statements. When a company does not have strong internal control procedures, fraud can occur much easier. Organizations should protect themselves from possible threats by monitoring their internal control systems often and adjusting them to be stronger.

Internal controls are procedures companies develop to safeguard their assets and to produce accurate, reliable financial statements. When a company does not have strong internal control procedures, fraud can occur much easier. Organizations should protect themselves from possible threats by monitoring their internal control systems often and adjusting them to be stronger.

Inaccurate Financial Statements

If an organization discovers there are inaccuracies in its financial statements, there might be a problem with the organization’s internal control system. One basic fundamental of internal controls is the principle of separation of duties. This means that different employees handle different areas of the accounting duties. If the same person handles all duties, it is a sign of a weak internal control system. If inaccuracies occur in the financial reporting, a company should

look into the accounting procedures it uses.

Missing Documentation

If a company cannot find certain documents, such as invoices or purchase orders, this might be another sign of weak controls. An organization develops procedures for recording, posting and filing documentations. If a document is lost, there is a good chance that there are problems in the company's processes. If one employee has too much control, he may manipulate documentation to deceive the company.

Lack of Written Procedures

Every process and activity an organization uses should have written procedures to follow. Without written procedures, employees may not know the proper procedures and may complete activities the wrong way. A strong internal control system has written procedures and policies for all business activities.

Customer Complaints

Another sign of a weak internal control system is a higher than usual number of customer complaints. Organizations should develop a system to ensure that customers are pleased with the products and services. If there are a high number of complaints, management should look into the problem and understand that there might be a weakness in its internal controls.

Audits

Organizations hire auditors to determine how accurately the financial records are being kept. An audit will uncover problematic areas, threats, risks and other potential problems. If a company does not hire an auditor on a regular basis, these threats will be harder to detect. It is a regular business practice for companies to have audits completed on a regular basis.

How to Implement Six Sigma

How to Implement Six Sigma. Six Sigma was introduced by Motorola in the 1980s to set standards for the way defects are counted. It is a statistical measure and business strategy. The goal of Six Sigma is to achieve fewer than 3.4 defects per million opportunities by training internal leaders to apply established techniques. Six sigma has been adopted by all sizes and types of organizations.

Commit to the project. Make sure all top-level management is on board and that financial and managerial resources are available. Establish policies and guidelines and hold training programs

for employees.

Define the project scope and goals based on customer feedback and needs. Inspiration for six sigma projects can come from surveys, studies or existing projects. Set goals for the whole organization or for a specific level of the organization that needs improvement.

Measure the defects in the current system and performance. Use statistical data analysis.

Analyze the system to identify defects and problems. Identify the possible causes of problems. Explore possible solutions and assess their possible effect on the organization.

Improve the system by finding ways to do things faster, cheaper or better. Use management and planning tools to put the improvement projects into place. Test the improvement with statistical data.

Control the new process by modifying systems and measuring processes to continue to achieve results. Use customer feedback and statistical tools. State what was done to improve performance. Document methods to recognize and solve future problems.

How to Maintain and Update Policies and Procedures

The best practices for an organization are often called policies and procedures. A policy is the overriding, overarching basis for a decision. A procedure explains how to do something. For example, a policy would be to treat a customer with respect. The corresponding procedure is to greet the customer using their first and last name. For new and existing employees, the policies and procedures are often online which makes it easier to keep them updated and current.

Identify job roles that are responsible for the maintenance of the policies and procedures. Often, this responsibility is the duty of a quality analyst or a business analyst.

Review the current policy or procedure for changes. If either needs to be changed, use language that is concise. Change policy/procedure titles and key points accordingly. Ensure that both the policy and procedure are factual.

Perform the procedure as it is explained or give it to another employee to perform the procedure. If there are any missing steps or assumptions in the procedure, add those steps, clarify any assumptions and do the procedure again.

Audit the policies and procedures once every two months. Select procedures that are used frequently and not as often.

Advise the affected groups of the policy/procedure changes.

How to Design an Audit Checklist

Audits are conducted by companies, government agencies and accrediting bodies to evaluate if individuals and businesses are meeting desired outcomes, documenting accurately and complying with set standards. In addition, audits can assist in identifying areas of improvement. The audit can be conducted by assessing particular pieces of information and evaluating the results.

Using a checklist to conduct an audit will shape the specifics of what needs to be looked for in an audit, how to measure the results, and provide a documentation process for the audit.

Determine what exactly you want to audit and how auditing is achievable. Consider the outcomes your wish to achieve and who is best to complete the audit. For example, if you want to audit a call center employee's performance, consider reviewing the individual's average telephone call statistics during a typical week to assure they are meeting company standards.

Document the questions that will answer a definitive response that can be measured or scored. For example, if auditing a policy against accreditation standards, on your checklist, ask "Does this policy require the company to xxx?" (List the accreditation standard's requirement.)

Develop measurements that correspond to each area of your audit and determine scoring method. For example, if you are auditing whether or not employees completed a particular training, the answer to your question will be a yes or no response. Create methodology to achieve an overall or pass/fail score.

Create a checklist document or software program to capture the results of each audit. Documentation of your audit is important to prove you've completed all aspects of the audit and scored each element.

Complete quality assurance testing to determine if the criteria in your audit is valid and makes sense for the outcomes you want to achieve. If the audit consistently fails or does not produce desired outcomes, evaluate if you are completing the audit correctly. For example, if you are auditing system documentation and the audit repeatedly fails, determine if you are reviewing the appropriate area of they system where the information should be captured.

How to Identify Process Improvement Opportunities

Process improvement is essential for business in a climate of competition, market rivalry and a

global economy. Identifying the processes in your business that can be improved -- by gaining an understanding how efficient and effective processes are -- will help your company grow and expand. The first step in correcting any problems is identifying the processes in your business that can be more productive and efficient.

Be familiar with the business processes. Process improvement starts with having a firm foundation of all parts of the company, understanding what makes the organization work. If you are coming from outside the company, interview as many employees as possible, on all levels; familiarize yourself with all departments and how they work together. Visually chart company processes.

Identify measurable processes in the core business functions. Gather data measurements of the business processes such as inventory levels, costs, sales, demand, labor hours, lead times and space allocations.

Look to where waste occurs in the process flow. Waste is defined as processes that do not add value to an organization. Process improvement drives away waste and increases value in an organization. Wastefulness in processes can take the form of redundancy of personnel or tasks, excessive quality testing, inventory overages or excessive labor. Identifying waste is a key step in determining where processes can be improved.

Construct root cause analysis. You can identify opportunities for process improvement when determining what prevents a process from adequately meeting its objectives. Some tools of root cause analysis include the 5 Whys, Fishbone Diagrams and Value Stream Mapping. These tools can help identify where a process breaks down.

Problems with a Balanced Scorecard

Balanced Scorecard is a method of implementing a metrics system which aligns activities with the vision and strategy of the organization in a way that fosters action. It was created by Drs. Robert Kaplan and David Norton as a method of “performance measurement framework that added strategic non-financial performance measures … to give managers and executives a more 'balanced' view of organizational performance.” (Balanced Scorecard Institute)

Balanced Scorecard Principles

According to Kaplan and Norton, organizations should be viewed from four angles: 1. Learning and Growth Perspective- relates to employee training and development. 2. Business Process Perspective- refers to the internal business processes which allow managers to recognize if the business is running well. 3. Customer Perspective- understands the customer and his needs. 4.

Financial Perspective- implements timely and accurate funding data

Statistics

It is reported that over 50% of Fortune 1000 firms now use the Balanced Scorecard methodology and an estimated 85% of organizations have adopted a performance measurement initiative of some form. Despite the prevalence of implementing Balanced Scorecard solutions, it still has problems.

Misconceptions

While there is nothing inherently wrong with the Balanced Scorecard system, some managers view it as a "quick fix" system to implement that will solve the problems of the business. Businesses will fail when they neglect to realize that Balanced Scorecard is an evolving process which should be carried out over the long term.

Problems

In a 2006 article for BPM Institute, Steven Smith outlined five of the major problems with using the Balanced Scorecard system: 1. Poorly defined metrics- "A system that has sloppy or inconsistently defined metrics will be vulnerable to criticism by people who want to avoid accountability for results." 2. Lack of efficient data collection and reporting- companies should prioritize performance indicators and allocate research money accordingly allowing for the most vital information to be reported. 3. Lack of formal review structure- "Scorecards work best when they are reviewed frequently enough to make a difference." 4. No Process Improvement Methodology- instead use time-tested process improvement methodologies in conjunction with problem solving methodologies. 5. Too much internal focus- consider beginning with external focus and then reflecting on the business' strengths, weaknesses, opportunities and threats. (BPM Institute)

Considerations

Focusing on one measurement of business success can be detrimental to the company. Companies should employ a comprehensive view of measurements, including "an equal emphasis on outcome measures (the financial measures or lagging indicators), measures that will tell us how well the company is doing now (current indicators) and measures of how it might do in the future (leading indicators)."

Risks of Benchmarking

Businesses of all types and sizes recognize the value of comparing themselves to other organizations. This process of benchmarking yields valuable information about the processes and services within an organization that may need improvement. There are, however, some dangers inherent in the benchmarking process.

Failure to Analyze Process

All benchmarking must begin with the organization looking inward. It must analyze its own processes and operations before it can compare itself to another organization. Knowing that your competitor is selling more candy bars than you doesn't help your candy shop improve its sales plan unless your shop first understands the mechanics behind it own strategy. While managers may think they know their own processes, this self-check can reveal some surprising and useful information.

Limiting the Scope

While looking inward is a key first step in the benchmarking process, an organization eventually must start to look outside its own boundaries. This is called external benchmarking because it's about looking at the way the organization as a whole does business. In addition to comparing your organization to other businesses in the same industry, it's a good idea to look at companies in other industries. This shows you new strategies and techniques for managing operations and services. The trick is to balance the inward-looking benchmarking with the external, market-focused benchmarking.

Managing Time

If not managed properly, benchmarking can be a very time-consuming process. Ron Adner and Daniel Levinthal of the Wharton School of Business note the many benefits benchmarking can bring an organization, but they warn that there is a danger in spending too much time trying to be just like another organization -- your competition, for example. Ideally, a small and dedicated team should be appointed to work on the benchmarking process, led by a reliable and responsible project manager who can keep the team on task and who has laid out clear goals and deadlines.

Onboarding

Benchmarking should enable an organization to identify service gaps and areas for improvement. Perhaps one of the most evasive risks of benchmarking is that employees, customers and other stakeholders of the organization may not readily accept the change that should result from the benchmarking process. Change can be frightening when it is seen as a threat to the way business

has always been done or to standard policies and procedures. While your organization's leadership plays a large role in initiating this change, getting everyone on board is important to the long-term success of any change resulting from the benchmarking process.

What are the Key Elements of the Strategic Management Process?

Strategic management is broadly concerned with how an organization's leaders create and implement goals. The process of strategic management involves considering how resources such as money, personnel and time impact the environment in which the organization operates. There are four key elements of the strategic management process: environmental scanning, strategy formulation, strategy implementation and strategy evaluation.

Environmental scanning is the foundational step in the strategic management process. This involves taking a deliberate look at how **internal and external factors** affect the success of an organization. For example, a company can look at how its human resources data, including employee turnover rates and staff satisfaction, have an impact on the organization's performance. The same organization might also look externally at its competition within the industry to determine at which level it can compete. This might involve creating a **SWOT** analysis, or Strengths-Weaknesses-Opportunities-Threats analysis. Understanding the SWOT is an important baseline for further strategic planning.

Once an organization has done its environmental scan and identified its strengths, weaknesses, opportunities and threats, it can then move on to formulating or drafting its strategies. These should be based on improving the key competencies outlined in the SWOT. For instance, an organization might want to capitalize on a new market opportunity, or increase its foothold in a particular technological arena. The important thing to remember is that a strategy should give the organization a **sense of direction**. This is what is commonly called "strategic direction," which business coach Steve Robbins says on his website is about envisioning what the future looks like for a company and making sure that all its leaders are onboard to take it to the next level.

Once a strategy plan has been formulated, it is then up to the organization's leadership to put that strategy into action. This is called strategic implementation and it is all about creating **specific action plans** for how the strategies will be achieved. Suppose a company wants to introduce a new customer relationship management system. The managers would need to set out clear steps toward the implementation of the CRM system. This might eventually turn into dozens of baby steps that each add up to taking the organization in a new direction. Of course, one of the elements of proper strategic management is making sure that all of the resources -- be they human or material -- are available to successfully implement a new strategic direction.

It might seem that the organization's job is done once it has successfully implemented a strategic

plan, but there is actually still work to be done in evaluating the strategy's **longevity and effectiveness**. Evaluation is an ongoing part of the strategic management process because it allows the company's leaders to quantitatively and qualitatively evaluate the impact the new strategy has had on both day-to-day work flows and on the company's broader strategic direction. In some cases it may even be necessary for an organization to rethink its strategy and start the process all over again.

How to Calculate Profit Contribution

In any retail or manufacturing business, it is important to know how much each unit sold contributes to the business's profit. This is commonly referred to as the "contribution margin." This is part of cost volume profit analysis, a management accounting technique that allows businesses to understand their profit levels at varying levels of production. By calculating the contribution margin, a manager can determine which products are most profitable and make production decisions accordingly. It is easy to calculate the profit contribution of a product by following several basic steps.

Write down the unit price. This is the price at which each unit is sold; it is not the unit cost or the unit profit.

Calculate the unit variable cost. This is calculated by first determining the total variable costs for all the products. Variable costs are all the costs that increase proportionately to an increase in production. They include material costs, direct labor costs and any other costs that increase as production increases. Variable costs include all costs that are not fixed costs, such as equipment, indirect labor and real estate. Add all of the variable costs and divide the total by the number of units produced. This will give you the unit variable cost. Write this number down.

Subtract the unit variable cost from the unit price. This figure gives you the contribution margin of each unit, which tells you how much one unit contributes to the profit. Write down the unit contribution margin. For example, if your unit price is $5 and your unit variable cost is $2, then each unit that you produce will contribute $3 toward profits.

Multiply the unit contribution margin by the the number of units produced. This will give you the total contribution margin for all units. This is useful if you want to know how much your total production is contributing to profits.

MODULE 4

CONTROL TECHNOLOGICAL AND DESIGN PARADIGMS

❖ CONTROL TECHNOLOGICAL AND DESIGN PARADIGMS

The term *paradigm* has appeared in the literature owing to Kuhn's theoretic contemplations on the historical development of science. Over the last forty years, this term has often been used by a great number of researchers specialized in different scientific fields, including almost all parts of the economic theory. Paradigm as a term has been used in economic researches to explain the dominant modes and forms of economic consideration. Thereat, as a rule, the analogy has been drawn with Kuhn's idea that there exist different scientific paradigms.

The term technological paradigm is also used within wide research field of the economics of technological changes to explain the radical changes in technology as the material basis of production of goods and services. Technological paradigm denotes concretization of solving the existing technological and economic problems, based on the highly selective principles. It should be noted that certain number of authors use the term disruptive innovations instead of the neologism technological paradigm. A term techno-economic paradigm is also in use, which underlines the indissoluble link between technology and economics. Techno-economic paradigm denotes a group of technical and economic characteristics of a certain technological solution, which is constantly being improved, thus becoming more coherent and complex, with a strong influence on forming all parts of great economic system. That is a general model which operatively leads to the intensive process of generating the innovations of products and processes. In contemporary conditions, the term techno-economic paradigm substantially incorporates common characteristics, complementarities, or mutual links of several partial paradigms related to semiconductors, computers, industrial automation, robots, etc.

Developed techno-economic paradigm denotes a new concept of efficiency for an organizational model on the level of the basic production unit and a new model of managing a firm. As a rule, it implies a lower input of the labor force per final product unit (labor productivity increase) and engaging very different qualified and educational profile of workers.

It manifests a strong orientation toward generating technological innovations. It presumes investment growth, primarily in the fields which are directly linked to the key growth factor.

By observing historical development of the capitalist modes of production, it can be noticed that the dynamics of production and employment in some countries is in the positive correlation with the key innovations of technological paradigms within long time interval.

In a word, manifestation of the long waves as the manifesting forms of economic dynamics over the last two centuries has been directly linked with the widest diffusion of disruptive innovations characteristic for certain technological paradigms.

All rising phases of long cycles are generated owing to the effects of disruptive technological innovations, which dominantly profile each new technological paradigm. More precisely, each of the cycles is concentrated around the existing technological paradigm, that is, certain type of technology which dominates and lasts for about 50 years. In theory, suchlike cycles of development are named after the Russian scientist Kondratieff.

This author was conducting researches on the economic dynamics during the eighteenth, nineteenth and the beginning of the twentieth centuries and made clear distinction between evolutionary (unrepeatable) and wavy (repeatable) processes. Whereas the first occur in certain direction, that is, there is no returning to some of the previous stages, as far as the second is concerned, the process can be restored to the initial state. In real economic life, both types of processes occur at the same time. Kondratieff's theory of long cycles refers to the repeatable (cyclical) processes. The rhythm of long cycles defines the model of the economic growth, which is the result of social, technological, economic and institutional transformations of the subjects of the world economy.

The idea of long cycles was revived during the fourth decade of the last century by Schumpeter, who regarded disruptive technological innovations as their main prime-movers of the economic development. Different types of innovations precede the expansion of certain industrial sectors, whose development profiles the greatest part of economic life. By way of illustration, by the beginning of the seventies of the past century, the model of mass production based on the cheap petroleum was dominant. After that starts a gradual introduction of a new, nowadays dominant production model, based on the mass use of information technologies. However, the indications of defining a new technological paradigm are becoming more and more obvious, and that paradigm is enabled by the scopes of the nanotechnology domain.

DOSI'S CONCEPT OF TECHNOLOGICAL PARADIGMS

The term technological paradigm sounds like a loan-word from science, or to be more precise, it is associated with the ideas of scientific paradigms which are used to differentiate among certain schools of scientific thought. According to Dosi, technological paradigms represent one general sphere or field of technology, within which the search for the innovation is conducted by a larger group of innovators, within certain historical context. The author mentions nuclear technologies, semiconductor technologies, and organic chemical technologies as examples of technological paradigms. Technological paradigms as such set the technological domain within which the dominant technology evolves.

Accordingly, one technological paradigm efficiently demarcates the research field in which the search for innovations is conducted. As regards to the innovations, the research process is limited by determining these boundaries, in terms of the direction of the research and the transcriptions which have been searched for. It is very likely that the technological paradigm will be based on the selected set of principles. These principles, in return, will most probably limit the process of innovation, concerning:

- The Research Field
- Problems To Be Solved
- Applied Procedures
- Comprehensive/Genetic Task On Which It Is Applied
- Manifested Characteristics
- The Material The Technology Uses.

Technological paradigm plays a very important role in setting the framework of the research by defining "the rules of the game", although it may occur completely unintentionally.

Indeed, as Dosi points out, technological paradigms tend to manifest a very strong "excluding effect" which limits the efforts and technological imagination of the engineer, as well as of the

entire organization, thus making them blind for other technological possibilities.

When a new technological paradigm appears, it represents a great discontinuity or a change of the way of thinking. The change brought by the paradigm may be related to some form of radical innovation which applies some new technology. Dosi mentions a change in electronics as an example, which implied the transition from thermo valve to semiconductors. That required new principles of handling, new materials and the whole group of new tasks. Similarly, in the field of aviation technology, the transition from the piston drive to jet drive is one more example of the change which technological paradigm brings. The piston drive required new materials, new scientific principles and new control systems, and it implied facing completely new problems.

In case the technological paradigm is changed, the transition from the old technology to the new one can be very difficult for the existing firms, especially because the firms invested in irretrievable possibilities of the production through skills and marketing, as well as in the support, capacities and the reputation of the product. When the new technology of electronics struck cash register industry, it brought big problems to the responsible producers, such as NCR, which adhered to the old mechanical technology very strictly. NCR's investing in the plant capacity, R&D, patent, intellectual property and service networks were marked as outdated. The need to redesign the character of the product was even more problematic question. NCR, for instance, saw the new technology of electronics as a way of manufacturing cash-registers which can register large number of digits in a short period of time. As distinguished from other entrepreneurs, they failed to create a new concept of the product.

DESIGN PARADIGMS OF AGILE MANUFACTURING

Worldwide competition among manufacturing enterprises has acted as a driving force for the design, development and utilization of manufacturing systems with an increased degree of agility. In these regards, Holonic Manufacturing Systems (HMS) is considered an intelligent systems paradigm to meet requirements for agile manufacturing systems. Despite all advantages of HMS, design and implementation of such control systems for real industrial cases is time consuming and requires risky, but careful consideration. While some universities may be able to expose their students to the latest manufacturing systems and technologies, others may not be that fortunate due to the lack of financial resources. Because of this, alternative ways for providing their students with equivalent education and training need to be developed. A potential solution for this issue is the adoption of advanced computer technology to facilitate the provision of flexible manufacturing-related education and training programs. To date, many studies have shown that the use of computers for teaching and training purposes is feasible and rapidly becoming an integral part of the general learning process. This paper presents a Virtual Reality (VR) system tool “VR-HMS” developed for training on design of holonic manufacturing control systems to enhance the development process. The proposed VR system is a safe approach to teaching the operations of HMS, which is well known as a large-scale and complex systems for a number of operational and structural reasons. The VR-HMS allows trainees to self-experience on these systems without the need to work in actual industry.

One widely accepted approach in response to the above challenges is the introduction and utilization of so-called Holonic Manufacturing Systems (HMS). To date, there have been many

studies on HMS development. Most of those conducted are based on a generic shop floor control system with a main focus to the model definition or to a specific description of algorithm at a theoretical state. In terms of the experimental research, HMS developments are typically conducted on "toy simulation cases". As a consequence, many researchers are refrained from problems and uncertainties that a real shop floor could impose. Furthermore, HMS possesses non-deterministic behavior. Hence, testing HMS in a real manufacturing environment is costly and requires several experiments in order to predict the behavior of the system.

Taking all into account, the design and implementation of such a highly complex control system is costly, time consuming, and requires a lot of experience to mitigate potential risks of failure.

Therefore, new methods and tools for designing manufacturing systems with intelligent control architectures, such as HMS, in a quick, cost-effective manner that is error and risk free, which are needed by the industry.

While there are a number of simulation methods and commercial tools available for design and development of integrated manufacturing systems, most of the state-of-the-art manufacturing simulation tools do not contain built-in capabilities and functions regarding negotiation and self organization.

Overall, applications those are capable of simulating the de-centralized control of manufacturing systems is very limited. It still is a challenge to build a system which is able to provide an efficient and effective means to design and develop manufacturing systems with modular, interactive elements that, in addition, facilitate a de-centralized, intelligent manufacturing control architecture into the manufacturing simulation in order to allow for the design of an agile factory.

In light of this, the authors address the issue of how engineering students and practicing engineers can be trained (safely and cost-effectively) in the design and implementation of Holonic Manufacturing Systems. Utilizing Virtual Reality (VR), an integrated methodology for design and operation of holonic agile manufacturing systems that only requires limited expertise and minimum cost has been proposed. The aim is to integrate so-called Virtual Factory (VF) simulation into the design process of modular and re-configurable manufacturing systems. The methodology utilizes two major components: 'VR-based simulation' and 'holonic manufacturing control' in an information system framework for design and operation of manufacturing systems.

A 3-D visualization platform provided through a VR-based simulation tool allows system designers to create any kind of common manufacturing operations. The underlying holonic control architecture is built upon a multi-agent system (MAS) of autonomous and cooperative decision making agents. The overall methodology has been implemented as an easy-to-use tool for manufacturing systems education.

Holonic Manufacturing Systems: An Overview

Holonic Manufacturing Systems are Intelligent Manufacturing System (IMS) that integrate the entire range of manufacturing activities from order booking through design, production and marketing in order to realize a highly agile manufacturing enterprise. In production environments, the main advantages of HMSs are their distributed computational operations, their distributed decision making functions as well as the cooperation between intelligent entities characteristics that do not exist in conventional control systems.

HMSs are based on a combination of hierarchical and heterarchical control structures by means of cooperating holons. The term holon, in the sense in which it is currently used in the manufacturing area, was introduced by A. Koestler. He stated that – in principle – wholes and

parts in the absolute sense do not exist anywhere. To emphasize this point, he suggested a new term 'holon' as a fusion of the Greek word 'holos' meaning the 'whole' and the suffix 'on' denoting a particle (as in neutron).
The most common implementation of HMSs is through Multi-Agent System (MAS) technology. MASs possess special features for modeling intelligent systems, such as autonomy, rationality, reactivity, pro-activeness, adaptability, mobility, and benevolence. They provide clear, unambiguous analysis and design guidelines for HMS modeling and development.
Many researchers have pointed out that holons and agents are very similar concepts.
However, some extensions must be considered in MAS methodology to model the HMS requirements in an appropriate way. These are: a 'holon recursive structure, system abstraction levels, and a mixed top-down and bottom-up approach for design and analysis processes.
Moreover, the availability of complete MAS methodologies makes such technology suitable for HMS modeling and implementation in such a way that holons and their interactions are modelled and simulated throughout the agents.

Virtual Environment in Manufacturing Education

In engineering education it is desirable for students and trainees to obtain a great deal of practice, which leads to a sound understanding of the subject matter. Unfortunately, this is not always possible due to lack of resources in terms of state-of-the-art equipment, laboratory space, personnel, and maintenance. One potential approach to improve experience-based education is through the utilization of so-called Virtual Environments (VEs). Simply put, a VE is a computer system, which generates a virtual 3-D environment within which users can interact and receive real-time feedback. Studies have emphasized the great potential of VEs for educational purposes at all the levels. For example, Tan and Francis showed that it is possible to use VEs as a training tool, especially in domains that use complex and potentially dangerous equipment.

In the manufacturing sector, simulation packages with three-dimensional modeling and animation capabilities are progressively gaining favor. The visualization capability provided by 3-D modeling and simulation packages not only provides much richer, closer-to-reality information for users, but also enables new application domains to be addressed, such as design and development models for rapid prototyping of machine systems, layout design, process planning, tele-robotics, assembly planning, manufacturing system visualization and simulation. These applications have a significant role in bringing systems into operation more rapidly and more reliably because more testing and verification can be done earlier in the life cycle and in a safe environment.
A major outcome of the virtual environment research in manufacturing has lead to the development of Virtual Factories (VFs). A Virtual Factory can be defined as 'a complex computer based simulation system that provides the manufacturing system designer all the resources and tasks necessary to achieve the optimized operation of designing, producing and delivering a product'.
The utilization of VFs in manufacturing education has been emphasized by many researchers. It has been shown that people can indeed learn to perform certain tasks such as console operation from virtual environments and that knowledge and skills acquired through a VR simulation can be effectively applied in the real world.

VR-Based Holonic Design and Operations Environment: The Overall Methodology

The proposed approach exploits simulation in a much wider range of applications with significant benefits in the design and development of agile manufacturing systems. To this end, a number of integration mechanisms are facilitated in supporting processes in a typical design and development life cycle.
These include:
(i) Creating VR manufacturing environments based on functional and holonic control requirements.
(ii) Identification of holons and holarchies for modeling holonic control architectures by MASs in a wrapper model as shown in figure 1. Exchanging the control requirement/design information between VR simulation and the holonic operations environment.

(iii) Performing distributed control of manufacturing devices and execution of control functions in VR operations environment with holonic architectures with runtime support application verification.

The overall methodology, as shown in Figure 1, is built upon design and integration of two major environments: (1) holonic control, and (2) VR operations environments. A common design platform based on object-oriented design and programming is employed for modeling the two environments and the interactions between them.

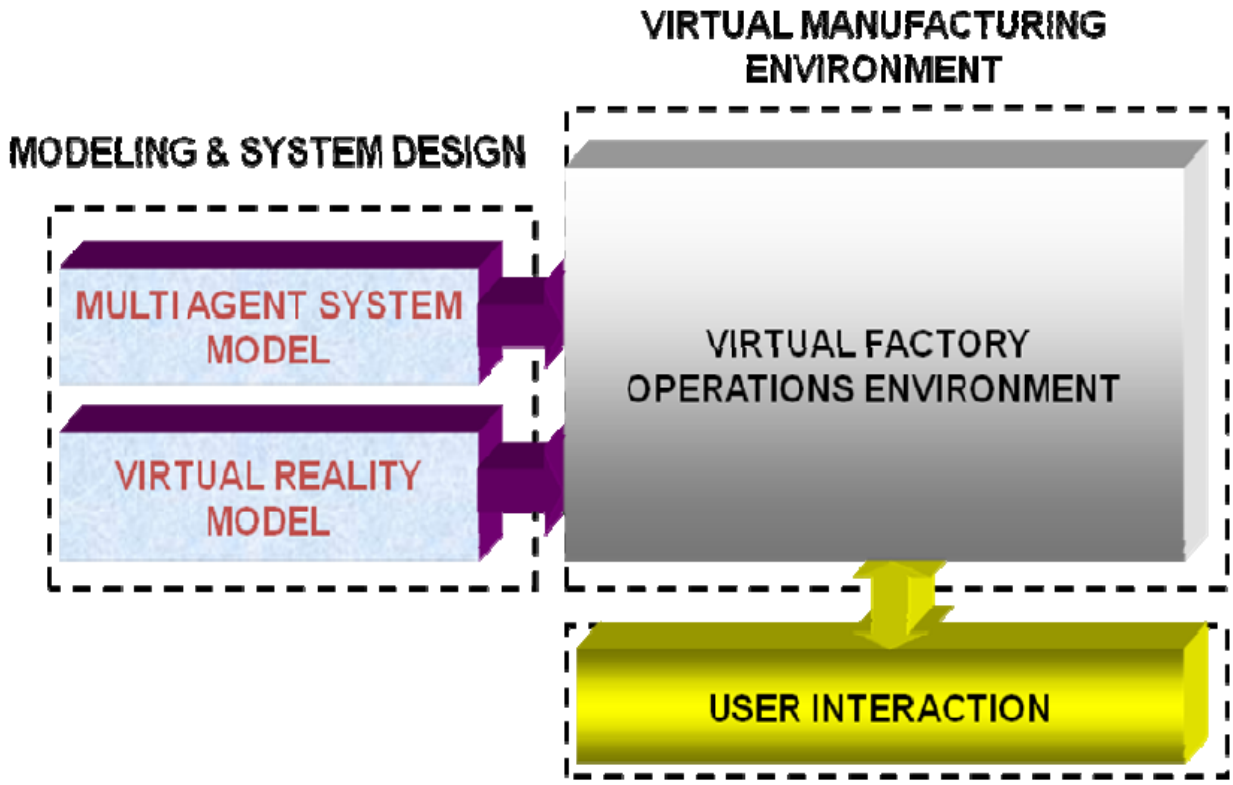
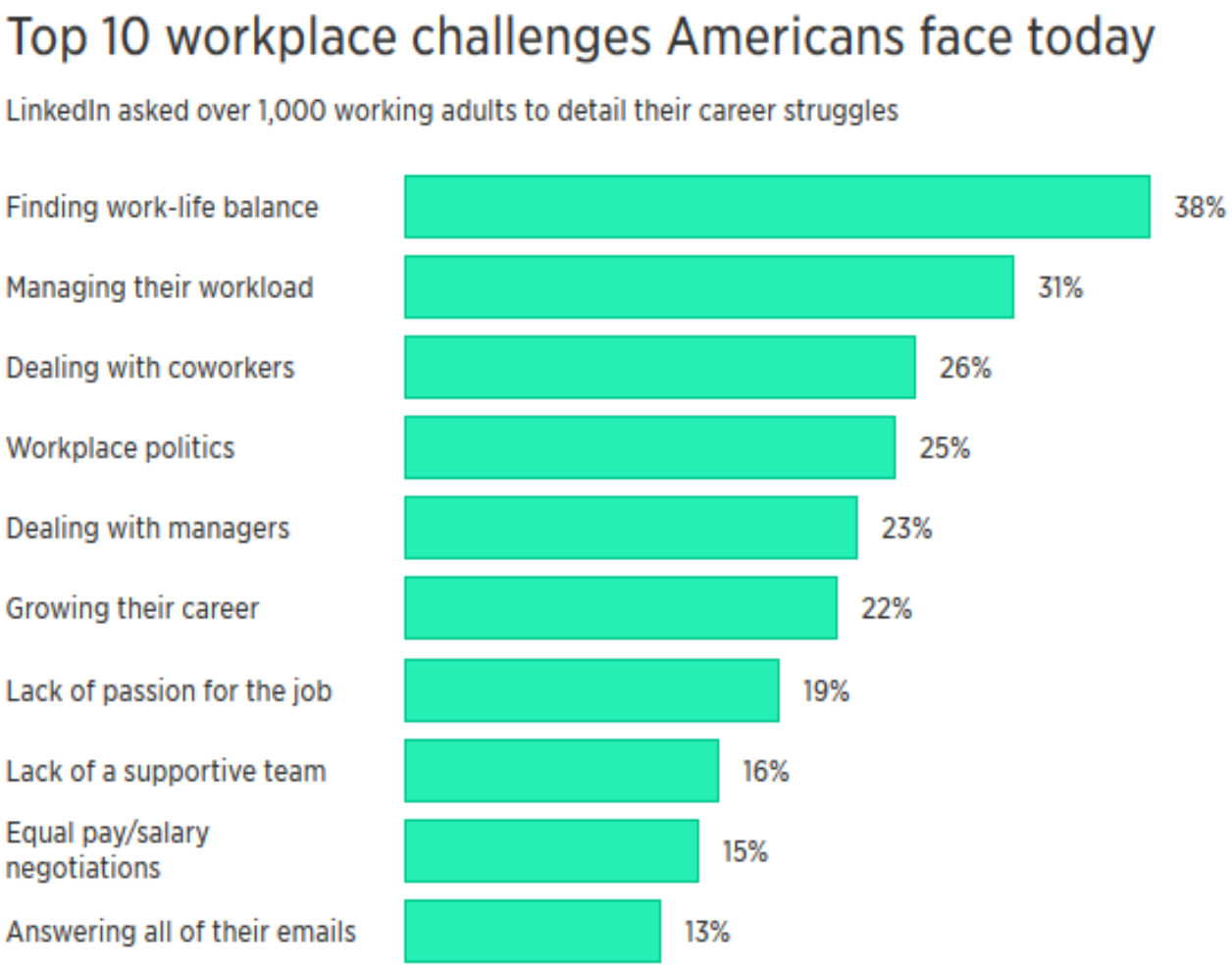


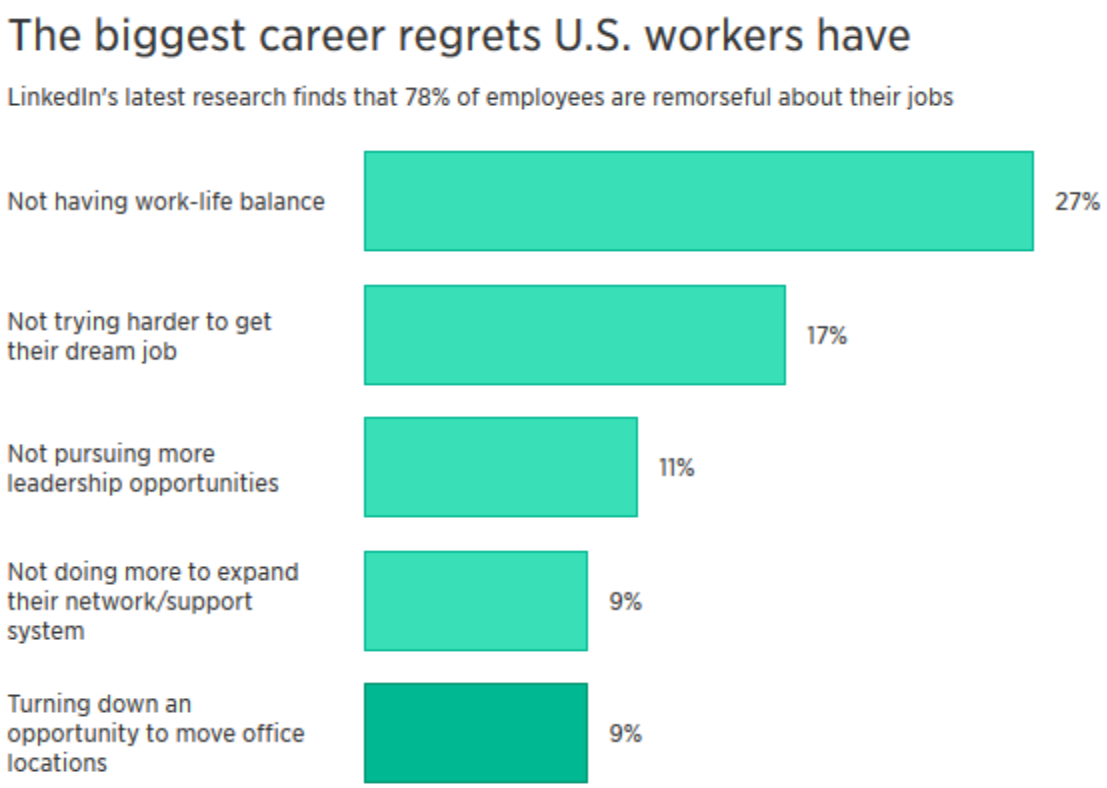
Figure 1: The Overall Methodology

❖ TRADITIONAL PROBLEMS IN WORKPLACE

10 Drawbacks to Traditional Organizational Culture

1. Slow to react to external/internal changes as systems are designed for stability
2. Too many structural layers slow down and reduce communication effectiveness
3. Authority Is maintained centrally, reducing the effectiveness of front-line staff
4. Problems take too long to solve and keep recurring, wasting time and resources
5. Purposes are often in conflict (Ex: finance wants to save – depts. need to spend)
6. The structures and systems create problems by dividing and boxing people
7. Most people are excluded from the decision-making and thinking processes thereby limiting potential to change and adapt quickly
8. People are not involved or included in the purpose of the organization and feel apart from it rather than a part of it
9. Failure is a greater focus than success
10. The organization does not perform as well as it should or could


Top 10 workplace challenges Americans face today
LinkedIn asked over 1,000 working adults to detail their career struggles
Finding work-life balance
38%
Managing their workload
31%
Dealing with coworkers
26%
Workplace politics
25%
Dealing with managers
23%
Growing their career
22%
Lack of passion for the job
19%
Lack of a supportive team
16%
Equal pay/salary negotiations
15%
Answering all of their emails
13%


The biggest career regrets U.S. workers have
LinkedIn's latest research finds that 78% of employees are remorseful about their jobs
Not having work-life balance
27%
Not trying harder to get their dream job
17%
Not pursuing more leadership opportunities
11%
Not doing more to expand their network/support system
9%
Turning down an opportunity to move office locations
9%

❖ ORGANIZATIONAL ISSUES

1

Table IV:8 – Common Types of Issues in Organizations

Board operations ▪ Low attendance at meetings ▪ Low participation in meetings ▪ High turnover of Board members ▪ No, or poor, decision making ▪ Rubber-stamping recommendations from the Chief Executive Officer ▪ Conflict among Board members ▪ Micromanagement of day-to-day activities
Strategic planning ▪ Lack of clear focus for the organization and for making major decisions ▪ Frequent, conflicting suggestions from Board and/or employees ▪ Continual shortage of funds across the organization ▪ Low attendance and participation from Board and/or employees ▪ Poor results from products and services ▪ Conflict among Board members and employees about priorities, roles and responsibilities

Business planning

- Lack of clear goals and outcomes with products and services
- Shortage of resources for products and services
- Little or no results from products and services
- Frequent complaints from employees who deliver products and services
- Conflict and turnover among employees who deliver products and services

Management development

- Poor planning, organizing, leading and administration of resources
- Lack of direction and guidance to employees
- Conflict among employees
- High employee turnover
- Poor communication between employees and between Board members
- Incomplete implementation and evaluation of products and services
- Board is not involved at all, or far too much, in planning and leadership

Employee development

- Frequent turnover
- Frequent complaints and conflict
- Poor performance
- Compliance ("going through motions") on the job

Teamwork

- Conflict between team members
- Inefficiencies in activities
- High turnover of members
- Confusion about decision making and problem solving
- Poor performance among members
- Ineffective meetings
- Low morale

Financial management

- Shortage of resources for products and services
- Lack of understanding of costs of various resources
- Bills continually not paid on time
- Problems reported by annual financial audits
- Numerous requests for funds from investors
- Frequent refusals from investors
- Financial goals are not clear

Advertising and promotions

- Little or no available feedback from customers
- Strong testimonials and results from customers, yet little growth in products and services
- Confusion among customers about features and benefits of products and services
- Lack of resources to obtain, develop and deliver products and services

Evaluations of products and services

- Confusion among employees about products and services
- Inability to successfully describe products and services to others
- Poor results from products and services
- Frequent complaints and conflicts among employees who deliver products and services
- Ineffective advertising and promotions

❖ ROLE OF TECHNOLOGY

Any framework that is used to structure, plan and control the process of developing a system is its development methodology. Several such frameworks have evolved over the years. Each one has its own strengths and weaknesses. There are several of them available for developers. Scrum, Waterfall, Lean, Agile methodologies are some of them. For their projects, businesses have a number of options to choose from. Though Agile methodology has proved to be very effective in larger organizations the communication and co-operation dynamics in a start-up is very different from that of a larger organization. So does Agile methodology works for start-ups too? Let's find out.

#What is Agile Methodology?

Agile Methodology is a development method in which requirements and solutions evolve in cross-functional teams through the collaborative effort. Its approach aligns project and product development with requirements of the customer and overall company goals. It is a methodology based on iterative development. This process encourages frequent inspection and adaptation which helps in rapid delivery of high quality software. Agile methodology is developed for products and projects that require flexibility and speed- which actually means, almost every product and project which is being managed today. Agile Methodology does help start- ups. How

#1 Adapts to Organizational Change Quickly

Agile methodology provides a rapid response to change in the organization. It aids the dynamic characteristics of business processes and helps in managing changing requirements of the projects. One of the important principles of Agile Manifesto stresses on welcoming changing requirement, even if late in project. Agile methodology enables both the customer and the stake holders to gain feedback on latest iterations and new features sooner than later. Stakeholders can rethink on requirements and features; can add new ones and the development teams can follow

them quickly. Development teams innovate and take risks according to the requirements of the customer as they are constantly in the loop. Adapting quickly to the changes saves time and resources which help the start-ups sustain themselves. It is the best methodology for the environment that changes steadily. Start-ups constantly adjust and readjust their sails to get the headwind.

#2 Encourages Individual Interaction

Agile methodology majorly depends on its stand-ups, the meetings. Every team member has to come prepared with answers to these three questions.

i) What have you accomplished since the last meeting?

ii) What are you currently working on until the next meeting?

iii) What is getting in your way from doing your job efficiently?

The answers to these questions majorly describe the scope of the projects, profiles, schedules and specify everyone's individual role in it. Everyone knows who is responsible for what. This eliminates the chances of any kind of duplication of work and clarifies confusion if any, among the team members ensuring good communication. In a big organization with big teams, formal structures – this process might not work effectively, but in start-ups it works magnificently.

#3 Installs the Culture of Working Cohesively

Interacting with your peers on daily basis to discuss the ongoing projects and ensuring collectively that the projects stay on schedule and on track promotes teamwork- a sense of belonging with a clear sense of responsibility. You find out your own strengths and weaknesses and collectively decide the role that optimally utilizes your expertise. If you need motivated leaders, you provide them with right environment. If you need people who can carry the load for the duration it needs to be carried, provide them with right support. For start-ups better teamwork translates into lesser wastage of resources, which is important.

#4 Agile Development Boosts Quality

There is no doubt about the fact that Agile Development improves the overall quality of the software. In agile development cross-functional teams eliminate bottlenecks through constant communication. Developers depend more on the quick feedback from the stakeholders for requirements than on the formal documents prepared months ago. There is a sense of immediacy and dynamism. The teams use artefacts like DoD –The Definition of Done, to assess if the list of requirements is complete. Automated testing process identifies the problems early in the development. Integrations are easy and the concept of CI – Continuous Integration prevents the issues from cropping up. Test driven development ensures there in no complexity in the architecture and the design. As an upcoming unit, it is very important for the start-ups that they stay focused on quality and agile development helps them do that.

#5 Saves Time and Effort, Fostering Resourcefulness

Agile methodology ensures your projects remain in budget, on schedule and are completed without hitches. Start-ups work on limited resources. Agile development ensures optimal use of its resources. Teams are smaller and can work cross-functionally. Agile is a mindset. It believes in constantly adding value to the product by managing the constraints. Feedback is gathered from the customers and the small agile teams then perform work in small sprints all guided by the feedback. When you compare it with waterfall technology, agile methodology provides more transparency in the processes and the products made reach the customers faster with the help of sprints (which basically are short delivery cycles). Project development guided by customer feedback and iterative cycles ensures there is less wastage of resources. The best part is, agile development can start by being a part of the system in a lean start-up but slowly being advantageous, it almost always becomes the whole ecosystem.

#6 Enables Diffusion of Knowledge and Cross-Training Across Organization

Daily meetings, the stand-ins, ensure everyone knows what everyone else from the team is working on at any given time. There is diffusion of knowledge and by sharing the details of the development process together team members know and understand even the parts of the components they aren't directly associated with. Agile software development techniques like pair programming where two programmers share a single workstation – one screen, keyboard and mouse where one programmer takes the role of a driver and the other takes the role of a navigator are getting more traction. The driver codes and the navigator provides the direction to the project. There are several advantages of this agile technique which the start-ups can benefit from. Better code quality, better coordination, better dispersion of knowledge when a developer who knows all about a component pairs with a developer who is unfamiliar with the component being developed and yes, agile development helps you find alternate and more effective ways of developing applications. Resources being limited, a lean start-up benefits when there is cross-functional training and one man is able to pick up another man's role effectively with immediacy.

#7 Keeps all the stake holders in the loop

Many a time's founders and key stakeholders are not a part of actual development process. Agile methodology is aimed at promoting sustainable development while ensuring all the stakeholders -like product owners, developers and users are in the loop.

Scrum, a part of the agile movement helps you achieve that. Instruments of scrum like burn down charts and product backlog charts serve the purpose of demonstrating progress to all the stakeholders which tells them more than the list depicting which features have been shipped can tell. All this information is very useful for founders of the lean start-up who need to think quickly and decide the course of action quickly too.

Winding up

Agile methodology is the best bet for start-ups. It ensures that iterations are faster. It helps in managing

its resources optimally and the business gets on track at their earliest. By adopting agile methodology start-ups can reduce their costs, keep the teams closely knit, keep their projects on schedule and yes, stakeholders get better returns on their investments.

MODULE 5

AGILE MANUFACTURING ENTERPRISE DESIGN

❖ AGILE MANUFACTURING

Meaning of Agile Manufacturing:

Agility refers to the capability to adapt. Agile manufacturing is adopted where a company having processes, tools and trained personnel is required to quickly respond to changing customer needs and market changes, without compromising quality and reducing costs, thus delivering value to the customer.

The technology has emerged as a follow up from lean production. Agility addresses new ways of running companies integrating flexible and nimble organisation, trained people and technology into a meaningful utility.

It thus attempts to do with less and less human effort, less equipment, less time and less space, while coming closer and closer to providing customers what they want. The products are customised in agile manufacturing against standardised products in huge volumes in mass production.

Agile manufacturing is enterprise level manufacturing strategy of introducing new products for rapidly changing markets, and having organisational ability to thrive in a competitive environment characterised by continuous/ unforeseen changes by rapidly reconfiguring the human and physical resources to changing environment and market opportunities. Such organisation values knowledge and rewards the innovation. It has entrepreneurial spirit, and there is a climate of mutual responsibility for joint success.

The top priority of agile companies is to cooperate internally and with other companies even if it involves partnering with them (competitors) by forming virtual enterprises. Pricing of product is based on the value of solution to customer rather than on manufacturing cost.

Key Enablers of Agile Manufacturing:

The key enablers of agile manufacturing are:

(i) Virtual enterprise formation,

(ii) Physically distributed manufacturing architecture and teams,

(iii) Rapid partnership formation,

(iv) Concurrent engineering,

(v) Integrated product/ business information systems,

(vi) Rapid prototyping,

(vii) Electronic, information technology and communication technology utilisation, etc.

A lean, agile, and global company results in a virtual organisation consisting of several sub-production units geographically dispersed in the world as branches, joint ventures, subcontractors, etc. It focuses on strategic planning, product design, virtual enterprise, automation and information technology.

Strategic planning is concerned with virtual enterprise, rapid-partnership formation, rapid prototyping, and temporary alliances based on core competencies. Agile manufacturing can be achieved through customer -integrated multidisciplinary teams, supply chain partners, flexible manufacturing, computer-integrated manufacturing systems, and modular production facilities.

In agile manufacturing, usually the functions, knowledge and operations are geographically distributed and these have to be integrated by networks. It is, therefore, necessary that such manufacturing enterprise must establish co-operation with suppliers, customers, partners, etc.

Further it must be possible to allow different organisation structures and the changing relationships between then dynamically, in order to adapt to the volatility of the global markets. The system must react to the occurrence of disturbances in order to minimise their impacts on the system.

Fig. 42.1 shows elements of agile manufacturing (AM) and Fig. 42.2 the elements of AM Strategies and Technologies.

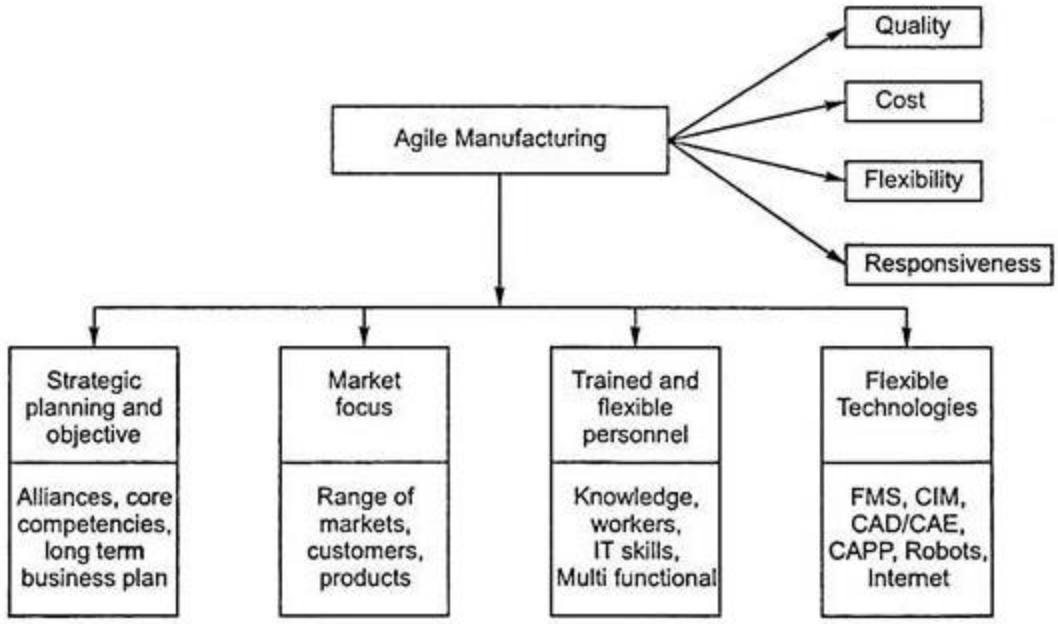


Fig. 42.1

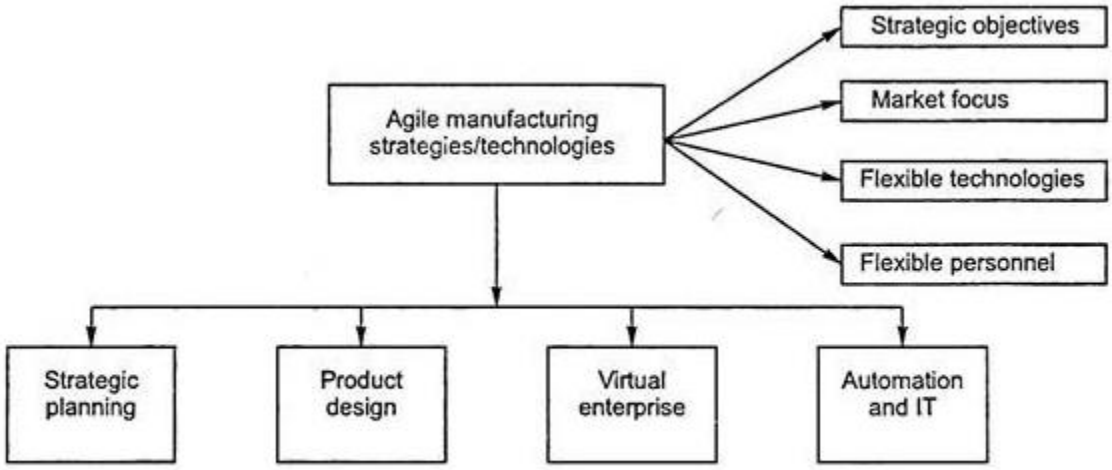


Fig. 42.2

Production Planning and Control (PPC) in Agile Manufacturing (AM):

Operation management of virtual companies in AM requires:

(i) Flexible or dynamic company control structure to cope with uncertainties in the market,

(ii) Adaptive production scheduling structure and algorithms to cope with uncertainties of the production state,

(iii) Modeling of production states and control systems,

(iv) Modeling of concurrent product development and production under continuous customer's influence,

(v) Real-Time monitoring and control of the production progress.

For achieving agility in manufacturing, radical changes are needed in line with productive reengineering business process.

Agile manufacturing has evolved a new architecture of production systems, i.e. responsibility-based manufacturing (RBM) which enables close alignment between system behaviour and business process requirements. RBM allows most adjustments for process and product variety without system reconfiguration.

Active resources take the responsibility for production of individual parts, implementing the relation of individual customer to individual producer. An integrated supply chain acts as a global network used to deliver products and services from raw materials to end-customers through an engineered flow of information and physical distribution.

Product Design in Agile Manufacturing (AM):

Agile manufacturing demands a change around the formation of product development teams to include representation of design, manufacturing, marketing, quality, purchasing groups. It requires a rapid product design system with objective of switching over to new products as quickly as possible.

Non-value adding activities need to be reduced by grouping various resources and products so that right products reach market at the right time. Virtual Design Environment is information architecture to support design – manufacturing – supplies – planning decisions in a distributed heterogeneous environment for systematic selection of planning alternatives that reduce cost and increase output.

Virtual Enterprise in Agile Manufacturing (AM):

A virtual enterprise results from the integration of complementary core competencies distributed among a number of carefully chosen real organisations, all with similar supply chains focussing on speed to the market, cost reduction and quality.

Since virtual enterprises are temporary, these must be carefully assembled and disassembled, and careful attention be given to security, focus being on cost-reduction. Supply chain management also needs a different set of frameworks, strategies, techniques, and performance measurement criteria.

Automation and Information Technology in Agile Manufacturing:

M requires intelligent sensing (like vision systems) and decision making systems capable of automatically performing tasks without human involvement. Agile enabling technologies like

virtual machine tools, flexible fixturing, agile design alternatives are required. Physically distributed facilities demand high-level communication systems to exchange information at various levels of manufacturing organisations.

Lean Production:

Mass production was feasible with huge quantities, building inventory buffers and concerned with acceptable quality, high efficiency and go on producing till stopped by faulty condition. Thus a certain level of fraction defects was satisfactory in mass production.

However with customer demand and need changing fast, companies had to shift to lean production. It utilises concept of just in time delivery, minimum inventory, and minimum waste. It works on zero defect level and follows philosophy of perfect first-time delivery.

It utilises flexible production systems for small batch sizes and shorter set up change overs and utilises expertise of workers fully to solve technical problems. It believes in continuous improvement with dynamically changing market environment. It constantly searches for and implements ways to low cost, improve quality, and increase productivity and also make improvements in design. It is accomplished by doing one project at a time.

The emphasis in lean production is more on technical and operational issues whereas agile manufacturing emphasises on organisation and personnel. Lean production is associated with a factor whereas agility is applicable to the enterprise level and formation of virtual enterprise. However lean and agile technologies do not compete.

Lean manufacturing tries to minimise change (particularly, external change). It attempts to reduce the impact of change-overs on factory operations so that smaller batch sizes and lower inventories are feasible. It uses flexible production technology to minimise disruption caused by design changes. However agile manufacturing embraces and is responsive to change. For a company to be agile, it must be lean also.

Robust Manufacturing Company:

Robust manufacturing company must be agile, adaptive, efficient, knowledgeable, innovative and well managed so as to be able to increase productivity and competitiveness. It must have capabilities to handle high value-addition, low volume products that are in demand.

It must possess ability to maximise leverage from strong and sustainable partnerships through local and global supply chains, and seek markets in emerging growth economies. It must have ability to adapt quickly to meet challenges and capture emerging opportunities.

It must be able to secure supply of resource inputs and skills by direct acquisition, partnering or engaging in global supply chains. Manufacturing processes adopted should be more energy and resource efficient.

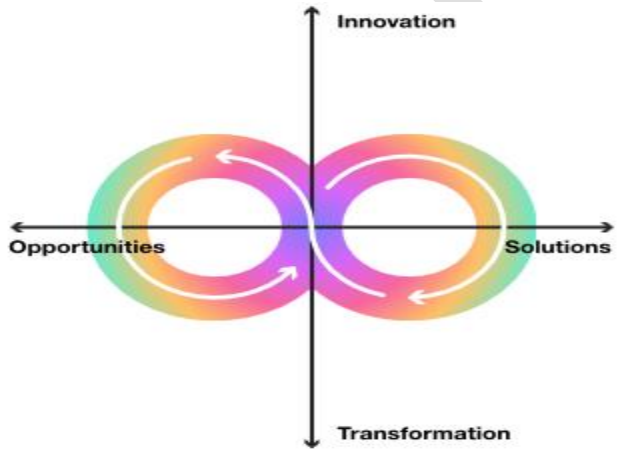
❖ ENTERPRISE DESIGN / ENTERPRISE DESIGN PROCESS

Instead of delivering isolated solutions as delivered by traditional design thinking and practice, Enterprise Design tackles challenges of enterprise-wide innovation and transformation. In an iterative design process of rigorous filtering and focus, it works through the complexity of the enterprise ecosystem rather than ignoring it.

Enterprises are complex environments, both in their internal organization and the markets they address. It's easy to get entangled in this messy reality, caught up in conflicting goals and unexpected constraints. As a consequence, many enterprise initiatives end up in dead ends, and fall short of the intended impact.

Enterprise Design is an approach for navigating this space, making sense of the various moving parts. It is about triggering key events within the enterprise to make a leap towards a thriving future state, bridging two key gaps:

- From innovation (creating something new) to transformation (changing what already exists).
- From uncovering opportunities (exploration and mapping) to developing solutions (experimentation and validation).



How to design an enterprise?
A phased design approach adapted to reshaping complex systems.

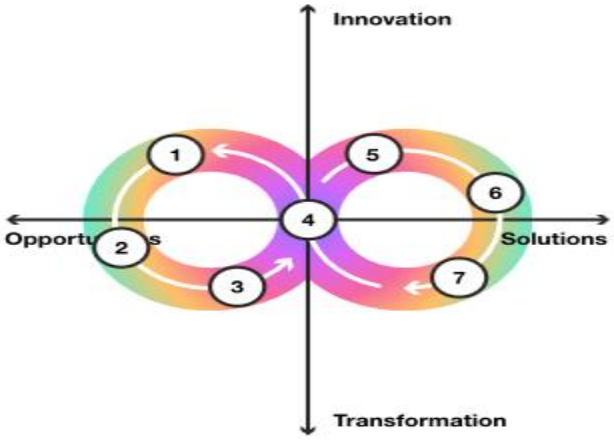
From high-level strategic initiatives to applied Design Sprints or workshops, following these steps helps guiding team activities through the design process.

Moving across the Stack and going beyond product-level design processes, it emphasizes activities linked to engagement of key actors, as well as ensuring delivery through subsequent programs and transformation initiatives.

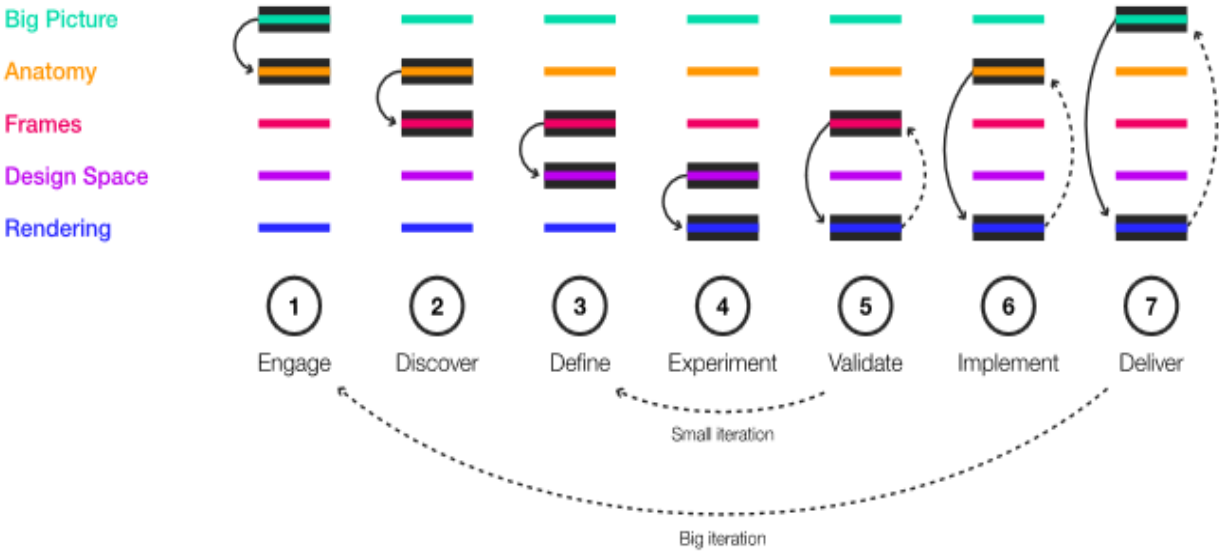
It follows 7 iterative steps to be applied in a fractal fashion, for focused drilldown and gradual

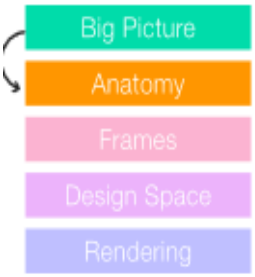
synthesis. Moving between stages and iterations is easy and communicative.

As a scaffold for a custom toolbox designed to fit a particular enterprise context, it allows to define a process model that supports an open exploration of what might be.



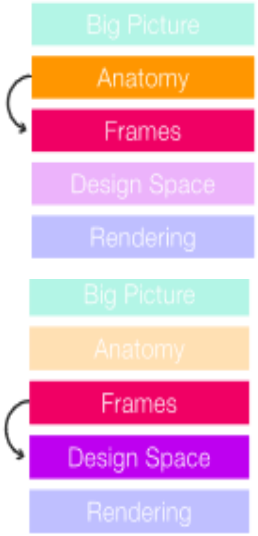
The Enterprise Design Approach step by step





1. Engage stakeholders and start the conversation

Engage with key stakeholders, understand the Big Picture intent behind the initial brief and develop the design challenge to tackle. Develop first mappings of the Anatomy and conduct first workshops.

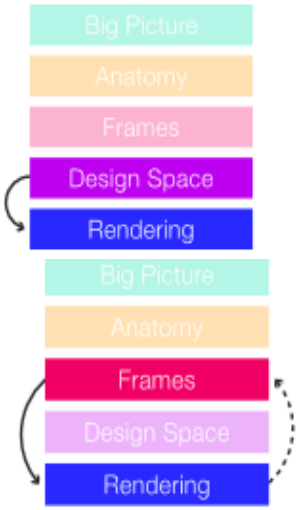


2. Discover insights, constraints and data points

Perform research, data collection and analysis on Anatomy elements developing an idea of elements to consider. Map out the environment and the problem space by applying different Frames on the design challenge.

3. Define and conceptualize challenges worth tackling

Think to develop a point of view on relevant Frames and define how to address challenges and conceptual aspects that form the Design Space. Envision conceptual solutions for suitable future states.

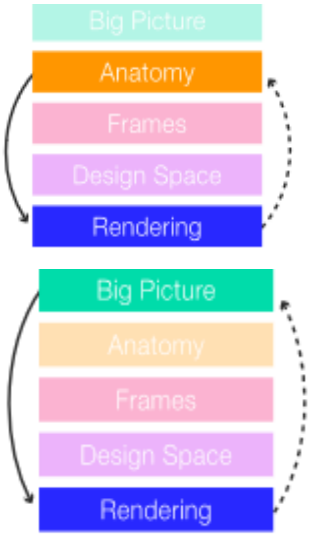


4. Experiment and prototype the new enterprise

Generate potential outcomes implementing the conceptual basis across the different aspects of the Design Space. Illustrate and prototype Rendering elements to bring key moments of the evolved enterprise to life.

5. Validate potential solutions for different success criteria

Validate Rendering elements by applying human, business and systems Frames, ensuring meaningfulness, viability and feasibility of proposed solutions. Iterate conceptual definitions based on validation outcomes.



6. Implement changes and create new enterprise components

Make the Rendering tangible with just enough documentation and production, sharing them with the wider enterprise. Transform Anatomy elements such as services, content or channels and touchpoints.

7. Deliver and measure adoption

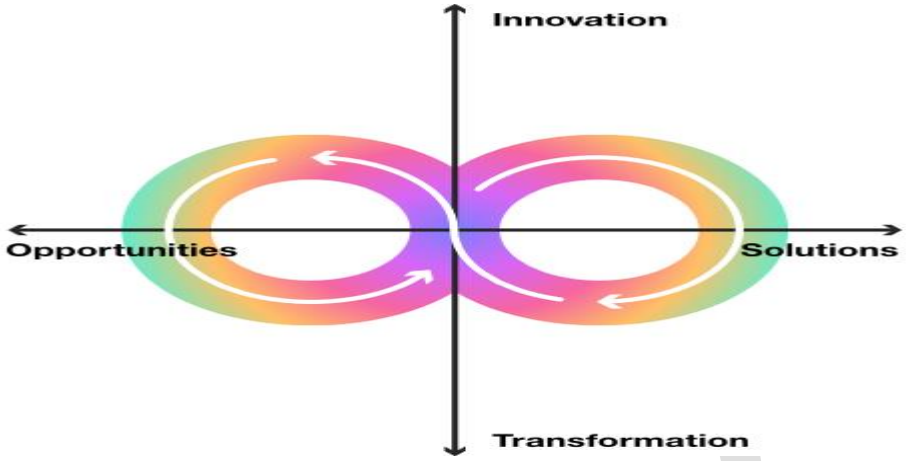
Make the Rendering available to enterprise audiences, manage the communication and change processes involved in this transition. Set up governance and measure Big Picture impact to plan your next steps.

- **SYSTEM CONCEPTS AS THE BASIC MANUFACTURING THEORY /**
- **JOINT TECHNICAL & ORGANIZATIONAL DESIGN AS A MODEL FOR THE DESIGN OF AGILE MANUFACTURING ENTERPRISE /**
- **INSIGHTS INTO DESIGN PROCESSES**

Enterprise Design is the design of ambitious endeavours. It is about bringing together all the elements needed to make an enterprise successfully deliver, using a holistic and systemic design approach.

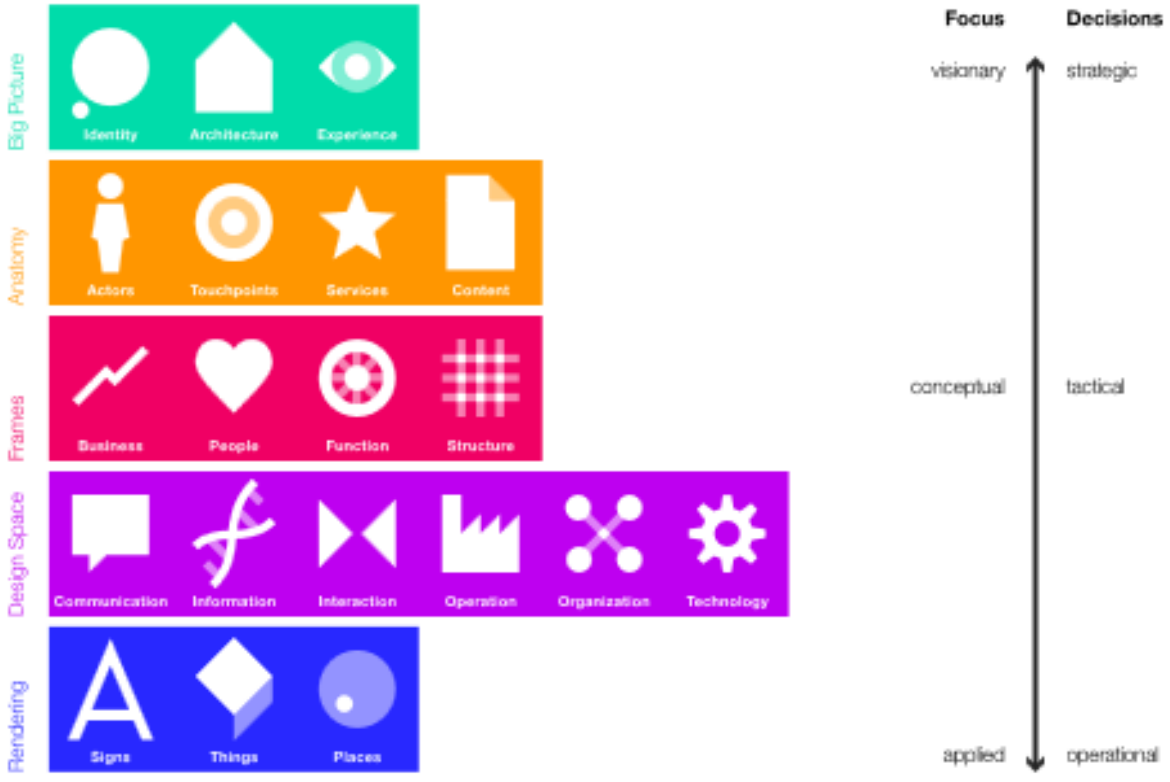
Customer experience, digital transformation, agile architecture, compliance, disruptive shifts: enterprises are challenged to reinvent themselves and adapt to a complex, dynamic environment.

Developed over 10 years of professional practice, the Enterprise Design Framework gives designers, architects and analysts a coherent toolkit to chose the right approach at each stage of the innovation and transformation process. It is built on a strong foundation of systems thinking and experience design, 360° research and enterprise mapping practice, and blends lean and agile approaches into 5 tools: Stack, Scan, Scenarios, Sprint and System.



- The Enterprise Design Stack is a common vocabulary, a set of lenses and a practical navigation aid to understand, frame and tackle enterprise challenges.

Introduce a shared language to discuss challenges in enterprise environments and ecosystems driven by complexity. Apply a system of lenses, explore key aspects to consider and prioritize. Introduce a map to navigate and translate between viewpoints.



What is it?

The Stack is the centrepiece of the Enterprise Design Framework. It is a map of 5 layers and with 20 aspects relevant to Enterprise Design practice. It guides teams in their decision-making what aspects to focus on, what to put aside for now, and how to make the link between different viewpoints on the enterprise. By scoping engagements to design everything needed to make the entrepreneurial project succeed, the Stack helps you to ultimately deliver on the underlying intent.

When to use it?

When starting an engagement, use the Stack to discuss which aspects are the most relevant to your challenge, your team members, your stakeholders and your environment. This is especially well applicable to any brief with an unclear scope, challenge definition or problem framing, and with a large stakeholder diversity. It is a tool to tackle the big questions: what are the strategic topics for the enterprise's leading thinkers and strategists, and how do they translate into investments and initiatives? What is happening in daily customer or employee interaction, what opportunities for innovation can be addressed? What needs to change soon, how to go about it?

How to use it?

The Stack is designed to establish a common frame of reference for cross-disciplinary teams, first introduced in our book Intersection. Use the reference white paper, poster, aspect icons and stickers as visual thinking aids, and refer back to them when applying the other tools of the Enterprise Design Framework. Move around the Stack aspects to discuss what to consider when, and make it part of your conversations with team members what level and what aspects you are talking about. Revisit the Stack regularly over the course of team activities.

- The Enterprise Design Scan reveals insights and opportunities for innovation matching market demand and enterprise capabilities.

Apply a 360° research tool to reveal innovation opportunities from your ecosystem. Combine all data sources, ideas and insights into a comprehensive intelligence synthesis to drive your decision-making.

What is it?

The Scan is a blended research tool to reveal opportunities for innovation. Using the Stack as a navigation aid of aspects and concerns, it consciously mixes research modes to get a quality and breadth of insights that reflects the complexity of the enterprise context: surveys and data analysis to generate meaningful quantitative data, interviews, probes and other qualitative research tools for deep insight, and relevant existing materials. It enables teams to develop a holistic research strategy, applying 3 filters to understand the enterprise: intent, behaviour and structure.

When to use it?

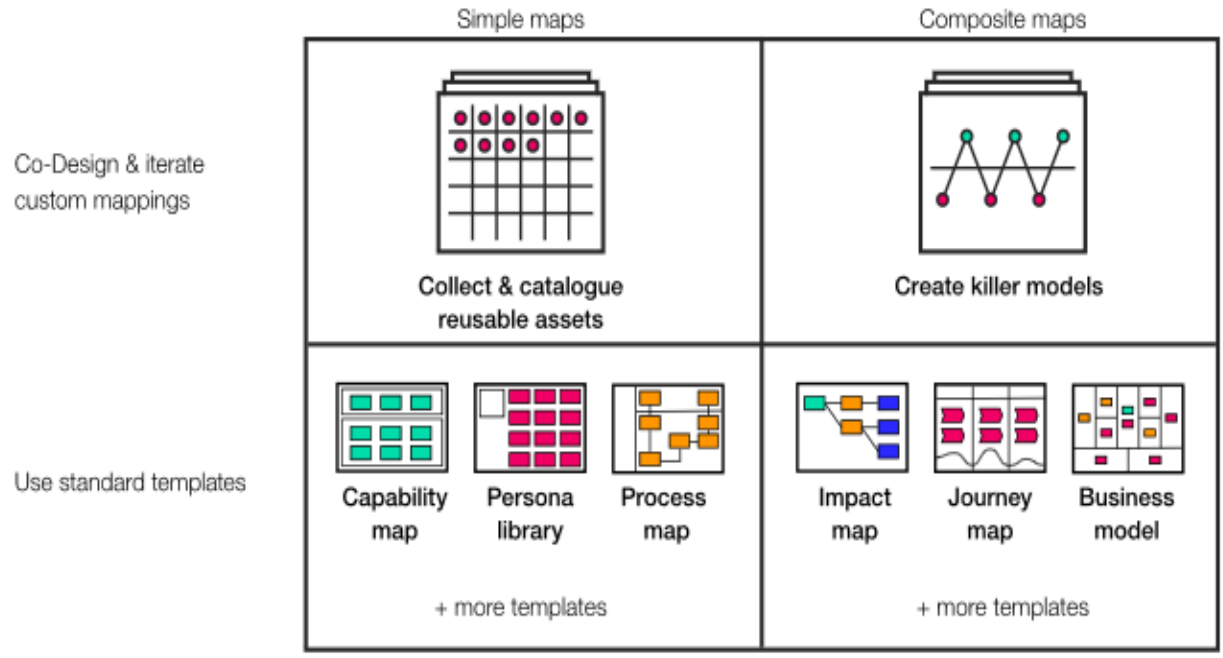
Usually applied at the beginning of an engagement, the Scan can be used at any moment to choose or validate the area of focus, reveal additional insights or data, or cross-check research results through complimentary techniques. Running a Scan delivers the missing evidence to make crucial decisions: what matters most to our enterprise and should be in focus, what else do we need to consider? Where is our fit with the market we are adressing? Who do we need to talk to in order to be more confident in our decisions? What data, insights, baseline mappings should we generate?

How to use it?

The first step of running a Scan is a combined Top Task and Assessment Survey, a standard quantitative research module that will result in a clear set of priority aspects and tasks to be prioritized. Use the results of this survey to engage stakeholders, assess organizational buy-in for evidence based decision making, and chose where to invest into generating additional insights. Plan and scope further complimentary research activities and choose appropriate techniques. Use the results of the Scan to map baseline Scenarios or as input for a Sprint.

- Mapping out an Enterprise Design Scenario using EDML notation provides a way to explore relevant parts of the environment to be transformed.

Map out Customer Experience, Operating Model, Strategic Drivers and other relevant perspectives on your enterprise ecosystem and organization. Translate, connect and make sense of all the pieces to create a shared view on the enterprise as a whole, identify opportunities and design transformations.



What is it?

Mapping out a Scenario allows a diverse group of enterprise designers and stakeholders to create a shared visual model of the enterprise, looking at it from different angles. Scenarios are using the Stack to navigate the lenses to apply and what to map. They apply the unified Enterprise Design Modelling Language (EDML) to express a variety of aspects and explore the links between them. Similar to drawings and blueprints for a building, this provides a basis for sharing ideas and insights, joint decision-making and planning.

When to use it?

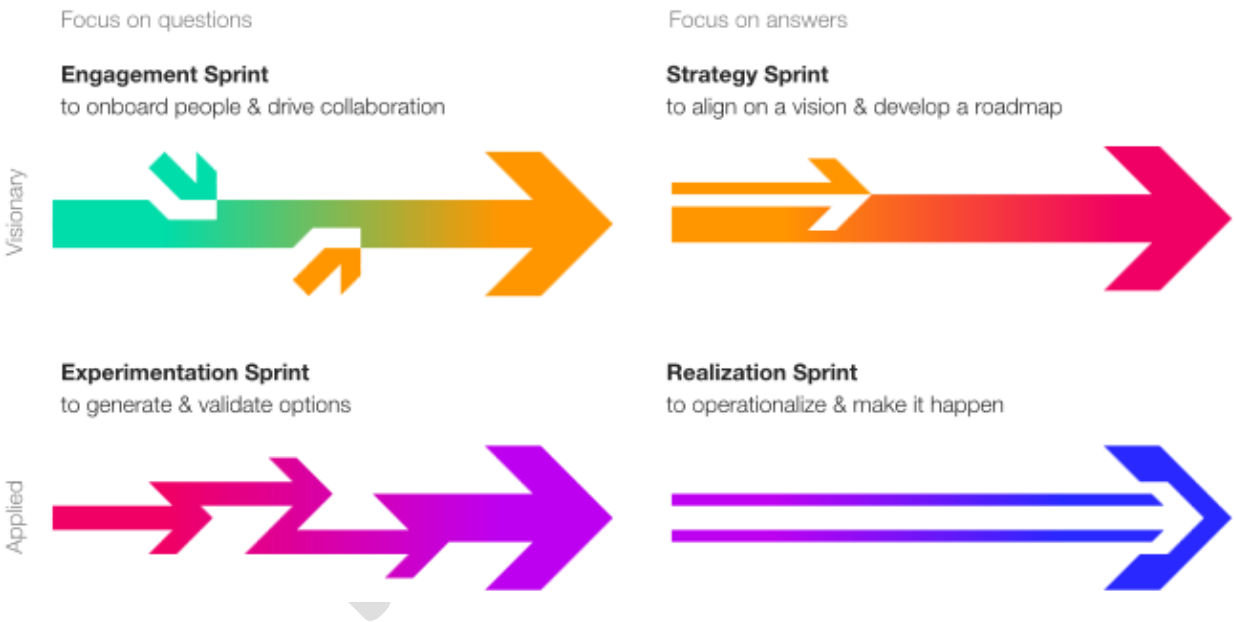
Scenarios are particularly useful when a diverse design team needs to make sense of the insights gathered, collaboratively process what they found and spot opportunities to explore. Especially in complex environments, good ideas are not enough and solutions don't come out of thin air. Map out scenarios for analysis and exploration to identify opportunities, understanding of trade-offs, and joint thinking and decision-making involving a variety of stakeholders.

How to use it?

Map out relevant parts of the current (as-is) state of the enterprise environment to transform, typically informed by running a Scan. This works best when opportunistically choosing what to look into, and what to put aside for now using the Stack. Start with simple maps collecting elements of a single aspect, such as operational processes, services, stakeholders or personas, and bring in relevant data. Then connect the dots by mapping relations in composite models, such as standard journey maps or blueprints -- or design custom canvases or matrices mapping what you need to map to make your point. Use these maps in Sprints and workshops to develop a shared vision of a desired future state (to-be) of the enterprise, steps how to get there, and the transformation impact.

- Running an Enterprise Design Sprint enables rapid, co-creative generation and validation of innovative solutions.

Respond to priority challenges in record time. The Enterprise Design Sprint format makes GV-style Design Sprints from the agile startup world enterprise-compatible. Engage your stakeholders, identify strategic options, and rapidly co-design, test and build innovative solutions. Compress weeks of work into just a few days.



What is it?

Running an Enterprise Design Sprint enables diverse teams to co-create solutions for the enterprise's most important and urgent strategic challenges. It is designed for rapid team onboarding, developing a shared understanding of a complex problem space, taking into account a variety of inputs. Teams then work through a fast paced workshop format, to unpack and reframe the challenge at hand, make sense of key insights and data, and develop and test

potential solutions within just two to four days.

When to use it?

When moving too slowly in enterprise environments, the best work can suffer from a lack of impact: even the best ideas will fail if changing stakeholder priorities, sudden reorganization or unforeseen market dynamics hit. An Enterprise Design Sprint will speed up the process from insight to solution, co-creating solutions to making major leaps on key challenges in a fraction of the time usually allocated to classic project work. As a collaborative tool easy to be deployed and adapted, it is designed to bring in everyone needed, make sense of even the messiest problem, and together go through a rapid co-creation workshop using a custom set of tried and tested activities.

How to use it?

Plan for an Enterprise Design Sprint for any significant challenge that requires your team to act quickly. Bring together team members and meet decision-makers to turn a loose problem into a formulated challenge definition using the Stack to discuss and prioritize aspects based on the key questions to be resolved. This makes it easy to select an appropriate Sprint Flavour and customize the workshop format: Sprint team, duration, activities and desired outputs. Do research using a quick Scan and turn available inputs into baseline Scenarios and visual mappings that underpin the workshop activities. Run the Sprint workshop and capture concepts and ideas, solution prototypes and results from first validation. Highlight top performing outputs within your organization and integrate them into a System for transformation, tracing impact to Sprint results.

- Launching an Enterprise Design System permits teams to autonomously develop coherent solutions and transform their environment.

Enable your teams across the enterprise to self-organize and make better design decisions faster, through a system of established practices and readymade building blocks. Deliver a coherent, integrated set of solutions across the experience of your customers, and achieve transformation at scale involving all key stakeholders.

What is it?

The System is a tool made for teams involved in redesigning and transforming parts of the enterprise, such as new products or services, processes or organizations. Designed as a collection of reusable and interconnected building blocks, it regroups the elements needed to co-design and deliver better solutions, faster and more coherently than in isolation: guiding principles for a common purpose, data and insight, reusable pattern libraries, tools for automation and algorithms, and collaboration platforms for cross-team learning to run experiments at scale. The System provides the ingredients and guidance needed to implement solutions that deliver positive impact on the enterprise, itself represented as system landscape. It enables enterprise

stakeholders and teams build the right thing the right way.

Beyond individual solutions for singular problems, your challenge involves change at scale in order to deliver across the board. Introduce the System to make the leap from innovation to transformation: work in parallel on a portfolio of connected projects and products, increase coherence between outcomes, align various teams on a common purpose, and reduce the effort of later integration (design debt). Designing a System enables transformation across areas, products and domains of the enterprise. It provides multiple teams with a single tool to design and deliver their part both coherently and autonomously, and doing so faster by working with a shared set of integrated and automated components.

When to use it?

The System is designed to be made available as a digital product, a shared resource across all teams designing parts of the enterprise, connecting various initiatives, products and areas. Start to develop parts of the system that had been triggered by Sprints, a "minimum viable system" out of building blocks that makes it easier running similar workshops. Identify priority Stack aspects across all 5 layers where a System will be the most effective. Make available Scan insights and data relevant beyond individual projects or solutions and measure continuously. Create generic, repeatable Scenarios describing your system landscape making them available for reuse, such as platforms, tools, capabilities, teams that feature again and again in your designs.

How to use it?

The System tool provides guidance and structures to build and adapt a system for transformation. Start to develop parts of the system that had been triggered by design sprints. What would have made the sprints easier to run? A good starting point is to think about a minimum viable System that cuts through the 5 layers of the System rather than focusing only on one layer.

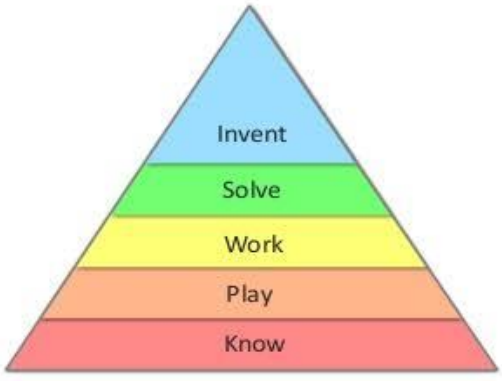
- Used in combination along an iterative design process, the 5 Enterprise Design Framework components enable teams to make the leap from uncovering challenges to working towards a future state.

MODULE 6

SKILL & KNOWLEDGE ENHANCING TECHNOLOGIES FOR AGILE MANUFACTURING

❖ SKILL & KNOWLEDGE ENHANCING TECHNOLOGIES FOR AGILE MANUFACTURING TECHNOLOGY DESIGN STRATEGIC

A skill is the ability to carry out a task with determined results often within a given amount of time, energy, or both.



Hierarchy of Skills

I. Kokcharov

NEEDS OF SKILL DEVELOPMENT

1. To survive in the advancing world.
2. To compete with other advanced person.
3. To achieve success.

Ways to Improve Your Skills

1. Find out what you are good at.

First, you need to identify what are the skills that you already possess—especially those that you want to improve. No matter how many skills you have, you need to pick your topmost expertise so you can focus on enhancing them

2. Do not hide them

Being shy is one of the reasons why a skill is usually left forgotten in a corner. If you want to improve your skills, then you need to come out of your closet and use them whenever and wherever needed. You need to get used to using them around people so that they can be beneficial to yourself and others.

3. Be involved in activities that will require them

The more you use your skills, the more that they are honed. For this reason, do not miss opportunities that will allow you to showcase what you got there. For instance, if you are good at playing instruments, then be involved in a band that plays in events.

4. Keep using them

What you do not use, you will eventually lose. If you do not use your skills for a long time, there is a tendency that you will forget about them. Therefore, keep your skills active and growing by constantly using them, whether professionally or just for your personal satisfaction.

5. Practice, practice and practice

Aside from frequently using your skills, you need to be intentional in practicing them. Practice makes perfect, so if you want to improve your skills, then you need to allot a practice time for each those. It may not be possible to achieve perfection, but at least you can gain excellence.

6. Learn from the expert

Aside from YouTube, there are other online platforms, featuring experts, which can help you gain more knowledge about your skills. You can also read books from well-known individuals from your field. However, the best way to learn from experts is by working with them up close and being able to observe how they do things.

7. Ask others to help you evaluate your skills.

Evaluating the current status of your skills will help you find out what needs to be done so you can improve. Of course, if you want an unbiased evaluation, then you should involve other people who see you use them. They can be your family, friends, colleagues, or mentors.

8. Monitor your growth

Aside from evaluation, regular monitoring can help you track your skills' progress. You can create a checklist of the developments that you want to see in a certain period. This is a tool that can help you figure out your strengths and weaknesses.

9. Avoid comparing your growth with others.

Stop comparing the level of your skills with that of others'. Do not measure your progress based on their progress because each person has his/her own pace of development. This will make you either jealously competitive or insecure

10. Give time and focus through consistency.

Consistency is the difference between all-time greats and one-hit wonders. Remember, creating a routine can help you achieve your desired result.

KNOWLEDGE

Knowledge is a familiarity, awareness, or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning.

Knowledge enhancing techniques

1. Include quizzes and exams throughout the eLearning course

Periodically assessing learner knowledge is key, and one of the most effective ways to do this is by integrating quizzes and exams all throughout the eLearning course. Including a test at the end of the eLearning course is common practice for many eLearning professionals, but there are benefits to testing more often, such as at the end of every module or lesson. This will help to ensure that the learners have successfully absorbed the information before moving onto the next section, and will allow them to review key terms and ideas prior to acquiring new knowledge or skills

2. Use stories and characters to make it relatable.

To create a connection with the learners will inevitably help them to more effectively retain knowledge. By using storytelling in eLearning and creating characters that they can relate to (such as those that feature a situation they might encounter on-the-job or a character that they can sympathize with) you offer learners the chance to remember key concepts or ideas successfully. When creating stories don't go into too much detail about the characters or the situation, as this will narrow your audience reach. However, you'll still want to foster that emotional connection with them. So, make it relevant, relatable, and motivational, while still keeping it short and sweet in order to focus on the content rather than have the story steal the spotlight

3. Encourage them to put their newly acquired information to use.

Group role play exercises, simulations, and eLearning course recaps can all be used to boost retention. This is due to the fact that these practices encourage learners to mentally access previously acquired information, so that it can be rooted into their long term memory storage. It also allows them to carry out an all-important process- repetition. Completing the same tasks again and again, or learning about the same concept multiple times can help your learners to more easily absorb the information. For example, if you ask your learners to repeatedly participate in a simulation that requires specific skill sets, they will eventually master those skills.

4. Utilize search engines

Search engines like Google, Yahoo, and Bing enable you to find any answer to any question within seconds. Routinely use these internet sites to discover current news, trends, and topics of interests

5. Register for an online class.

Nowadays with the free flow of information, you can join a full-fledged university class online with little or no cost to you. Several top universities like MIT, Harvard, and Stanford provide top-of-the line courses in everything from philosophy to politics in MOOC (Massive Open Online Course) platforms.

6. Talk to a mentor

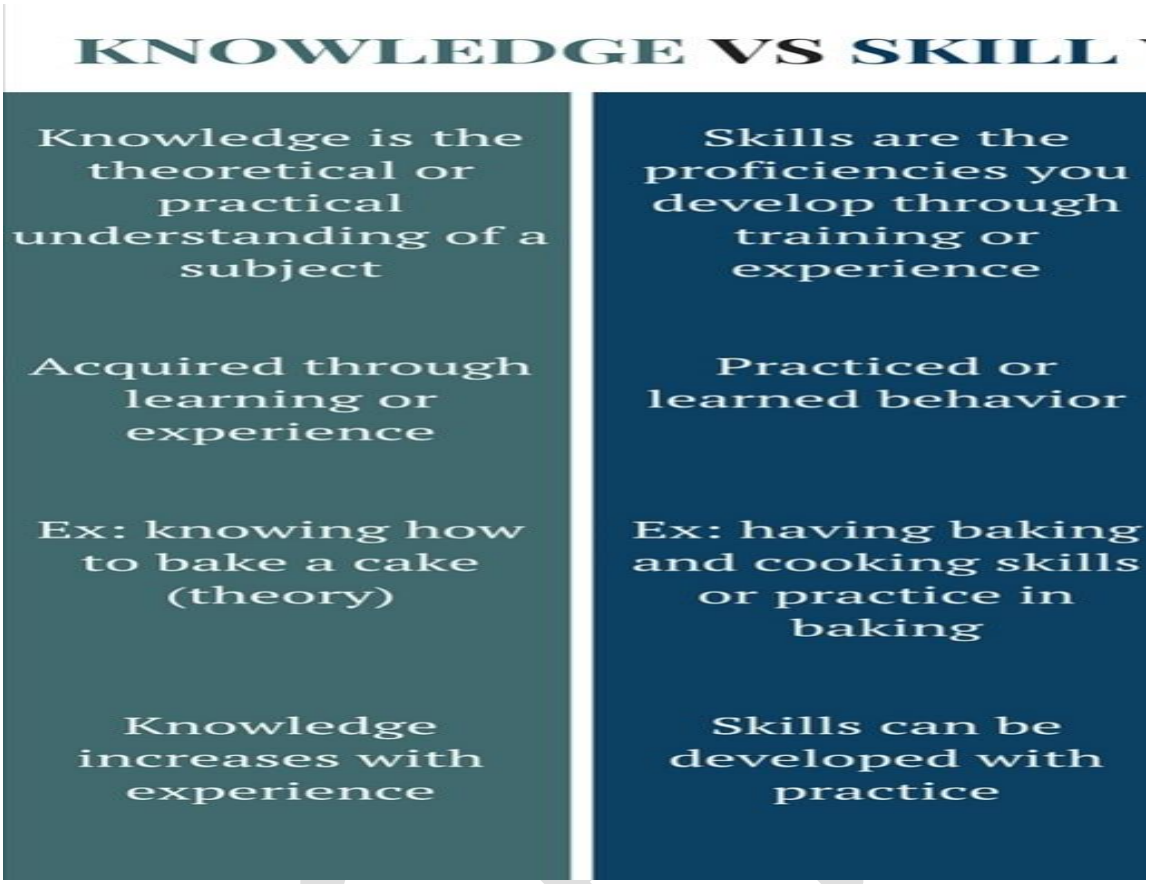
Learning from other people is one of the most effective ways to stay educated. Also, in today's technology-driven world, having a mentor keeps you sharp with your people skills.

7. Try something new

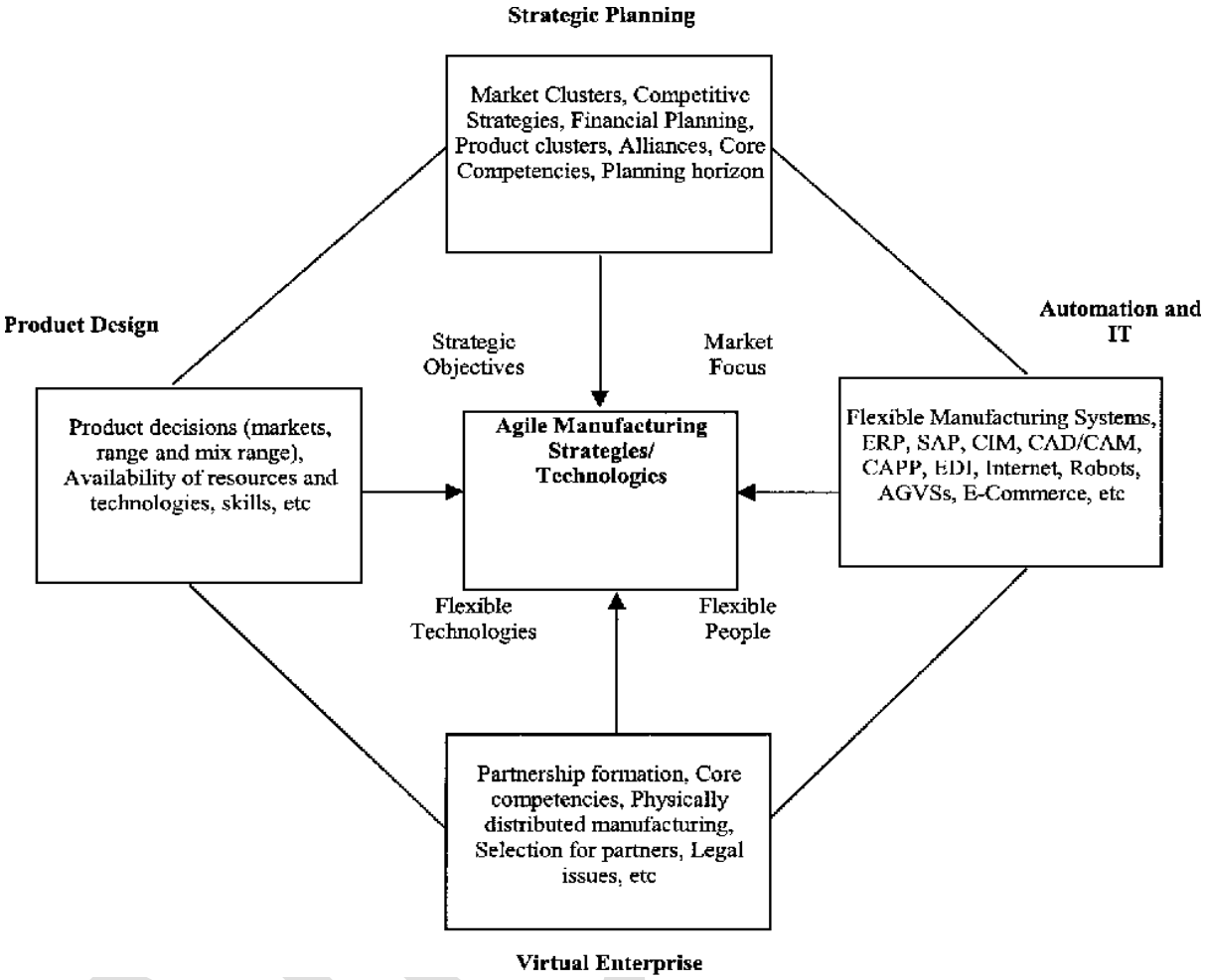
Another way to expand your knowledge is to throw yourself into a new situation. No one is forcing you to become an expert in these things, and that’s the fun of it! You get to learn what you want, when you want.

8. Don’t be afraid to ask questions.

This is the most important one (in my opinion): Ask everyone EVERYTHING. Ask them about their jobs, their hobbies and their interests. People love talking about themselves and what they're good at. You'd be surprised by how much you can learn from your best friend if you just ask the right questions.


KNOWLEDGE VS SKILL
Knowledge is the theoretical or practical understanding of a subject
Acquired through learning or experience
Ex: knowing how to bake a cake (theory)
Knowledge increases with experience
Skills are the proficiencies you develop through training or experience
Practiced or learned behavior
Ex: having baking and cooking skills or practice in baking
Skills can be developed with practice

❖ TECHNOLOGY DESIGN STRATEGIC - DESIGN CONCEPTS



Analysing the overall characteristics of strategies and technologies, the literature available on AM can be grouped under the following themes: (i) strategic planning, (ii) product design, (iii) virtual enterprise, and (iv) automation and Information Technology (IT).

1. Strategic planning

Strategic planning of performance improvement is gaining attention in all areas of manufacturing. To achieve agility in manufacturing, several sub-strategies are needed, including virtual enterprise, rapid-partnership formation, rapid prototyping, and temporary alliances based on core competencies. For virtual agile manufacturing, temporary alliances and integration of complementary core competencies is a necessity. Therefore, based on a given demand along the supply chain, there is a need to select partners based on their involvement in the value-adding chains. Development of VE requires the following:

(i) a framework for the corporate strategy formulation process based on global competitiveness for manufactured goods and services,

(ii) a decision support system for selecting suitable partners based on the required core

competencies,

(iii) an IT-based SCM system for controlling operations in VE, and

(iv) Performance measurement system for continuous improvement in an AM environment. Existing methods and tools can be used for strategy formulation and selecting partners for AM enterprise development.

Marketing research would help to identify the competitive performance objectives, based on which agile strategies can be formulated. Moreover, VR tools and techniques could be used to make a quick decision based on the more accurate data analysis. CE within a fast-paced product development environment favors collaborative work between engineering disciplines. Certain challenges of human factors posed by the agile environment can be overcome by a series of team meetings during which the team jointly develops the project plan, including objectives, strategies for meeting objectives, a detailed task network, schedule and resource and funding projections. The information technologies alone are not sufficient to achieve the desired communications efficiency and, if anything, the unfamiliarity of the technologies could impede communications efficiency.

Agile manufacturing has different requirements for the workforce as compared with traditional systems, and they are: (i) closer interdependence among activities, (ii) different skill requirements, usually higher average skill levels, (iii) more immediate and costly consequences of any malfunction, (iv) output more sensitive to variations in human skill, knowledge and attitudes and to mental effort rather than physical effort, (v) continual change and development, and (vi) higher capital investment per employee, and favor employees responsibility for a particular product, part or process. These, to some extent, define the characteristics of an agile workforce and the training and education required which include IT-skilled workers, knowledge in team working and negotiation and advanced manufacturing strategies and technologies, empowered employees, multifunctional workforce, multilingual workforce, and self-directed teams.

An agile organization should possess the capability of a learning organization. For this purpose, IT can be used along with a suitable organizational structure that Agile manufacturing 1373 promotes innovation and training and education. In a global manufacturing environment, the communication should be standardized for improving the cooperative supported work in a VE. This requires a standard computer-aided communication system with suitable changes to suit the local environment, such as translation into a different language. In addition, the agile manufacturing can be achieved by suitable strategic alliances based on mergers and acquisitions with the objective of obtaining required services. Other external factors, such as type of the market and products, location, government policies and environmental regulations need to be considered in the strategic planning for the suitability of AM and its development.

2. Product design

The reduction of product development cycle time is important in an agile manufacturing environment to meet the changing market requirements by suitably reconfiguring the available resources and developing suppliers. Generally, a major portion of the manufacturing cycle time is shared by product development time. Reducing the product development cycle time is a major task in AM. For this, concepts/techniques such as CE, DfM, DfA, DfQ and QFD, and technologies such as CAD/CAE, Virtual Design Environment

and Rapid prototyping can be used. Even when a design firm is contracted for high quality design products/services, it still needs to interact with all other partners along the value-adding chain of the VE. In order to achieve this, a multi-firm cooperation in line with a multidisciplinary team for reducing the overall product development cycle time is required. Online data gathering (such as E-Commerce) could be used to learn more about exact customer/market requirements.

3. Virtual enterprise

It is essential to develop VE in a more productive way by reducing the time and cost as well as delivering goods/services in a competitive manner in global markets. The following steps can be employed for developing a VE: (a) identify the corporate objectives; (b) based on the multiple manufacturing performance objectives, identify the product/service requirements from suppliers; (c) select partners based on the core competencies using a suitable supplier ranking system; (d) using the time scale, which should be rather short, link it all as a VE with the help of automation and IT. In addition, the human resource management should be given due attention while developing VE for AM. A Data Management Framework (DMF) to support agility in manufacturing is needed (Bocks 1995).

A DMF has been defined as the ability of an enterprise to manage distributed data, information, and knowledge as the decisive enabler for core enterprise business processes. The purpose of DMF is to provide a seamless enterprise data management solution in support of the AM environments. It must be stressed, however, that such seamless data integration is potentially complex. Integration of current fragmented computer systems, causing over-complexity, is perhaps the biggest challenge the AM enterprise faces. In the AM environment, information can be transmitted via multiple channels depending on urgency, content and distribution through phone, voice-mail, fax, email, and http. In a VE, the nature of training and education should have a different focus compared with that of traditional organizations.

For example, an international team of empowered employees and self-directed teams should be developed with a view to improve the effectiveness of a globally distributed manufacturing enterprise. This requires the understanding of the culture and language of each other together with sufficient literacy in computerized information analysis and synthesis. GroupWare has been used as a group decision-making environment to assist teams evaluating a quality function deployment framework for risk management and agile manufacturing system designs.

4. Automation and Information Technology

Automation and IT play a predominant role in the development of a physically distributed enterprise. The role of automation and IT can be identified in several areas of the development process. The most important are (i) strategy formulation, (ii) tactical management, (iii) operations control and (iv) systems.

For example, the concepts of AM can be validated using computer-aided simulation and a full scale-manufacturing cell. From the review of agile-enabling technologies, it can be noted that the selection of technologies for achieving agility in manufacturing depends upon the strategies that are selected to meet changing market requirements. For example, JIT may require EDI, FMS may need AGVs, Robots and NC machine tools whilst agility heavily relies on virtual manufacturing/ enterprise or physically distributed manufacturing environments. Suffice to state that technologies such as IT, manufacturing cells, robots, flexible part feeders, modular assembly hardware, automated visual inspection systems,

virtual machine tools, flexible fixturing, CAD/CAM and automated high-level process planning are essential for developing agile manufacturing systems.

An object-oriented model of an Agile Manufacturing System with a definition of the Agile Objects at four levels and their features will be useful. In addition, it explains the process in which the Agile objects, under the stimulation of tasks (market demands) get assembled into objects at higher levels and are integrated into an agile system by sending information to each other and by accepting information selectively.

Agile enterprise characteristics	Strategies	Technologies
Quick Response Manufacturing	Virtual Enterprise, Supplier Development, Partnership Development	Rapid Prototyping, Internet, WWW, E-mail
Flexible Organization	Group Technology (GT), Manufacturing Cells, Concurrent Engineering	Robots, AGVs, NC Machines, CAD, CAPP, and CIM
Learning Organization	Matrix Organizational Structure, Strategic Alliances, Systems Thinking, Knowledge Management and Transfer, Change of Culture, Empowerment, Team Work	Information Technology, Groupware, Internet, E-Commerce, Multimedia
Integrated Value Chain	Supplier Development	MRP, ERP, SAP, Internet, E-Commerce
Physically Distributed Manufacturing Environment	Lean Manufacturing, FMS and JIT	Knowledge workers, Learning Organization
Mass Customization	Flexible Resources	GT, EDI, CAD/CAM/CAPP, E-Commerce
Reconfigurability	Virtual Enterprise, Flexible Resources	CE, STEP, CIM

Table 3. Linking agile strategies with technologies.

Criteria	References	Strategies/Methods/Technologies
Strategic Planning	Adamides (1996), Pellew (1996), Forsythe and Ashby (1996), McMullen (1996), Abair (1997), Medhat and Rook (1997), Tu (1997), Forsythe (1997), Walters (1997), Weston (1998), Noori and Mavaddat (1998), Gunasekaran (1998), Gunasekaran (1999), Yusuf *et al.* (1999)	Extended enterprise, Temporary strategic alliances, Response-based manufacturing, virtual enterprise, Information Technology, Advanced manufacturing concepts and technologies, performance measures (ABC and ABM) to be proactive. Software for integration, supply chain management, Integration of functions, Innovation, Competitive conscious, Knowledge workers, Employee empowerment, Top management support, Concurrent product development
Product Design	Candaida *et al.* (1995), Medhat and Rook (1997), Monsplaisir (1997), Kusiak and He (1997), Lee (1998), Subbu *et al.* (1998a, b), Gunasekaran (1998, 1999a, 1999b)	Virtual design environment, Automated high level process planning, Design for agility, DfM, DfA, Group Technology, Standard Exchange for Products (STEP), CSCW Prototype, CAD/CAE
Virtual Enterprise	Abair (1995), Bocks (1995), Mills (1995), Herrmann *et al.* (1995), Gupta and Nagi (1995), Tracy *et al.* (1994), Hessney (1997), Lee (1997), Orady *et al.* (1997), Gunasekaran (1998, 1999a)	Integration of core competencies, Supply chain, Temporary alliances, System integration, Modular structure, Prequalifying partners/partner selection, Data Management Framework
Automation and Information Technology	Graham and Ragade (1994), Hong *et al.* (1996), Wang *et al.* (1996), Yang (1996), Adamides (1996), Quinn *et al.* (1996), Ashley (1997), Medhat and Rook (1997), Kim *et al.* (1997), Lee *et al.* (1997), Erdel (1997), Mathieu (1997), Song and Nagi (1997), Jo *et al.* (1997), Kirk and Tebaldi (1997), Merat *et al.* (1997), Langford and Scheuermann (1998), Ahmed (1998), Ayoyama (1998), Wang *et al.* (1998)	Internet, EDI, E-Commerce, Real-time object-oriented software environment, CAD/CAE, CAPP, MRP II, ERP, Multimedia, Robots, AGVSs, NC machines, CCD, VMEbus control system, WWW, WAIN, SAP< ASEE, CNC, IMS, OOM, Simulation, Object-Oriented Model

Table 2. Summary of AM literature and key observations.

➢ Design concepts:

1. Enrich the Customer

The strategy is simple here, if one's organization cannot enrich the customer, then the customer will find an organization that can. The emphasis is on becoming a customer-driven enterprise. Quality, delivery, and price requirements of customers must be identified, monitored, and understood using approaches such as Quality Function Deployment (QFD). The firm must then satisfy the customers' demands by adopting customer focused philosophies and by using manufacturing methods and technologies such as JIT, Materials Requirements Planning (MRP), and Activity Based Costing (ABC).

2. Co-operating to Enhance Competitiveness

Co-operation is a key requirement for partnering firms within a physically distributed or virtual manufacturing enterprise. Collaboration between partners is made possible with tools/approaches such as Multimedia, Internet, EDI, CAD/CAM, and electronic commerce. Business Process Reengineering (BPR) may be used to reduce the number of non-value adding activities, resulting in improved information flows and hence, better co-operation between partnering firms. Cross-functional teams, empowerment, reengineering of business processes, virtual companies, and partnerships–possibly with direct competitors– are all means employed to leverage resources through co-operation

3. Organising to Master Change and Uncertainty

An agile company is organised in a way that allows it to thrive on change and uncertainty. Its structure is flexible enough to allow rapid reconfiguration of human and physical resources. The goal of very rapid concept-to-cash time implies innovative, flexible organisational structures that make rapid decision making possible by distributing managerial authority. People need to be empowered to convert change and uncertainty into new opportunities for the company.

4. Leveraging the Impact of People and Information

People–what they know the skills they possess, the initiative they display–and the information to which they have access, are the differentiators among companies striving for agility. Because knowledge-based products offer the greatest potential for individualization, continuous work force education and training are integral to agile company operations. Companies must invest in information and manufacturing technologies that can contribute to agility, but they will not get the benefits of the technology without corresponding investments in human capital (education and training as well as appropriate compensation and incentives. Both are necessary to leverage the value of people and information in the pursuit of agility.

❖ HISTORICAL OVERVIEW-LESSONS-PROBLEMS AND FUTURE DEVELOPMENT

The field of manufacturing emerged in the world during ancient days when humankind began to shape the naturally available components to fulfill specific needs. Particularly, the humankind that lived during ancient days would have sharpened the stones for killing animals. Thus, the manufacturing field has ancient day roots. On further development, the manufacturing field expanded to produce little more sophisticated products like utensils and furniture. In order to manufacture these little more sophisticated products, humankind began to adopt manufacturing paradigms. The first paradigm that the manufacturing world adopted was craft production. Craft

production paradigm enabled humankind to produce products in low volume by employing few people.

After the industrial revolution, the manufacturing field witnessed the emergence of the mass production paradigm. Mass production paradigm enabled humankind to produce products in large volumes by employing many people. Mass production paradigm dominated the manufacturing scenario till the 1960s. Thereafter, the manufacturing world began to witness competition. In order to face this competition, the companies started adopting a lean manufacturing paradigm which focused on eliminating wastes which occurred during the mass production. From the 1980s, the world began to experience the intensification of competition. The world began to experience globalization from the 1990s.

Globalization resulted in the entry of products produced by different countries into the local markets. This scenario fueled the global competition between companies situated in various parts of the world. This global competition enabled the customers to demand products with innovative features at low price and high degree of quality. In order to meet the dynamic demands of the customers, few companies in the world acquired agile capabilities to manufacture innovative products within a short period of time to withstand the global competition.In order to face this kind of intensified competition; the world witnessed the emergence of an agile manufacturing paradigm.

Agile manufacturing paradigm focuses on manufacturing products based on the dynamic demands of the customers. Furthermore agile manufacturing paradigm enables an organization to supply products according to the choice and specifications of the customer. This capability is addressed by their researchers under the term “mass customization.” Today, the companies which have been able to mass-customize the products produced by them through the installation of agile manufacturing paradigm have been able to thrive in the market. Though agile manufacturing has been adding certain industries to face the competition, its application in many other industries is not significantly reported.

A very apt example to be cited to support this claim is the capabilities being demonstrated in contemporary days by the mobile phone manufacturing companies. The modern mobile phone manufacturing companies have been manufacturing and selling several models of mobile phones with amazing innovative features.

In the early period, mobile phone manufacturers produced large sized mobile phones with the provision for telephoning and utilizing other few facilities like calculators and calendars. Today, those manufacturers have brought out mobile phones under different names like tablet and iPad, which are incorporated with facilities like high resolution cameras and high speed internet technology. Thus, the mobile phone manufacturers are capable of quickly responding to the

dynamic demands of the customers. This is due to the fact that mobile phone manufacturing companies are incorporated with a type of production paradigm that is agile in nature. In the year 1990, a group of researchers coined the term "agile manufacturing" after seeing this kind of development. Then, researches in the direction of achieving agile manufacturing were pursued by forming an agile forum at Iacocca Institute in Lehigh University, USA.

➢ PROBLEMS OF AGILE MANUFACTURING

Agility and agile manufacturing can maintain organizational competitive advantage as customer requirements dynamically evolve. A central issue facing organizations is the lack of a proper roadmap for its implementation and adoption. As with most paths to organizational changes, there are numerous barriers and conflicts, causing the roadmap to become a vicious circle. Adoption and instillation of agility and agile manufacturing principles in manufacturing organizations requires a systematic study of the various paths that may be taken along with a removal of barriers that would exist within this path, allowing efficient and effective introduction of these practices.

- Limited Resource Planning - Agile manufacturing operations are unclear of the end results of their production. This makes it extremely challenging to account for resources, cost, time, and various other factors of the production process. Therefore, agile is limiting the amount of insight within resource planning.
- Measuring Difficulties - Tracking the progress within agile is challenging, mainly because of the same reasons as resource planning. Agile manufacturing is unclear of the end result, which makes it nearly impossible to track overall production progress.
- Poor Output - Although incremental delivery may bring products to the market at a much quicker pace, it also puts operations at a rather large disadvantage. As the cycles vary, teams are unable to deliver output in one complete unit, leaving the output to be fragmented.

➢ FUTURE DEVELOPMENT

The factory of the future will require an operating methodology which effectively utilizes all of the elements of product design, manufacturing and delivery. The process must respond rapidly to changes in product demand, product mix, design changes or changes in the raw materials.

Following are some of the future research directions that would assist in achieving agility in manufacturing more effectively

(i) A methodology for evaluating potential partners for agile enterprises based on core-

competencies and market forces needs to be developed. Criteria for selecting partners of agile enterprise should be identified with the help of suitable conceptual and empirical research.

(ii) A framework for determining the type and level of different skills required for agile enterprise should be developed using multiple site case studies. Furthermore, the nature of training and education required for the workforce should be precisely denied taking into account the geographically dispersed partners in AM environments. Suitable information systems need to be developed for determining the type of skills and numbers of workers required in agile environments.

(iii) The infrastructure and organizational characteristics of agile enterprise can be determined by developing a suitable theoretical framework and testing them with real life manufacturing environments. This framework essentially centers on the nature of information and material flows in AM enterprise. The issues of temporary alliances based on core competencies are to be embedded in the proposed empirical studies.

(iv) In agile enterprises, supply chain links are often temporary and hence flexible. Therefore, there is a need to develop suitable performance measurements and investment justification techniques for this environment.

(v) An investigation on the selection of suitable architectures for agile enterprises would offer further insights into the design of AMSs. Also, appropriate capacity planning and scheduling methods are to be devised to support the effective operations of physically distributed virtual enterprises in AM environments.

(vi) In a physically distributed agile enterprise environment, there is a need for a different quality management system. All the modern quality management strategies and methods can be used for agile environments, but need to be modified taking into account the reconfigurability and dynamics of agile organizations.

(vii) The cost accounting systems such as Activity Based Costing (ABC) would be suitable for advanced manufacturing environments. However, considering the characteristics of agile enterprise, the application of ABC needs further investigation. Physically distributed manufacturing environment demands a simple cost accounting system to overcome the difficulties of communication, integration and domestic regulations among geographically dispersed partners.

(viii) Gaining rapid response to changing customer demand requires equally agile logistics. Logistics can be helped by appropriate product design and tooling to ease materials handling. Fewer stock lines and greater interchangeability of items reduce the working capital and the risk of obsolescence of slow moving lines. The issue of logistics in AM environments has not received significant attention from researchers. For example, what sort of systems would be

suitable for purchasing and distribution of goods would be appropriate in AM environments which include VE based on temporary alliances need to be investigated further.

CONTENT BEYOND SYLLABUS

BIG BANG VERSUS PHASED

When a new system(ERP) needs to be implemented in an oganization, there are three different ways to adopt this new system.

1. Big Bang adoption
2. Phased adoption
3. Parallel adoption

Parallel adoption

The old and the new system are running parallel, so all the users can get used to the new system, and meanwhile do their work using the old system

Phased adoption

The adoption will happen in several phases, so after each phase the system is a little nearer to be fully adopted.

Big bang adoption

It is the adoption type of the instant changeover, when everybody associated with the old system moves to the fully functioning new system on a given date.

Big bang adoption

When a new system needs to be implemented in an organization, there are three different ways to adopt this new system: The big bang adoption, phased adoption and parallel adoption. In case of parallel adoption the old and the new system are running parallel, so all the users can get used to the new system, and meanwhile do their work using the old system. Phased adoption means that the adoption will happen in several phases, so after each phase the system is a little nearer to be fully adopted. With the big bang adoption, the switch between using the old system and

using the new system happens at one single date, the so-called instant changeover of the system. Everybody starts to use the new system at the same date and the old system

will not be used anymore from that moment on.

Advantages and disadvantages

The advantages of this method:

- Training is only needed for the new method, not also for the changeover period.
- User documentation does not need to be updated during the implementation process, because it happens in such a short period.
- The changeover is at one date and this date is clear for everyone.
- There are no special interfaces needed to be able to get used to the new system, because the new system is all there is.

The disadvantages on the other hand are:

- There is no time for extra additions
- The completeness and validity of the converted data is not completely proved, only in the pre-phases, but not in the whole system situation.
- Start up problems
- The operation is complex, one of the main complexities is tuning all activities to happen on one moment: the big bang
- 'Fall back'-plans are hard to develop and become more impossible when the big bang has taken place
- There can be a catch up period (as explained above)
- This adoption is vulnerable because of the limited possibilities to maneuver. There is a lot of pressure because the deadline must be met.

Phased adoption

Phased adoption is a strategy of implementing an innovation (i.e., information systems, new technologies, processes, etc.) in an organization in a phased way, so that different parts of the organization are implemented in different subsequent time slots. Other concepts that are used are: phased implementation, phased conversion, phased approach, phased strategy, phased introduction and staged conversion.

The phased approach takes the conversion one step at a time. The implementation requires a thoroughly thought out scenario for starting to use the new system. And at every milestone one has to instruct the employees and other users. The old system is taken over by the new system in predefined steps until it is totally abounded. The actual installation of the new system will be done in several ways, per module or per product and several instances can be carried out. This may be done by introducing some of the functionalities of the system before the rest or by introducing some functionalities to certain users before introducing them to all the users. This gives the users the time to cope with the changes caused by the system.

It is common to organize an implementation team that moves from department to department. By moving, the team learns and so gains expertise and knowledge, so that each subsequent implementation will be a lot faster than the first one.

Advantages

- The conversion will be done in parts. Time is available for adjustments
- Negative influences that arise at the start are less critical
- No ‘catch-up’ period is needed.
- Time for the users to adapt is longer
- Technical staff can concentrate on part of the system or some of the users.

Disadvantages

- Several adjustments are needed
- Training sessions are confusing for users as they are asked to work with the new and the old system

- Several changes in documentation
- The duration of the project
- System delivery milestone is unclear
- Correctness and completeness of the dataset has to be checked several times
- A ‘fall back’ to the old system is becoming more difficult every new phase.
- The implementation may appear unclear to the employees and other users.

So both approaches have their advantages and disadvantages.Sometimes a big bang approach can be used to implement within the core ERP modules, followed up with a phased implementation of of non-core modules such as document management, business intelligence and maintenance management. Moreover firms needs to examine the factors such as organisation size, complexity and control inorder to decide which approach they should use.

`