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THE POST-INDUSTRIAL PARADIGM: AN IMPERATIVE FOR MANUFACTURING SURVIVAL

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Abstract

The increasing complexity of a manufacturer's environment is driving the evolution of the industrial management mindset towards a new post-industrial management paradigm. More and more it is becoming critical for a manufacturer's competitiveness and survival to continuously assess and align its core competitive capabilities with its contextual environment. For managers it is important to have a clear understanding of both the industrial and post-industrial paradigms in order to design more effective strategies to evolve from an industrial to a post-industrial organization. In this paper we use the Human Activities Systems formal model (HAS) to analyze the scope and content of the industrial and post-industrial paradigms. Suggestions for self-assessment and for manufacturing-environment alignment are given.

Keywords

Management, post-industrial management paradigm, core capabilities, manufacturing-environment alignment, Human Activities Systems model.

Introduction

A lack of fit between a manufacturing system's capabilities and its environment can have a negative impact on the manufacturing system's performance[1]. In the electronic, apparel, paint, and consumer electronics industries, customers are becoming more and more demanding and sophisticated. They demand quick fulfillment of highly customized products and services. Most companies have found it difficult to fulfill orders quickly at an acceptable cost because their mass production systems lack the flexibility to accommodate product variety, and have high setup costs, and long cycle times. An increasing number of companies in these industries like Hewlett-Packard, Xerox, The Limited, Motorola, etc., are delivering customized products quickly and at a low cost by developing competitive capabilities that fit the increasing demands of a post-industrial environment. These capabilities can be more effectively developed and implemented when the managerial mindset is guided by a set of values and premises which are defined as the post-industrial paradigm.

In this paper we use the human activity system (HAS) formal model to perform a comprehensive and systematic analysis of the industrial and post-industrial paradigms. In what follows, we present a brief review of the HAS formal model, and apply this model in the analysis of industrial and post-industrial manufacturing systems. In the end, suggestions for manufacturing managers on how to implement the post-industrial paradigm are presented.

The Human Activity Systems Formal Model

Checkland[2], realizing the limitations of mathematical models to describe problems in the real world, developed a new systems taxonomy. In his taxonomy systems can be classified as: natural systems, designed physical systems, designed abstract systems, human activity systems, and transcendental systems. He argued that the kind of modeling tools that were used to model natural and designed physical/abstract systems were not fitting the unique needs of the human activity systems (HAS). He then developed what he called the formal systems model to study human activity systems. This formal system helps building of conceptual models of human activity systems which are themselves formal and based on experience. The HAS model, though not prescriptive, is practical. Brief description of the attributes of the formal system model are given in Table 1.

Table 1. The HAS Model Analysis of the Industrial and Post-Industrial Paradigms

Ecology theory and systems theory suggest that to understand and analyze any system, the external environment in which the system of interest is embedded needs to be examined. This has to be followed with an analysis of the internal aspects or subsystems of the system. In the following paragraphs, the environment of manufacturing systems both in the industrial and post-industrial stages will be discussed to bring out the major differences. Later, the differences in the internal aspects of the manufacturing system in the industrial and post-industrial stages will be brought out.

Environment

The environment or system's context include all other relevant systems that are outside the system's boundary and that interact directly or indirectly with the manufacturing system. Our analysis of the environmental components is based on three attributes: knowledge, complexity, and turbulence[1,3,4]. We selected as relevant the following environmental factors: markets, competitors, technology, customers, suppliers, ecology, and government, (Table 2).

Markets

In the industrial environment markets are characterized by being more stable -less turbulent-[4], mostly domestic (less complex in terms of diversity, and interrelations), and relatively few in number. To the contrary, In the post-industrial environment markets are more turbulent in terms of speed of change (less stable), more global (more complex in terms of diversity), and many (more complex in terms of number).

Competition

Competition in the industrial environment is characterized by fewer competitors and most of them domestically located. In the post-industrial environment competitors are numerous and globally located. As an example of the growing global competition in the U.S. more than 70 percent of manufacturing output has a foreign competitor. And similar patterns are observed in other countries as the process of globalization grows.

Technology

The issue of technology can be viewed from different perspectives in the industrial and post-industrial paradigms. First, technology as an enabling force behind the evolution from the industrial to the post-industrial stage. The enabler role of technology is important since it highlights the technology capabilities to manage the increasing complexity of the environmental components. A second view of technology is related with its availability and accessibility attributes. In the industrial environment technology is characterized by its limited availability and accessibility. However, the evolution in technology and particularly communications technology facilitated its world wide dissemination. The post-industrial environment is characterized by greater levels of technology availability and accessibility.

Customers

Customers in the industrial stage are domestically located, and have limited access to information. Most of the industrial customers' concerns are related with the features of the product[5]. In contrast post-industrial costumers are described as being more holistic, more complex, and more diverse. They are older, better educated, more informed, and far more demanding than ever before and they lack tolerance for products that fail to meet their needs and expectations. These changes in consumer

behavior can also be seen in channel intermediaries or organizations that buy products. Organizations are more and more demanding of their suppliers.

Suppliers

Manufacturer-suppliers relationships in the industrial environment are characterized by being more transactional and focused on the short term. A common practice in the industrial paradigm is to have larger number of suppliers in order to obtain lower cost and to maintain power over transactions. In the post-industrial paradigm, manufacturer-supplier relationships are playing a more important role for both parties' competitiveness. The focus on the relationships has changed from transactional to partnership and the number of suppliers is being reduced driven by a more long term perspective. One of the significant changes in the new post-industrial manufacturer-supplier relationships is the more proactive role played by suppliers during the new product development process, and the manufacturer's continuous improvement effort.

Ecology and Role of Government

The relative importance of these two environmental components is believed to be industry contingent. In other words, while some of these variables could not have great impact for some industries, they could be extremely critical for others. Just recently the new ISO-14000 environmental standards have been released which is a reflection of the growing concern to reduce the negative impact of industrial outputs. In the industrial paradigm manufacturing organizations were not concerned at all about the ecological impact of the processes and outputs of the manufacturing system. Ecology impact was not considered as an important issue when decisions were taken about the content and process of the production system. However, the increasing degradation of our natural environment has made consumers and government more aware of the importance of being ecologically responsible. This is now particularly critical for industries with high ecological impact like the oil and chemical industry. The negative impact on ecological systems can have a very high cost as it is the case of the oil spill by the Exxon Valdez which cost the company billions of dollars. The post-industrial environment is demanding a more proactive role by manufacturing companies to reduce the negative impact on ecological systems.

One of the differences between the industrial and post-industrial environment is related with the government regulatory role. It seems there is a trend in the post-industrial environment to reduce the role of government in the economic sector. This is illustrated by the de-regulation on the airline industry in USA, and the privatization of a large number of state companies in England, Mexico, Peru, Argentina and other countries.

We will now focus our analysis on the internal manufacturing system's components (Table 3).

Purpose

Industrial manufacturing systems are characterized by being more internally oriented in nature. Objectives and goals are defined in terms of maximum production, minimum cost, high internal operational productivity, and process efficiency[4,5,6]. In the post-industrial stage manufacturing companies are characterized by being more externally oriented towards goals and objectives where satisfying and delivering value to customer is essential. This internal versus external orientation provides a significant difference in the way that industrial and post-industrial manufacturing systems approach its strategic and tactical operations. Post-industrial goals are stated in terms of maximum responsiveness, utility for customers, high value, and high dependability. These differences in goals also show a very important change in the management mindset which is an imperative to avoid the disfunctionality that leads to failure when the type of environment and the type of management mindset do not match[6]. One example of this post-industrial management mindset is reflected in the values of the Vought Aircraft Company which manufacture major aircraft subassemblies. In Vought, all employees understand that the mission of the company is to provide customers with quality products and services and meet their requirements 100% of the time. This means never compromising quality and always doing the job right the first time.

Performance Measures

Most of the performance measures in the industrial paradigm are characterized by its internal orientation. Typical measures are in nature financial with a high emphasis on productivity and efficiency at the functional level. In the post-industrial paradigm manufacturing makes a strong emphasis on external performance measures, which are related with the extent to which the manufacturing company generates value and satisfy its customers.

Decision Making Process

The industrial paradigm decision making process is characterized by being highly centralized and authoritarian with organizational structures being mostly mechanistic and bureaucratic. The post-industrial manufacturing decision making process is more decentralized and participative with organizational structures being more organic and flat.

Resources

Three critical resources are analyzed and their differences in the industrial and post-industrial manufacturing systems established:

(1) Production Technology. In the industrial stage manufacturing systems make use of long-linked production technologies[7] which are characterized by the use of functional or special purpose equipments. In contrast, in the post-industrial stage manufacturing systems make use of intensive manufacturing technologies (flexible manufacturing systems) in order to cope with the changing needs of customers in terms of product variety and volume.

(2) Labor Skills. In the industrial stage the workforce skill requirements are manual and narrow in scope. The fragmentation of task in mass production systems reduced the workers' job to a few manipulations with minimum skill requirements. In the post-industrial stage the workforce skills are more intellectual and larger in scope [8]. The automation and computerization of production process have changed the nature of work and the skills required. The new intellectual skills in a computerized production process encompass making sense of abstract cues, inferential reasoning, and systemic thinking.

(3) Information. The new roles assigned to labor have imposed the necessity of redefining the nature and role of information for manufacturing. In contrast with the industrial environment, information is more intense, more complex, more frequent, more customized, and it is the essential raw material for the intellectual activities in the work place in the post-industrial environment.

Other important differences between the industrial and post-industrial paradigms is the way in which manufacturing resources are perceived. For example, in the industrial stage top management views manufacturing managers as custodians or housekeepers of manufacturing assets. In contrast, in the post-industrial environment managers are considered more like architects of the manufacturing capabilities which help to create strategic competitive advantage. At the operational level, the industrial paradigm perceives workers as "machine tenders" while in the post-industrial paradigm workers are seen as "problem solvers"[9,10]. In terms of the perceived source of value, the industrial paradigm consider machines as the value generators while in the post-industrial paradigm people are the source of value.

Connectivities

The two most important flows in manufacturing systems are information and materials. In the industrial paradigm manufacturing's environmental information is only used for tactical objectives and the flow of information is vertical and fixed in the hierarchy[4]. The complexity of information is low in terms of diversity and number of linkages. In contrast, in the post-industrial paradigm, information tends to be more complex, and is more strategically oriented towards greater integration and the creation of competitive advantage.

Boundaries

The boundary limits the area of authority for decision makers. Boundaries in the industrial paradigm are rigid and fixed at all levels of the manufacturing organization. This rigidity is based on a mechanistic structure that looks to reduce the uncertainty and complexity of the environment, and is one of the causes of low responsive capabilities to changing customer needs. In order to be more responsive, in the post-industrial paradigm, manufacturing companies design and implement more permeable and flexible (elastic) boundaries under organic structures. This boundary elasticity and permeability help to adapt the area of responsibility of decision makers to be more responsive to environmental demands. The permeability allows the decision maker to incorporate external resources as needed to improve the effectiveness of the decision making and transformation process.

Transformation Process

In the industrial paradigm transformation processes are typically represented by the mass-production systems which are highly mechanized[6] and have limited flexibility in terms of product variety. Under this paradigm production managers are more concerned with the coordination and stabilization of the transformation process in order to achieve the efficiency/cost goals. In the post-industrial paradigm the transformation processes are represented by the mass-customization production approach. Mass-customization systems involve the utilization of advanced flexible manufacturing systems to deliver products/services with high value content for customers. In terms of the innovation processes, the approach in the industrial paradigm is mechanistic or functionally oriented. Product design and innovation is responsibility of just one department, usually named product development or product engineering. In the post-industrial paradigm the approach employed is multifunctional and holistic. Post-industrial product development teams include people from marketing, manufacturing, engineering, logistics, customers and suppliers.

Monitoring and Control

Monitoring and control in the industrial paradigm is characterized by being more focused on activities, more discrete, and more bureaucratic. In contrast, in the post-industrial paradigm monitoring and control is more focused on end results, more self-regulatory, and more continuous[4,10].

Managerial Implications

The above analysis has important implications for manufacturing managers. They need to continuously assess their contextual environment and align their manufacturing system's capabilities with it. The combination of the industrial and post-industrial environment variables with the industrial and post-industrial manufacturing capabilities variables creates four potential states for manufacturing companies (See Figure 1). Cells 2 and 3 show adequate fit between the environment and manufacturing capabilities. Companies that can be placed in these cells show that management has developed patterns of thinking adequate for either industrial or post-industrial environments and that adequate capabilities are in place. In both cases companies are expected to be successful. In cell

1 companies have developed a management mindset and capabilities adequate for a post-industrial environment but actually competing in a industrial environment. This lack of fit is interesting since it is not expected to have any negative impact on manufacturing's performance. On the contrary companies located in cell 1 are also expected to be successful. Cell 4 shows a critical misalignment between environment and manufacturing capabilities which will have a negative impact on manufacturing's competitiveness and survival. Companies located in cell 4 have three alternatives. First, to recreate its manufacturing capabilities to fit the demands of the post-industrial environment i.e., evolve to cell 2. Second, to move to cell 2 by either moving to a different type of industry which fit its capabilities (an industry with a industrial environment type), Third, within the same industry move to a sector of the market which has not still evolved to a post-industrial type environment. To stay in cell number 3 will be a path for extinction.

In order to assess the present fit between manufacturing's capabilities and environment, manufacturing managers need to assess first their industry environment. A set of questions based on the different attributes for each of the environmental components described in Table 2 need to be answered. For example:

Is our organization's environment characterized by heavy foreign competition?
Is our organization's market rapidly growing?
Are our product's life cycles shorter?
Is our organization's environment characterized by rapid changes in market conditions?
Are our organization's customers more global?

Through a thoughtful evaluation a team of managers should be able to assess in which environmental state (industrial or post-industrial) is their organization positioned. The next step is to assess the state of the manufacturing organization utilizing the HAS formal model elements and its attributes described in table 3. If the results of the evaluation show a situation like the one described in cell 4 there is a misalignment and top management needs to devise a strategy to align its capabilities with the environment.

Conclusion

We have outlined in this paper the nature of the post-industrial environment which will be upon us sooner than we expect. To survive in the post-industrial environment a paradigm shift is needed in the mindsets of managers. We showed how managers could attempt to assess the environment in which they have to operate, and also we provided guidelines to evaluate their manufacturing's capabilities.

Table 1. The HAS Model Attributes

Environment	The relevant context interacting directly or indirectly and located outside the system's boundaries. The wider system in which the system of interest is imbedded.
Purpose	It is related with the existence of a mission, objectives, goals.
Performance Measures	These are measures which signal the progress or regress in pursuing purposes or trying to achieve objectives.
Decision Making Process	The process through which the system takes regulatory actions in the light of purpose and performance measures.
Resources	It is related with the physical, abstract, and human participants which are at the disposal of the decision-making process.
Connectivities	It is related with all the forms through which the system's components interact.
Boundary	It is the conceptual area within which the decision-maker has the power to cause action to be taken.
Transformation Process.	The process that converts inputs to outputs.
Monitoring and Control	It is related with the process through which the system evaluate the performance measures and take corrective actions.

Table 2. The Industrial and Post-Industrial Environment Characteristics

Environmental Variable	*Industrial Manufacturing*	*Post-industrial Manufacturing*
Markets	More Stable More Domestic Relatively Similar	More Turbulent More Global More Diverse
Competitors	Few Mostly Domestic	Many Increasingly Global
Technology	Limited Availability Limited Accessability Long-linked Driver	Greater Availability Greater Accesability Intensive Enabler
Customers	Mostly Domestic Less Informed Concerned with Product Features Less Holistic Less Diverse Less Complex Less Sophisticated	Increasingly Global Well Informed Concerned with product plus service features (value) More Holistic More Diverse More Complex More Sophisticated
Suppliers	Focus on Transactional Relationships Short Term Focus Many	Focus on Partnership Relationships Long Term Focus Few
Ecology	Not Concern	Increased Concern
Government role	Highly Regulatory	Moderately Regulatory

Table 3. The Industrial and Post-industrial Manufacturing Organization-Internal Aspects

Internal Subsystems	*Industrial Manufacturing*	*Post-Industrial Manufacturing*
Purpose	Internally Oriented Maximum Production Minimum Cost Maximum Productivity Process Efficiency Satisfy Demand	Externally Oriented Maximum Responsiveness Utility for Customers Value Creation High Dependability Satisfy Customers
Resources: Production Technology Equipment Labor Skills Information	 Long-linked Technologies Manual and Narrow Less Complex Less Frequent More Standard An Important Output Tactical Use Fixed in the Hierarchy Top-Down Flow Mechanistic Focus	 Intensive Technologies Intellectual/Multiskills More Complex More Frequent More Customized A Critical Input Strategic Use Flexible to Needs Multiple Directions Flow Integrative Focus
Management View of: Managers Labor Source of Value	 Custodians of Assets Machine Tenders Machines	 Architects Problem Solvers People
Monitoring and Control	Focused on Activities Discrete Bureaucratic	Focused on End Results Continuous Self-Regulatory
Decision Making Process	Centralized Authoritarian Mechanistic	Decentralized Participative Organic
Performance Measures	Internal Financial	External Value to Customers
Connectivities	Few	Many
Boundary	Rigid and Fixed	Permeable and Flexible
Transformation Process	Mass Production Highly Mechanized Rigid	Mass Customization Highly Automated Highly Flexible

Figure 1. Environment-Manufacturing Capabilities Grid

	Environment: Industrial	Environment: Post-industrial
Industrial Manufacturing Capabilities	Cell 1 Successful	Cell 2 Unsuccessful
Post-industrial Manufacturing Capabilities	Cell 3 Successful	Cell 4 Successful

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