FORMS OF ENTERPRISE'S AGILITY

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Keywords: Agility, Agile manufacturing, Lean manufacturing, Agile enterprise, Virtual enterprise, Information technology.

Abstract: After lean production, agile manufacturing is considered to be the current paradigm for manufacturing businesses. However authors who write on this subject use the term as a synonym of agile enterprise, agile supply chain, and from the other side, even as a synonym of lean manufacturing. Each of these expressions have a different area of meaning, is connected with different scope of agility, and although in some cases they cane be used interchangeable, it should be done with an intent. In this paper the different scopes of agility are treated as its forms. In consistency a presumption is taken that there is no only one proper form of enterprise's agility and that contingency approach should be applied when deciding about the form. Each of these forms are presented including IT that supports the particular form.

1 INTRODUCTION

The business environment becomes more and more changeable and commonly is described as turbulent and unpredictable. Since 60's the production technologies and management concepts and methods which were used in mass production, slowly, first in Japan and next in western countries, have been replaced by these which constitute lean manufacturing. In 1991 the Iacocca Institute at Lehigh University, USA, presented a report, in which a characteristic of new bases of competition was included (Goldman, and Preiss, 1991). According to the researchers, in continuous and unpredictable changing business environment, to survive and compete efficiently, a quick respond to the market, quality improvement and social responsibility is needed. These features have been embraced by a new concept which is called agile manufacturing and is commonly considered to represent a new paradigm of manufacturing (Phillips, 1999; Brown and Bessant, 2003; Hormozi, 2001).

Some authors who write on this subject use the term of agile manufacturing as a synonym lean production or manufacturing, agile enterprise or agile supply chain. Each of these expressions have a different area of meaning, is connected with different scope of agility, and although in some cases they cane be used interchangeable, it should be done with an intent. To minimize the obscure of meaning of agility, in this paper, a relation between manufacturing system, production system, an enterprise as a whole and external value chain is presented. Agility which relate to each of the organizational whole is treated as a form of agility. These forms are contingency determined.

2 MANUFACTURING AS AN OVER AND SUB-SYSTEM

Manufacturing system transforms the needs and expectations of the customer into products (goods or services) which are delivered to him (Armstrong, 1994). Thus the systems encompasses mutually alternated stream of information and decision and stream of energy and materials. The last one which transforms an energy and material inputs into goods and services is called a production process and together with its controlling process creates a production system. Production line or production cell are examples of production system. Contrary to some authors, in this paper production system is meant as a subsystem of manufacturing system (Figure 1). From the other side manufacturing is one of a lot subsystems of the whole enterprise, which in a row, is a subsystem of the network of enterprises arranged in supply/value chain (it is worth to notice

Trzcieliński S. (2007).
FORMS OF ENTERPRISE'S AGILITY.
In *Proceedings of the Ninth International Conference on Enterprise Information Systems*, pages 397-403

that some authors (Ramasesh at al., 2001) define manufacturing system as a network of enterprises). Consequently, when talking about agile production system, agile manufacturing system, agile enterprise or agile value chain, the consistent researcher should distinguish the areas of interest, as other wise, the meaning of agility is obscured. Particular that concerns widely meant IT, as some technologies are dedicated only to particular scope of agility.

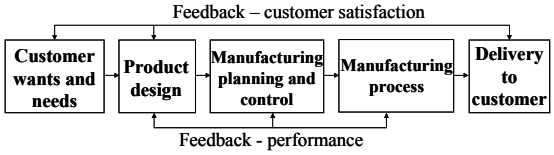

Figure 1: Manufacturing system (Armstrong, 1994, p.129).

3 FORMS OF AGILITY

3.1 Agile Manufacturing – Enterprise Internal View Point

3.1.1 Agile Manufacturing as a Lean Manufacturing

Some authors treat agile and lean manufacturing interchangeable. Even if they writ about "agile manufacturing" they describe the same managerial and production concepts and methods which constitute lean manufacturing (Brennan, 1994; Ikonen, et al., 2000). Particular it concerns such so called new concepts and methods as: Total Qualit Management (TQM), Concurrent Engineering (CE), Outsourcing (OS), Total Productive Maintenance (TPM), Supply Chain Partnering (SCP), Team Based Working (TBW), Empowerment (EMP), Just in Time (JiT), Manufacturing Cells (MC), Integrated Computer-Based Technologies (ICT), Business Process Reengineering (BPR), and Learning Culture (LC). Such approach has partly its source in observation that manufacturing can not be agile if is not lean, and is not lean when there are big stocks, production is led in big batches and respond to the customer is slow (Goldman, et al., 1995). Thus way concepts and methods of lean manufacturing are also basic concepts and methods of agile manufacturing (Figure 2).

However such view point on mutual compatibility between both concepts obscures their ideas which are different (Kidd, 2006). The key point to distinguish both concepts is the life time of opportunities which the enterprise is focused on. Lean manufacturing is concentrated on long life time opportunities. Such opportunities ensure some level of stabilization, so the company can optimize the resources which it has to posses. The optimisation depends on eliminating each symptom of wasting (Hormozi, 2001; Jin-Hai, et al., 2003; Paez at al., 2004).

Contrary "agility" is a concept depending on using short life time opportunities. Such opportunities are generated by rapid, continuous and unpredictable changes in business environment (Goldman et al., 1995; Varnadat, 1999; Zhang and Sharifi, 2000). More less the same set/system of managerial methods is exploited in both lean and agile manufacturing. The goal however is different; lean manufacturing uses them to reduce wasting when agile manufacturing implements these methods to improve the ability to respond quickly for changes of competitive environment.

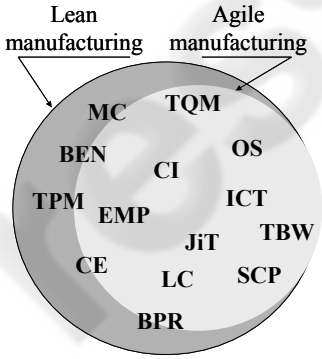

Figure 2: Some concepts, methods and practices used by lean and agile manufacturing (Trzcielinski, 2006).

3.1.2 Agile Manufacturing as the Ability to Supply Customized Products

A range of publications emphasize that ability to deliver a product fully adjusted to the customer needs and expectations is the defining feature of agile manufacturing (Homrozi, 2001; McCullen and Towill, 2001; Toussaint and Cheng, 2002; Jin-Hai at al., 2003; Brown and Bessant, 2003). Such product is high quality, costs cut and with short delivery time and able to be upgraded or reconfigured. To build such product the company looks mostly for opportunities at existing market of its customers. They change their expectation about the product under influence of different environmental factors so the enterprise has to recognize its customers needs. The basic role in such model of agility is played by marketing forces which have to identify the expectations and needs and pass them to R&D and engineering staff. To shorten the lead time to the market methods like CE and TBM have to be

implemented and appreciate IT must support the teams. These broadly meant information technology includes computer numerical control (CNC), automated guided vehicle (AGV), automated material handling (AMH), direct numerical control (DNC), automated assembly (AA), robots and FMS in production subsystem (Vastag at al., 1994; Zhang and Sharifi, 2000) and lot of tools supporting designing and engineering. Among others, they encompass CAD, CAM, CAE, virtual reality (VR), rapid tooling (RT), Reverse Engineering Systems (RE), and rapid prototyping technology (RPT) that can be integrated with FMS, (Onuh and Hon, 2001; D&ME, 2006) (Figure 3).

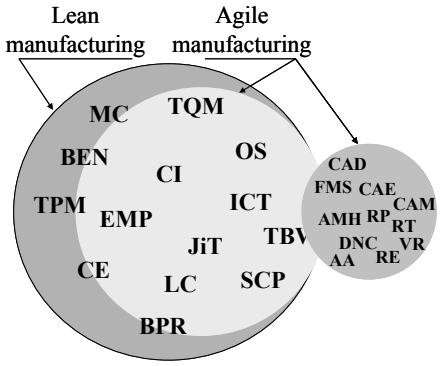

Figure 3: Product customization and quick respond tools of agile manufacturing.

3.1.3 Agile Manufacturing as the Ability to Create the Ceeds of Existing and New Customers

Agile manufacturing system not only identify and satisfy the expectations of their customers but create a demand for needs which are out of the customer awareness (Maskell, 2001; Brown and Bessant, 2003). For instance who of owners of mobile phone was aware in middle 90' that he needs his mobile phone to take photos, listening to the radio or watching TV? This possibilities of mobile phones were presented in the electronics fear in Geneva in 1998 and from that time people have started to feel these needs.

Creating needs is qualitative different approach that only satisfying them. The priority is given not to marketing but to R&D functions. It requires wider and deeper knowledge, new ideas and creativity (Maskell, 2001; Jackson and Johansson, 2003). As innovative staff is essential, learning organization and knowledge management become crucial concepts and practices.

These leads to changes of the model of manufacturing that we can see in multinational and global corporations. They concentrate the R&D functions in few places and pass the production functions to its subsidiaries and divisions located where the production can be the chipset. Some small and medium businesses do in the same way – they concentrate their activities on R&D and outsource the production and supportive functions.

Particular in big corporations the knowledge is dispersed. Teams, including concurrent engineering teams, are not co-locative. This generates the need for IT supporting distributed o virtual teams working. Variety of commonly used technology is available, including internet, extranet, intranet, video-conferencing (Trzcielinski and Wojtkowski, 2007) as well as some dedicated technology supporting project management. Examples can be systems like MS Project, Prima-Vera, Pert Master or PK*Online* – system which is used in VW to support continuous improvement distributed teams working and knowledge sharing (Figure 4).

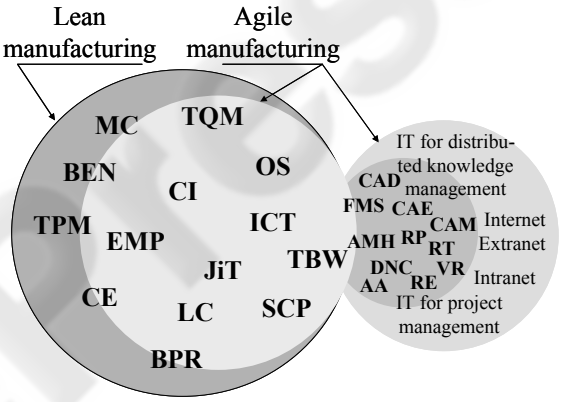

Figure 4: Tools to support distributed team working.

3.2 Agile Manufacturing – Network View Point

3.2.1 Agile Production in Virtual Work-floors

The traditional enterprise which looks for wide range of opportunities in turbulent and unpredictable environment meats a problem that it does not know if production system it has (technologies, machines, workers competencies, etc.) will be useful to undertake the future opportunities. One of solution to cope with this problem is to build an excessive production system which will be able to run a big variety of task. However this solution is extremely costly and irrational (Jin-Hai at al., 2003; Trzcielinski and Rogacki, 2004). The other one depends on using unlimited capacity of external

suppliers which are chosen up to the current needs determined by the opportunities the enterprise undertakes. Usually the enterprise keeps in its own structure production of some parts and technological phases like assembly, which add the key value to the final product and from the enterprise view point are subject of technology secret. Production of other elements is outsourced.

Easy, in technological sense, parts and processes are moved to small and medium businesses. Market of them is usually highly competitive. The contracts are short (small batches of products, short delivery time); shorter is the life time of the opportunity, more abrupt are the contracts. The occasion determined partners are chosen on the base of cost/price competitiveness as usually they meet the technological and quality requirements without troubles. Such partners are recognized as virtual production work-floors (VWFs).

The enterprise using virtual work-floors superbly increases its agility, as it is able to produce a wide range of products possessing limited capacities and keeping fixed costs on stable level in a long run (Hormozi, 2001).

Technologically difficult parts and processes are passed to partners on the base of long time agreement and alliances (SCP). Such production requires specialized both technology and knowledge. In this way relatively enduring supply chain (SC) is created. Example of such chain is shown on figure 5.

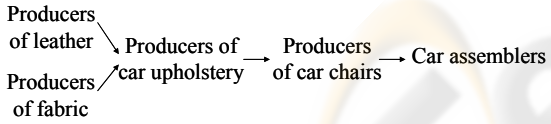

Figure 5: Example of supply chain.

Supply chains have highly specialized links and therefore are more stiff and less reconfigurable. Although the links represent advanced level of technology, there is rather low risk that the supplier will do forward product acquisition. That is because of narrow and deep specialization of the chain links.

The above two situations – virtual work-floors and chain of suppliers requires different IT to manage the cooperation. In defiance of some opinions, to manage the VWFs, no especial IT is needed. As it turned out in research undertaken in this field in Institute of Management Engineering – Poznan University of Technology, mostly use of stationary and mobile phones, internet, e-mail and communicators is enough. That is because coordination in this case depends on passing through the communication channel simply information about what, how many and when must be done. Usually the subcontractor does not need any especial technical assistance from the final manufacturer. However in case of supply chains, there is necessity for some standardization of IT which is used by partners. This concerns for instance MRP II/ERP systems, CAD, VR, work flow systems (WF) so data and solution generated in one link of the chain could be used in another one (McCullen and Towill, 2001).

3.2.2 Agile Virtual Enterprise

To be agile, in terms of being aggressive in creating opportunities for profit and growth (Goldman and Preiss, 1991, p.43) the organization has to ensure brightness (nimbleness), flexibility, intelligence and shrewdness for the enterprise. No single one of the features is enough to be agile; they must exist all together. Because of that they are considered to be morphological components of agility (Trzcielinski, 2006).

Brightness of Enterprise

To be agile the enterprise has to be able to perceive quickly market opportunities and threats flowing from the environment. The opportunities are independent on the enterprise and going by market situations, which are the necessary conditions to act in manner leading to desirable effect o goal. This component of agility is called here the brightness.
The diversity of opportunities increases with grow of changes in the environment as the changes evoke events and tangles of events create situations including opportunities. The scope of potentially available opportunities is called here the strip of opportunities (Figure 6). Better the brightness of enterprise the wider is the strip of opportunities. In this sense, the brightness is a function transforming the turbulent environment into the strip of potential market opportunities.

Flexibility of Enterprise

The scope of access to the potentially available opportunities stays in relation with the enterprise specialization. Specialization depends on narrowing the diversity of undertaken activities. The scope of specialization is determined by available and owned resources. More homogeneous are possessed resources narrow is the specialization of the enterprise. That means that the resources determine the width of strip of available market opportunities. It is called here a strip of resource available opportunities.

Resources are available in result of purchasing them (own resources) or by subcontracting the work. In the second case a network enterprise is created. Own resources can be more or less multi-objected, that means they can be used to realize wider or narrow repertoire of tasks. Broaden repertoire of task is possible when general purpose resources are used. The universality of resources can be traditional (like in case of general purpose machines or multi-job workers) or flexible (like in case of flexible manufacturing systems).

Like own resources also subcontracting creates possibility of broadening the repertoire of realized tasks. It depends on the character of the network the enterprise creates or belongs to. In static networks like strategic alliances, consortiums, supplier-subcontractor, cooperative agreements or outsourcing contracts, the repertoire of possible tasks to be perform is narrow than in dynamic networks like virtual work-floor.

The feature of resources available for the enterprise depending on possibility of extending the scope of their use, and the same on extending the repertoire of the task which can be realized with use of these resources, is called resource flexibility of enterprise. It is the second morphological component of agility. Larger is the resource flexibility, wider is the strip of resource available opportunities (Figure 6). In that sense the resource flexibility of enterprise is a function transforming the strip of potential market opportunities into strip of resource available opportunities.

The Intelligence of Enterprise

The intelligence of enterprise is its ability to understand the situations in which it functioning and finding intentional reactions in these situations. The reactions depend on activating proper resources to eliminate or reduce harmful influence of these situations (threats) or to use occasions (opportunities). The intelligent enterprise exploits the following resources: material, financial, people and knowledge. They are activated to move from one to other resource available opportunities. In that sense the intelligence is a function transforming the strip of resource available opportunities into strip available opportunities and constitutes the third morphological component of agility (Figure 6).

Shrewdness of Enterprise

From definition, opportunities are going by situations. The life time of market opportunity depends on the changeability of the enterprise's environment. It gets shorter when the changeability increases. More short life time and narrow is the strip of the opportunities more difficult to achieve them. The ability of enterprise to use quickly the opportunities in beneficial mode are called here the enterprise's shrewdness and is considered to be the forth morphological component of the agility (Figure 6).

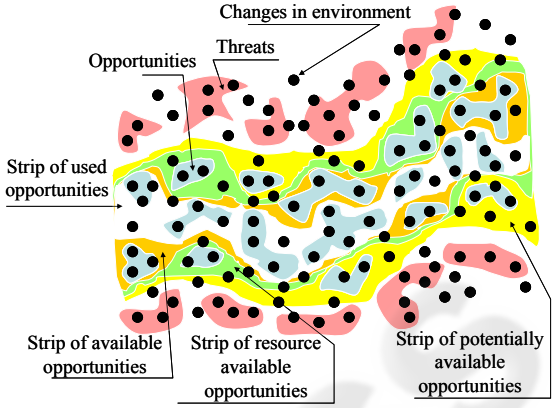

Figure 6: Agility as a function transforming environmental turbulences into a strip of opportunities used by the enterprise.

The only form of enterprise which enable to obtain all the morphological features of agility is virtual organization. The virtual organization is a temporary configuration of partners working together for achieving bargain goals. The aspect of reconfigurability and the same temporality of partners, is appointed by authors writing on the organization of the future, to be a vital feature of virtual organization (Galbraith, 1997, p.89; Cunha and Putnik, 2006, p. 36-40).

The opportunistic and temporary character of the relations means that virtual organization reconfigures itself, so it has a dynamic structure. The changeable components (partners), which are taken from the environment, cause that the boundary between the virtual organization and the environment becomes fuzzy. Because of this it is invisible for its customers (Handy, 1997).

The virtual organization bases on team working. It exploits the mutual adjustment mechanism of coordination which depend on informal and direct contact between team members. The mechanism is efficient when the partners conform their actions to the achievement of common goal and express the willingness of cooperation. The mutual adjustment means that there is not only one coordination and decision centre and that such centre is emerged spontaneously according to the core competencies possessed by a partner. The decision centre moves from one to another partner who has the key

competencies in particular phase of the project. In results the hierarchy is replaced by heterarchy.

There is a long organizational distance between partners in virtual organization. In case of network of institutional enterprises the distance is determined mostly by the location and social distance. Quite often the dispersed location is assisted by time distance. Both features make not only weaker the social relations among partners but difficult to build the climate of their trust, which is one of the powers integrating partners within virtual organization (Handy, 1997; Jin-Hai at al., 2003).

The reduction of the negative influence of location, time and social distance is possible by selecting competent partners and implementation of IT enabling effective communication and quick access to the common data basis. In this way the organizational distance and particular its information component becomes shorter. The information technology gives the organization a new quality and is an essential attribute of virtual organization.

Virtual Enterprise implements different forms of cooperation among partners including e-commerce, e-business, e-marketplace, e-negotiations, e-contracts and others (Cunha and Putnik, 2006, p. 150-181). All these forms require Internet and Web-based systems which provide support to them. Additionally intelligent agent-based solution are technologies which can be appropriate in both virtual organization (searching for partners) and electronic commerce (searching for products and services) (Cunha and Putnik, 2006, p.149) (Figure 7).

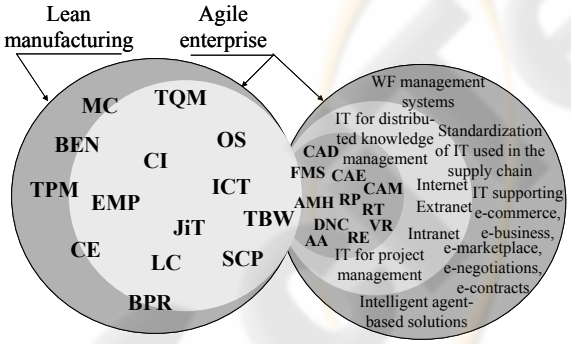

Figure 7: IT supporting transition from lean manufacturing to agile enterprise.

4 CONCLUSIONS

Agility is not state, it is process. Perhaps it starts from agile manufacturing where the enterprise is focused on product customisation and short time delivery of the product to the market. Just then, as regards of concepts and methods which are used, agile manufacturing looks like lean manufacturing. However both concepts differ each other. Lean manufacturing and lean enterprises looks for long life time opportunity when agile manufacturing and agile enterprise caches short time opportunity. The opportunity can be searched for at existing customers market or in any market when a demand appears or has been created for certain products or services. More changeable is the business environment more opportunities appears. Agile virtual enterprise is an organization which copes with such "unfriendly" environment. In fact such environment justify the sense of its existence.

Agility is not possible without IT. The concept has got to practice in result of IT development. That concerns technologies aided design, engineering, manufacturing, production, etc. New possibilities appeared when Internet and internet technologies became available. Just than distributed engineering and distributed work could enhanced on upper level up to purely virtual organization, as technology like work flow systems, distributed knowledge management, supply chain management, e-business, intelligent based-agents and a lot of others made them realistic.

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