5

The organization of the Self-Innovative Extended Factory in the Manu*F*uturing Model

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Abstract

The growing importance of environment and social aspects has lead to the emergence of the life cycle concept and to Sustainable Industrial Production. The Products-Processes life cycle matrix must then change to respond to mutations of the context. It may follow a stepwise path combining innovation (new generations) and evolution (within a generation). The model described containing "Manufacturing", at network level, of current products and (Genetic Matrix) of "future" products-processes generations, has been named Manu*F*uturing. Because of its capabilities to respond, through Research and Innovation, to context changes Manu*F*uturing may be seen as a contribution to a Sustainable Production model. This paper describes, the first top level of the Model, that is the Self Innovating Extended Factory.

Keywords

Extended Factory, Virtual Factory, product-process life cycle.

Organizing the Extended Enterprise P. Schönsleben, & A. Büchel (Eds.)

1 INTRODUCTION

The economy, the society and the technology evolve continuously and call for changes of products and related processes. The growing importance of environment and social aspects has lead to the emergence of the life cycle concept and to Sustainable Industrial Production. The Products-Processes life cycle matrix must then change to respond to mutations of the context. It may follow a stepwise path combining innovation (new generations) and evolution (within a generation). Industry must therefore respond to the challenge by creating networks where there is a close relationship between Virtual Factory (where the life cycle of product/process is created) and Physical Factory (where the same life cycle is tested). The networks for the innovation cycle will include academic partners, research centers, technology transfer centers, industries, suppliers and even clients: the integration of various networks would lead to a self-innovating extended factory (SIEF). It will be able on one side to respond to market tactic needs, on the other side, to the "demand curve", by "producing" and "maintaining" generations of:

- products
- processes, including its own configuration.

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Our investigation on the interaction between research institutions and industry has shown that it is necessary not only to create the "virtual networks" but also to find mechanisms of transfer between the "virtual" and the "physical" networks. Several production paradigms have been proposed, but mainly at the "micro" level that is at the physical network of suppliers and end-users. The macro level is instead responsible of the strategic long-term response of the industrial innovation. The trend here is towards the development of methodologies and tools for the systematization of information (through networks) and Synthetic Intelligence. Each level interact with each others but with different time scale. For example a new scientific discovery may lead to a concept for a new industrial product. To transform this concept into a real product, it will be necessary conceiving, prototyping and experimenting a whole life cycle of process and manufacturing modules. This can be done by transmitting the information to the lower level in order to experiment through the mechanism of the Virtual Factory the innovative concept of the upper level. This will be efficiently performed only within a well tested "virtual network". The paper concentrate on the methodologies and examples of the Self-innovative Extended Factory concept.

2 THE MANU*F*UTURING MODEL AND PROJECT

The Manu*F*uturing model approaches the problem of achieving the sustainability in production by considering four distinct levels (Boer, 1996), each one with a different time scale and different detail of investigation (see Figure 1). The lower level is responsible for the development and maintenance of the independent manufacturing modules,

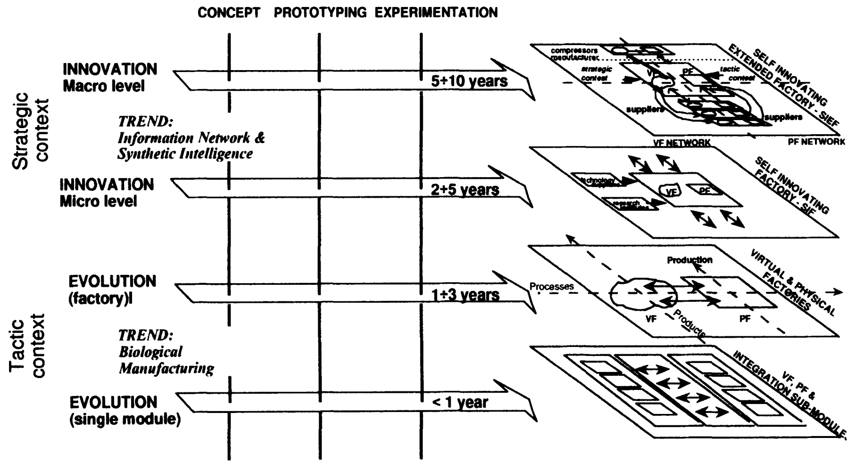
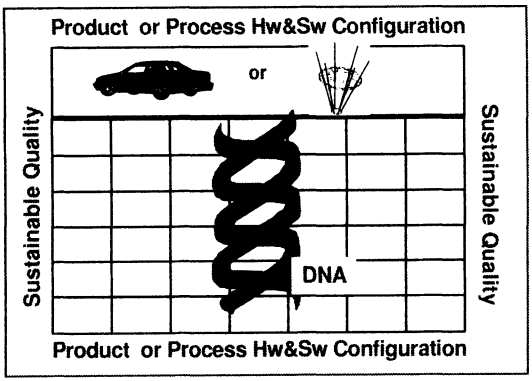


Figure 1 The ManuFuturing model.

the level above is responsible for the integration of modules of the lower level in a "factory". These two lower levels will be working with the mechanisms of evolution and the genetic matrix anti-obsolescence maintenance (Boer, 1996).



Sustainable Quality = Product or Process performances and compliance with enviromental requirements

Figure 2 The Genetix Matrix of Product/Process in a Sustainable Production context.

The two upper levels are concerned with Innovation or the development of the Genetic Matrix of new product/process in a Sustainable Production context (see Figure 2).

At these levels the concepts of "Virtual" and "Physical" networks are essential in order to cope with the complexity of the product and related processes. Each level interact with each others but with different time scale. This approach is particularly efficient when we are dealing with a "discontinuity" or a radical innovation or a "generation gap" but also with "genetic evolution" as shown in Figure 3.

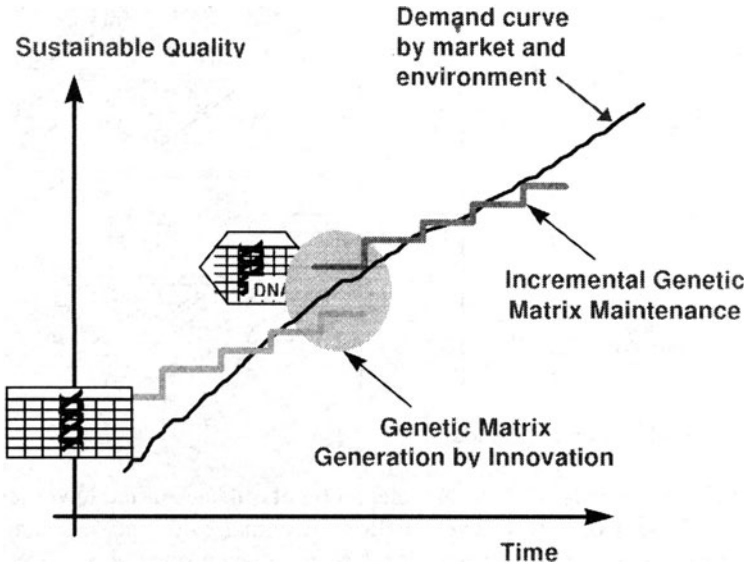


Figure 3 The Innovation process to respond to market and environment demand.

For example a new scientific discovery may lead to a concept for a new industrial product. To transform this concept into a real product, it will be necessary conceiving, prototyping and experimenting a whole life cycle of process and manufacturing modules. This can be done by transmitting the information to the lower level in order to experiment through the mechanism of the Virtual Factory the innovative concept of the upper level. This will be efficiently performed only within a well tested "virtual network". Therefore the "virtual network" has the two dimensions: vertical to test and experiment through the VF and PF and horizontal to improve the concept into a working prototype and experiment and create the "physical" network of the SIEF and SIF. It is also clear that each level is working towards a self-innovation.

The model, developed by ITIA, is implemented in a Eureka Factory Project with a network of Research Institutes and Industrial Partners. The top strategic levels have been implemented. They consist of R&D Centers (ITIA and CIMSI) in connection with ZEM (Zanussi Elettromeccanica) and Precicast as first end users and various suppliers. The horizon is 4 to 5 years and it deals with the Products and Processes. A Virtual Network is in a construction phase using methodologies and tools centered on "physical networks" like Intranet and Internet. ITIA will be testing the ManuFuturing model and enriching it, with the help of (present and new) partners, through the results obtained in various industrial plants.

3 THE IMPLEMENTATION MODEL OF THE SELF-INNOVATIVE EXTENDED ENTERPRISE.

An Extended Enterprise is normally based on a network of prime users and several suppliers and clients. It is organized to deal with mainly the business process in the most efficient way. The concept introduced in ManuFuturing is concerned with the innovation cycle as explained in the previous chapter. There are no available model in the literature concerned with the integration of the innovation cycle in the extended enterprise. There are some projects that deal with the change of the organization when the company is evolving towards new markets or new products but little attention is given, also because it is a relative new field, to the integration within the extended enterprise of the primary source of innovation that is R&D centers, Universities or up-front high tech SMEs. The various R&D programs (like Eureka or the IV Framework Program) can be taken as example of model for the SIEF but they normally are limited to the duration of the project and there is no mechanism to establish a self-sustainable network or extended enterprise. Lately the success of such initiatives as the Thematic Networks, shows that there is a necessity for the establishment of such organizations but they seems mainly to be limited to Universities and R&D centers with a minor participation of enterprises.

To be able to set up an extended enterprise it is necessary to establish the right cooperation with the right suppliers. To set up an extended enterprise for the innovation cycle (a SIEF), it is necessary to set a network with the suppliers that becomes partner but also to share some of the activities of R&D with some institutions able to supply highly skilled and trained personnel. Particularly in the case of highly sophisticated and up-front technologies, an interface with R&D centers and Universities has to be established. This interface is difficult to be managed in particular for SMEs. It is necessary therefore to have an intermediate partner that is half way between a advanced research institute and an enterprise that is directly selling on the market. It is known that be really innovative ine does not have to be too much specialized in order to not have preconceived feelings towards ideas that seems to be too much revolutionary. Furthermore the resources that has to be employed by a company to attack and sold directly into the market are very high and, for some companies, of such entities to be an impediment to maintain a strong and enough efficient R&D team. An example it is what has happened in the field of CAD industry where an innovative team developed a new core technology for 3-D geometry that is now the geometric engine of almost all the existing commercially available CAD systems. A survey of these commercial CAD systems have shown that only one tenth of the turnover is dedicated to advanced R&D while the rest is for marketing, client contacts, maintenance but also the development of less high tech technologies like good GUIs and integration between the various tools that are today part of the integrated package surrounding the CAD systems. Therefore the company developing the core technology can fully dedicate its highly skilled personnel to the most advanced research.

We have been studying and implementing a similar approach in the field of machine tool and robotics where new technologies promise a "jump" in evolution of these machines based on parallel kinematics (Annacondia, 1996). But these new technologies require an intensive and highly skill research team that most machine tool companies cannot afford because of its size particularly in Europe. Two of these machines will be part of the manufacturing process of two companies belonging to the Manu*F*uturing project and the integration of development of these machines will be one of experiment to test the Manu*F*uturing model.

4 TOOLS FOR THE SIEF

We believe usage of inter-organizational systems (IOS) will grow because of the need to integrate disparate organizations or individuals in the same IT-enabled processes, independently of formal boundaries. Information technology now allows us to consider and integrate whole value chains, independently of geographical or organizational boundaries. In most companies, the traditional IS/IT spending has been focused up till now on intra-enterprise projects, but a new source of added value can be derived from extending the scope of the IT projects. This is called IT-enabling the extended enterprise.

For the common functioning of the extended enterprise the following are the tools that accepted as almost standard:

- electronic mail linking all partners
- shared document databases, containing a copy of every document produced by the team (meeting minutes, software specifications, project plans, etc.)
- discussion databases, useful especially at the beginning of the project to discuss design conflicts
- a database containing copies of each piece of software developed, allowing the different design teams to keep track of each other's progress, and allowing the users to look at prototypes and react quickly
- a database containing resource use tracking, allowing the comparison with plans and insuring the respect of time and costs budgets.

In addition to the above tools, we are studying the implementation of other tools that we feel will be particularly useful for the SIEF:

- interactive TV,
- videoconferencing
- virtual reality

In the ManuFuturing project the R&D institutes and the industrial partners will be connected by interactive TV and videoconferencing in order to be able to monitor the work done at each partner site and make on-line conference on project progress. Virtual Reality started as a tool to enhance games and as expensive simulation for flight training and army simulator. Today it is becoming a tool for Concurrent Engineering (Imperio, 1996) and is used in the Manu*F*uturing project to help the design team to investigate new advanced manufacturing processes and equipment. Virtual Reality is part of the Virtual Manufacturing Environment. The approach of virtual manufacturing is very effective for the new requirements of manufacturing technology (Bianchi, 1996). It allows easy reconfiguration and extension of a system by offering systematic and modularized knowledge of manufacturing, and it makes computer support activities transparent for human understanding.

5 CONCLUSIONS

The paper is describing a model of Extended Enterprise that include the process of life cycle innovation of product and process. The Self-Innovative Extended Factory (SIEF) is part of a larger framework model called Manu*F*uturing that is the base for the a project with same name. This project, running under the umbrella EUREKA/Factory project, will test the model and in particular the Extended Factory in a real environment involving factories, suppliers and R&D institutions for the manufacturing of components and groups to be part of white goods.

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