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PRIORITY INDUSTRY EXPERIENCE IN THE DEVELOPMENT OF PRODUCTION MACHINERY

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Abstract: This paper aims at reviewing and systemising the research carried out in the field of manufacturing evolution with a particular focus on development and use of production base. The core part of the work consisting in a systemised analysis of the current methodologies dealing with evolving production base and a description of problems that remain unsolved.
Keywords: Manufacturing, Production base, Development and use producing technique.

Introduction

Manufacturing enterprises are changing the way they behave in the market to face the increasing complexity of the economic, socio-political and technological dynamics. Manufacturing products, processes and production systems result in being challenged by evolving external drivers, including the introduction of new regulations, new materials, technologies, services and communications, the pressure on costs and sustainability. The co-evolution paradigm syntheses the recent scientific and technical approaches proposed by academic and industrial communities dealing with methodologies and tools to support the coordinated evolution of production capacity, product quality and production base.

Dynamics of Machine Production

Manufacturing is radically challenged worldwide by complex economic, socio-political and technological dynamics that have a tremendous impact on enterprise behaviour in the market, and consequently, on the research priorities of the scientific community. Many external drivers are modifying the way products are designed and exploited, among them the introduction of new materials, technologies, services and communications, the pressure on costs and the attention paid to sustainability specifications. For example, the advent of composites in the aerospace and automotive industries has required the design of more complex product shapes and the achievement of challenging performance levels. The introduction of new legislation in manufacturing to reduce the product environmental footprint has had a profound influence on manufacturing processes and has resulted in the birth of a new generation of production equipment characterised by higher energy efficiency, for example machine tools [1].

Furthermore, the need to increase company competitiveness is leading to conceive products as more complex entities, with the physical product enriched by service and communication activities. This introduces a new generation of products, named adaptable products, that are adaptable in their design and/or their production. Adaptation prolongs the service and multiplies the functionalities of a product in time. As a result, the traditional technologies and decision support tools, such as Design for X (AutoCAD, Solid Works,...) and computer-aided technologies (Solid Works+Solid CAM, CATIA/DELMIA, CREO elemens,...), are not sufficient to deal with the challenges introduced by the process of adaptation. This represents a key issue especially in the early stages of the adaptable product design where the most important decisions are made with respect to the product functionality, quality, manufacturability, cost and environmental performance [4].

These aforesaid developments have led to requirements such as responsiveness and flexibility in production that are being transformed into cognitive adaptability, changeability, self-diagnosis, self-resilience, self-improving environment paradigms and co-creation. Companies are continuously absorbing these change drivers by shaping their corporate strategy and by combining external needs to the internal requirements of efficiency, productivity and cost-effectiveness. The inherently complex dynamics of change propagation has impacted all levels of the organisation, as illustrated in Fig. 1 [3].
Fig. 1 illustrates the integration of products (as part of a productservice system, i.e. physical product, service and communication), processes and production systems and their connection and reciprocal influences with the strategic decisions of the company as well as with the market (e.g. external driving forces). Herein, the change propagation behaves as a cause–effect wave across the enterprise, spanning the domain comprised between the corporate strategy and the physical plant. So that, referring to the example on the introduction of newenvironmental regulations, it can be noticed that the reduction of factory emissions severely impacts on the adopted processes and resources, constraining the design of machine tools in their requirements for higher thermal stability without the use of complex cooling systems, requiring materials with higher stiffness and damping, hydraulics and spindles configured for reduced energy consumption, and components configured for re-use or re-manufacture after their end of life.

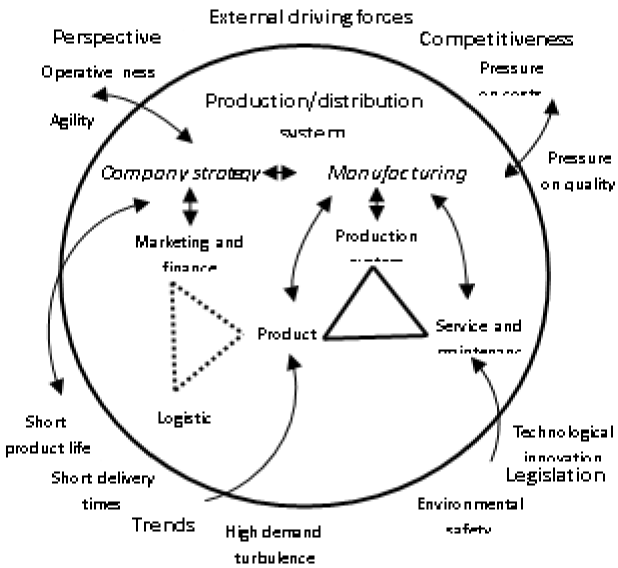

Fig. 1 Dynamics of Machine Production

To remain competitive companies must develop a number of possible scenarios, and thus face the production and dissemination of changes. Scenarios are often unpredictable, and it is a major cause of the complexity of the work in a dynamic manufacturing environment, together with the lack of a uniform approach to a solution. The term "coordinated development" demonstrates this idea. Is the ability to manage strategic and operational dissemination of technical changes to gain competitive advantage in the market and regulatory dynamics.

Requirements for new machine systems

A new generation of production and handling machines capable of reconfiguration of their structure in order to adjust the machine to the requirements of the production task require a new design approach on systems and machine level also. The key core moments by these approaches are connected with:

- development of basic principles and methods for design and analysis of reconfigurable machine and production systems,
- design and development of Reconfigurable Machine Tools (RMT), responsible of the key characteristics for reconfiguration (modularity, scalability, inerrability, convertibility, diagnostic ability and customization).

We are speaking about a new generation of products known as adaptable products that are able to solve the adaptability of the various stages of the life cycle (phase D, production and / or utilization), thus prolonging and extending their functionality over time. Examples of this are the traditional NC machines and new generation CNC machines dealt with elements of multifunctionality. While traditional problem solving not only for adaptability but also operability processes is not enough nowadays, using new ones is a key, especially if structural and technological elements (materials, energy / transformation / distribution members, IT) implemented directly into the CNC machine will allow progressive forms of operational use (complex shapes products, achieve higher performance and higher quality) at the stage of its application to machine. It follows that the dynamics of development requires focusing on requirements associated with the ability to react and adapt to changes associated with an interactive environment - Fig. 2.

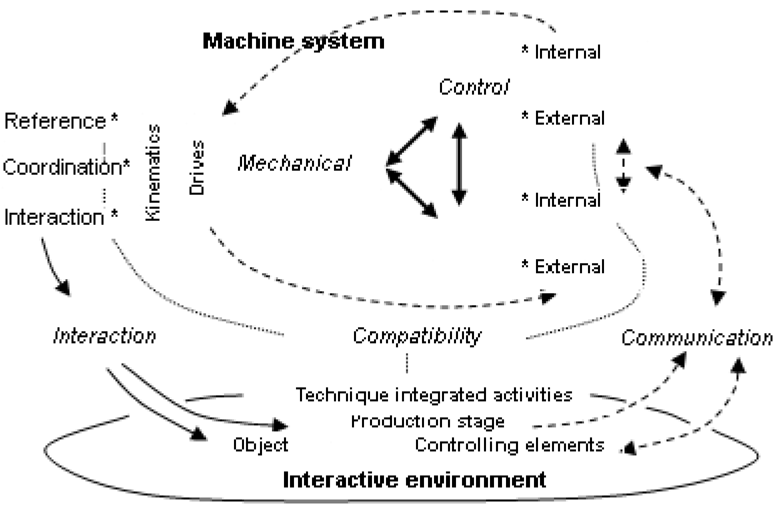

Fig. 2 Profile machine system and its links to the interactive environment

where:
construction- technology link,
information link,
physical function,
information, materials and physical communication.

It is a complex machine system (Fig. 2) integrating subsystems mechanical (kinematics mechanism drives), management (on-board, operator) and sensors (measure, perception), capable of autonomous, goal-oriented interactions in real environments [17]. Conception machine system and arrangement of functional subsets is presented from a functional perspective, however, may be physically different subsystems overlap, since their mission is

an interactive physical action environment. The working member, which operates the machine system object (work piece, the production stage) in accordance with the required technology, or acts with profiling interaction tool-part (head technology, materials technology), or coordination of the positioning and orientation of the object to the instrument (subject modules -tool) where appropriate a reference section (mobile base-production stage). All axes motion interaction, coordination and reference sections are equipped with actuators which are controlled in the simplest case management software system, using either open or closed circuits.
In the case of closed circuit system is a machine equipped with position sensors for position feedback. Thus the system is designed machine capable of performance, while automatic features, but do not receive information about their surroundings. For this purpose, it must be retrofit sensor technology, supported by fairly large software. Complex design with an external sensor equipment are transformed into a model of cognitive adaptability [19], variability [3], auto diagnostics, auto resistance [2], paradigms auto improving the environment and the coordinated development [14]. To illustrate the above facts, the present paper introduces the development of methods for structure generation reconfigurable manufacturing systems with concentrations of several technological / handling tasks in one place.

Conclusion

It can be concluded from the mentioned that the dynamics of development requires concentration to solve the requirements concerning ability to respond and adapt the changes of state in production. These are transformed to a model of cognitive adaptability, variability, auto diagnostics, auto resistance, paradigms of auto-improvements of environment and the coordinated of development.

References

[1] ČOP, V.: Projekty rozvoja výrobnej techniky a technológií. SPINEA s r.o., Prešov, 2005.
[2] TOLIO, T., CEGLAREK, D., ELMARAGHY, H. A., FISCHER, A., HU, S. J., LAPERRIERE, L., NEWMAN, S. T., VANCZA, J.: SPECIES-Co-evolution of products, processes and production systems. CIRP Annals - Manufacturing Technology, 59 (2), pp. 672-693, 2010.
[3] VALENČÍK, Š.: Riešenie pohybovej integrácie modulov robotickej techniky. ATP Journal plus 2 2/2006, Bratislava, 2006, s. 96-99.
[4] VALENČÍK, Š.: Metodika obnovy strojov. Košice. EVaOL Strojnícka fakulta TU Košice, Košice 2011, 330 s., ISBN 978-80-533-0679-7.

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Strana: 4
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