System framework of an decision basis definition of the manufacturing systems design

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Summary

System analyze of all complexity of the manufacturing systems design process result to the statement of basic factors. A platform of design process represent cultural and material base of design (or implicit factor wider environs of manufacturing system design) and particular problem situation (or explicit factor of wider environs of manufacturing system design). Factors of nearby environs are knowledge and axiomatic equipment and definition of singular goals and restrictions of designed manufacturing system. As theoretical base is used constructive theory of systems and theoretical conclusions of knowledge engineering.

Key words: automation, manufacturing system, knowledge engineering

1 Introduction

The manufacturing systems design process is count as highly intellectual activity with knowledge application and that is arranged as part of production management. Here were more of definitions of design process alone. Mesarovic [1] stated the design as combination of analyze, synthesis and decision making. Vlèek [2] introduce design process as a part of management. Tondl [3] state design process as proposal of solution of some problem situation, i. e. as collection of activities with aim to eliminate or cut original causality, original level of entropy. Buda a M. Kováè [4] characterize the design process specific creative process of making specific system (robotic system, manufacturing line and etc.), and the functions and structure of system are expressed in time and space, material and financial demands of realization and effective operation, in design documentation.

From point of view of research project VEGA 9344 there are three components notable from system access:

- decision base of design process
- model (design)
- procedures.

Cardinal components of environs and effects for manufacturing system design process are mentioned in Fig. 1.

2 Decision basis of design process

Generally as decision basis is understand cultural, material and ethical environment where design process is realized and particular problem situation that is solved by project. It has meaning like "environment" of designed object [5].

Generally as basic implicit components of environment of are considered cultural base of design process and material base of design process.

Specific in case of manufacturing systems as **cultural base** of design process it is possible to consider social-economic startingpoint of design process that is characterized as megatrends of production systems development and as paradigms of design often.

The essential megatrend [6] of present production is mainly increasing of competitive ability that is the motive power of production improvement. In world market we can to see hard competition that is result from high number strong manufacturers, diversification of product variety, technology and administrative innovation and other factors. Necessary to increase competition lead to demand of innovation and high quality of products, reducing of delivery times and decreasing of production costs.

Modern view of production efficiency can be characterized by three basic ways:

1. Increasing of product value

Made by cutting innovation cycles, using by last research and development information in design products, existence by wide spectrum of product modification, very high quality, reliability, prefect service and short delivery times.

2. Decreasing of product costs

Course to decreasing innovation material, energy or labor costs.

3. Minimalization of renewals

The aim is accomplish implementation of smart technology with acceptable level of capital assets.

Innovation of products is main goal. Analyses activity of strong enterprises on world market show that more that one half of turnover is made by products that were developed in time last five years. Therefore with regard to competition the present approach to the manufacturing count innovation as strategic goal. Technology innovation is rated as means how to carry this point. Adapting of producers to dynamically changed needs of customers involve a requirement of increasing of manufacturing flexibility.

Achieving second goal - decreasing of expenses is conditional by decreasing of number parts and operations. The base methodology standpoint of flexible manufacturing is group technology. Group technology in distinction from classic group representative of components with common technological process is understand wider and it interfere to region of manipulation with material, equipment and tool machines programs. Additional step is another of method of manufacturing process that is build on essential reduction of semi-finished production.

Third goal - minimalisation of capital expenditure has narrow relationship to manufacturing flexibility and its automation. Flexibility lead to the fact that it is necessary to allocate relatively greater to research and development of products and technology and to introducing of new products to production. Automation of production also represent radical increasing demands to investment. With regard of no manufacturer has no unlimited recourses it is necessary to find technical and administrative steps to minimalisation of investments. In no last matter a principle of successive steps is applying in introduction of automation. Rule is valid that investments to improving of technical level could be only the customer is able accept. Therefore investments to wide information systems are divided to longer time period and manufacturing systems are used to more shifts if it is possible. Development trends are related to so called "workstations without operation personal". This term involve workstation operation without operation personal in second or third shift respectively in first stage. In main shift operation will be concentrated to material preparation, equipment and machine programs to next period.

Above mentioned megatrends are representing changes of factory organization and manufacturing systems design. Years used methods and solutions are modified and they bring new paradigms [7]:

- dividing of job to simple operations (Taylorism), specialization, forced discipline and strong performance - qualified job with complex content, team work,, motivation, cooperation and self-control, design of system by demand of market [8],
- high complexity of compound products, off-line quality control - simplification of products and manufacturing, wide cooperation with subcontractors, on-line quality planning [9],
- hierarchical centralized organizational structures - shop-floor, dynamic and flexible, net or fractal organization structures [10],
- serial sequence of steps in R&D, manufacturing operations and manufacturing systems - function factory organization, computer integrated manufacturing, parallel, concurrent engineering, project organization [11],
- flexibility via stocks and storage and in-process stores, great manufacturing batches and narrow sortiment - flexibility via short manufacturing time and low stocks, small batches and wide assortment [12],
- special power tool machines and single-purpose manufacturing systems, organization based on technology - universal, all-purpose, easy reprogramming machine tools, miniaturization, manufacturing system modularity, cell and product factory organization [13],
- standard products offering to antonym market, development and design aimed to operation characteristics - individual products for individual customers, product development with regard to ecology and social point of view [14],
- the highest priority has machine utilization - the highest priority has deliver time [15],
- massive advertising and struggle on market share - dialog with customer and building of new market segments [16],
- observing of administrative standards with regard to environment - proper active ecology strategy (design with respect of recycling, permanent production) [17].

Although paradigms have not be explicit formulated, subconscious or conscious observation has serious social implication.

Material base of design process represent possibilities from point of view material, energy and labor resources. From it the technical and financial limits of design result. Material base of present discrete production is distinguished for great diversity and complexity and as follow from above mentioned facts the knowledge is base factor of design process. Factor of nearby environs is knowledge and axiomatic equipment and individual placing of goals and restrictions of manufacturing system. In work with knowledge in methodology of design theoretical conclusions knowledge engineering are applied. Knowledge analyze is necessary nor only to building complex concept of design process but also, and it is very important, to competent building modern CAD system with element of artificial intelligence.

A great deal of engineering tools has been developed to aid engineers in the manufacturing system design process or in improvement old. These tool include two categories:

Methods of knowledge engineering, that characterize manner of work with special technical knowledge in decision making and in routine activities.

Computer aided design that help to designers and architects make project documentation easy and quickly. CAD system may provide engineer with some simulation capabilities and results may to be review with knowledge.

Particular problem situation is feeling as requirement of business improvement and is solved by techniques of business reengineering [19]:

Work Process Reengineering - conversation of introenterprise processes in production and manufacturing and in information management with aim to cut expenses, delivery time, growth capacity etc.

Business Process Reengineering - conversation of enterprise activities with regard to environment, fitting of enterprise to changed economy conditions, increase of value of products, introducing of new products, new partners, growth of competitive,

Business Reengineering - radical redefinition of goals and functions of enterprise (and so manufacturing system), strategic change of production program.

3 Conclusion

Above mentioned approach was used in research project "Knowledge Databases for Intelligent Manufacturing Systems" granted by Research and Education Grant Agency of Slovak Republic - VEGA 9344. The scope of above mentioned project is formulation of generally valid methods and application of modern knowledge of system theory (mainly Constructive Approach and Object Oriented Design) in CAD systems used to manufacturing systems design.

References:

[1] MESAROVIC, M.D. - MACKO, D.: Theory of hierarchical Multilevel Systems. Academic Press, New York, 1970

[2] VLÈEK, J.: Metody systémového in enírství. SNTL, Praha, 1984

[3] TONDL, L.: Znalostní a hodnotová orientace systémového projektování. Automatizace, Vol. 3, No 3, 1988

[4] KOVÁÈ, M. ai: PYRAMÍ DA. Robotizácia, automatizácia a pru né výrobné systémy, roè. XVIII, è. 4/1988

[5] PETR, J.: Teorie systémového projektování, DT ÈSVTS Praha, 1989

[6] KATALINIC, B.: Megatrends in der Automatisierung der Produktion. Acta Mechanica No1.

[7] KOŠTURIAK, J. - GREGOR, M.: Èo prí de po CIM? Strojírenská výroba, 11-12/94, s.16-23

[8] VODÁÈEK, L.: Reengineering. Podmienky úspechu aplikácií. Podnikova organizace, roè. 50, 1/96, s. 5-10

[9] NENADÁL, J.:Výdaje vyvolané nízkou jakostí. Co s nimi? Podniková organizace, roè. 50, 3/96, s. 3-6

[10] WARNECKE, H.J.: Die Fractale Fabrik. Springer Verlag, Stuttgart, 1992

[11] FRANKOVIÈ, B.: Optimálne riadenie diskrétnych výrobných systémov - úlohy a problémy. . AT&T Journal, roè. IV., 8/97, s. 45-47

[12] KURIC, J. - DEBNÁR, R. - ÈUBOÒOVÁ, N.: Systém CAPP. Základ informaèného systému v strojárskom podniku. InfoWare, roè.II, è.3/1998, s. 8-10

[13] HAJDUK, M.: Orientácia výrobnej stratégie na pru né bunkové š truktúry. AT&T Journal, roè. IV., 8/97, s. 33 -34

[14] HAFEN, U. - BRTSCH, D.: Tvorba procesní organizace (s orientací na zákaznika). Moderní øízení, roè. XXXII, è. 9/97, s. 59-62

[15] MALIND ÁK, D.: Výrobná logistika. 1. Vydanie. Štrofek, Koš ice, 1996

[16] KOVÁÈ, M. - HAJDUK, M.: Projektové riadenie transferu inovácií. Moderní øízení, roè. XXXII, 10/97, s. 45-47

[17] FARSKÝ, M. - MÌ SÍÈEK, L.: Strategie podniku a teorie "udr atelného rstu". Podniková organizace, roè. 50, 3/96, s. 3-6

[18] ŠIŠKA, F. - BADIDA, M. - MAJERNÍ K, M. - ŠEBO, D. - HRÁDOCKÝ, L.: Environmentálne vzdelávanie, stav a perspektíva na Strojníckej fakulty Technickej univerzity v Koš iciach. Acta Mechanica Slovaca, Roè. 1., 1/97, 103-109

[19] MOLNÁR, Z.: Reengineering - zaklínadlo soudobého managementu. Systémová integrace, roè. II, è.3/1995

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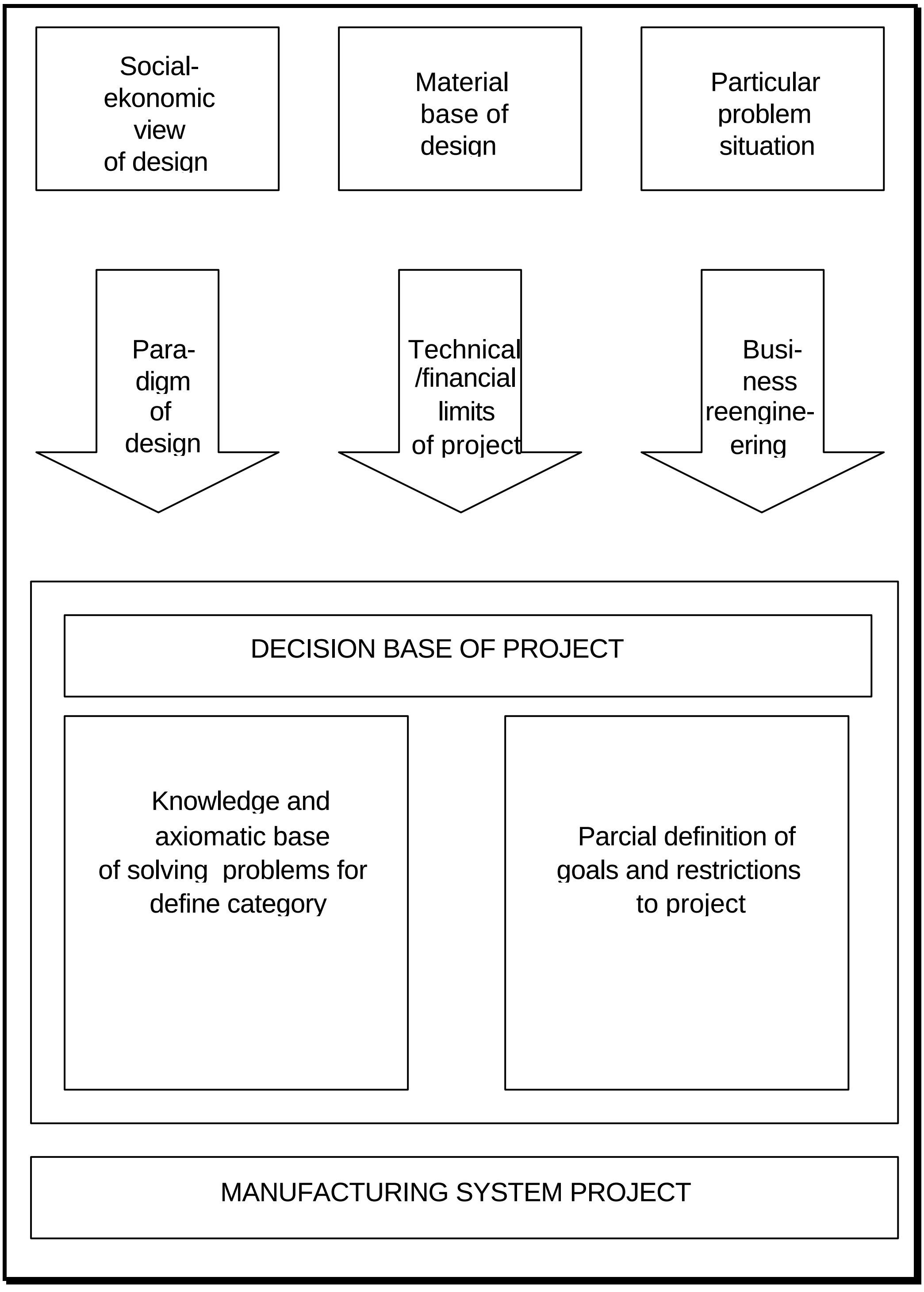

Fig. 1 Decision basis of manufacturing system design process