Towards demand-driven industry: supprot system proposal for Factories of Future (FoF)

Sanja Vasin vasinsanja@gmail.com , Srdjan Živković srdjan.vti@gmail,
Military Technical Institute Belgrade, Ratka Resanovića 1

***Summary* — EU platform called Manufuture aims goal to support manufacturing engineering and technology development in nearer and distant future. Manufacturing technologies are key for sustainable development of EU member states. Serbia as native part of this european nations union, needs to follow these european trends. This article presents an importance of national Manufuture platform adoptation - basic principles of Factories of Future are shown, Cyber-physical manufacturing systems, as well as Customer-oriented decision support systems. All together creating elements of new industrial revolution, called „Industrija 4.0“**

***Key words* – Factories of Future; Customer-driven Industry; Decision making; Support systems**

I. INTRODUCTION

World, and therefore industrial globalization has led to significant paradigma shifts, which have left no one behinde. In professional articles which deal with problems of industrial manufacturing it can be red between the lines that China is „an apsolute winner in globalization game“.

Europian union has adoppted an strategic research agenda in which manufacturing engineering has one of the key roles. New manufacturing philosophy is called as simple as manu*future* = manufacture of future. Manu*future* platform is an initiative of European Comission which overviews the trending issue and gives guidelines for industrial manufacturing in EU [1]. The term itself, in its essence, is game of words, which implies on manufacture in nearer future. Pivot pillars with joined structures are new technologies which potentiate possible industrial transformation [1]:

- ✓ New products and services with added value.
- ✓ New advanced industrial engineering.
- ✓ New technologies in manufacturing engineering.
- ✓ Transformation of existing research, development and education infrastructure.

Options for adjustment according to new global conditions are ilustrated in Figure 1. First scenario presents *status quo*. Scenario 2, presents placement of existing products and accompanying services on globalized market with permanent tightening of concurent struggle.

1. Centralised, local production
2. Distributed production,global market
3. Leadership in technologies
4. New business models & technologies for strategic innovations

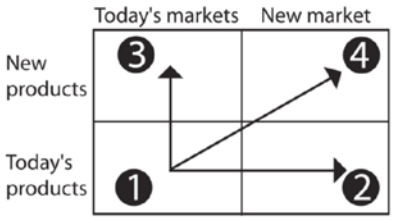

Figure 1. Markets trends

Scenario 3 relates on business organizations which have intensive devlopment and offer new products on markets where they exist and operate in longterm. Scenario 4, refers to breakthrough on new markets with new, technologically improved and innovated products. This scenario comprehends lonterm investments of high risk and therefore presents the great challenge, especially for smaller and medium enterprises (SME's). Manu*future* platform indicates that risks of leaning on existing and proved products without technological innovations are significantly higher [1].

Lisbon document from March 2000, states next – EU Council has placed goal, based on which economies of EU countries will became "mostconcurent and mostdinamical economies in the world, capable to provide sustainable economy growth with more better working places and bigger social cohesion" [2]. This ambicious goal can not be fulfilled without constant presence of strong competition in manufacturing scetor, figure 2. Economies based only on service activities will not survive in longterm perspective.

For european industries, it is significant, to stay concurent in more complex global economy surrounding. To achieve Lisbon goal it is necessary to modernize manufacturing bases and to strengthen the relationships between research and innovations [2].

EU has defined through adopted *Manufuture* platform four strategic goals:

- ✓ Concurent sustainable european industries based on manufacturing technologies
- ✓ Manufacturing technologies Leadership
- ✓ Ecologically efficient product and production
- ✓ Lidership in cultural, ethics and social values

Traditional structure of industrial manufacturing is builted on three bases: land, working force and capital. Modern challenges demand that industrial manufacturing is to be

DOI: 10.7251/ZRSNG1501087V

transformed to new structure, which can be described as "production innovation", based on knowlU radu su edge and capital. This transition will depend upon adoption of new attitudes in industry to permanent conqure, allocation, protection and financing of new researching activities and product development.

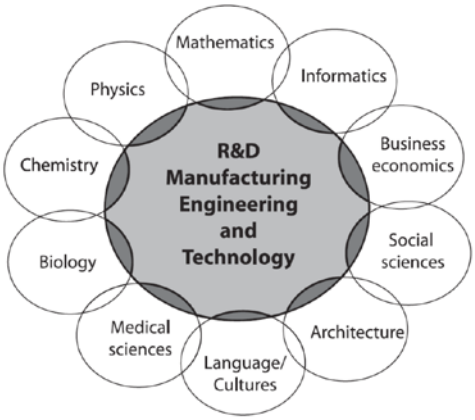

Figure 2. R&D Manufacturing Engineering and Technology

Manu*future* approach involves several basic directions in which future manufacturing should be innovated, originated from principle; „From manufacturing based on resources to manufacturing based on knowledge“

Serbia as natural and geographic part of European Union nations, must follow, comprehend and apply these european initiatives. Serbia has from recent become part of „national initiatives“ Manu*future* platform. Coordinator for Srbiju is Mechanical Engineering Faculty in Belgrade and Laboratory for manufacturing metrology and TQM. Our envolvement in this european platform is in initial process itself. Beside several projects which have been financied by Ministery of Science and Technological Development, there is no official decision made for Manufuture strategy.

Production generates social stability, providing different working places, and therefore one is of the vital significancies for serbian economy, which from transient state should pass to new-industrial ekconomy. In this way, Serbia could be the lider on Western Balkan in this area. Society oriented to services, with no manufacturing, is no more realistic, which is best shown with economical crises in Greece, Portugal and Ireland, which economies were exclusively oriented to services. These analyses show that there exist to much of intedependabilities between new products and new manufacturing solutions, which places Serbia in position to do the radical turnover in research activities, inovations and high education, from one side and grid development of highly specialized SME’ (small and medival organizatijons), from other side speaking. In this way, foundation for knowledge and practical experineces accumulation would be formed, as the basicpower of Serbian industry. Nowdays shortcomes e.g. lessened manufacturing in Serbia, only erodes base for faster development of our country.

II. FACTORY OF THE FUTURE

The manufacturing research and innovation community has been working on a strategic innovation agenda and a roadmap for the future, applying in a broad range of manufacturing sectors [4]. In response to the megatrends, following the Europe 2020 strategy and focusing on future market demands, it is foreseen that European Manufacturing sectors will undergo structural transformations.

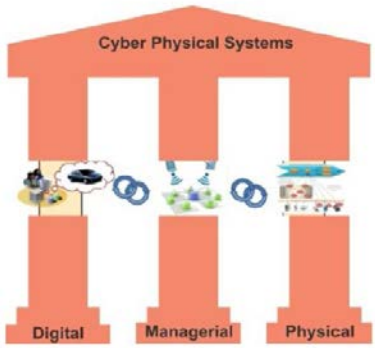

Figure 3. CPS Basic Pilars [3]

Achieving these transformations requires a coordinated research and innovation effort, where manufacturing challenges and opportunities are addressed by deploying successively a set of technologies and enablers providing the decisive answers to the manufacturing challenges as well.

The suggested priorities are organized under the following clusters [2]:

- Cluster 1: Advanced Manufacturing processes
- Cluster 2: Adaptive and smart manufacturing systems
- Cluster 3: Digital, virtual and resource-efficient factories
- Cluster 4: Manufacturing eco-systems
- Cluster 5: Human-centric manufacturing
- Cluster 6: Customer-focused manufacturing

For the research and innovation actions to have the desired impact, specific consideration is given to the fact that R&D&I (research, development and innovation) need to be associated to dissemination and demonstration activities, addressing market readiness (industrial implementation) at an early stage.

III. CYBER - PHYSICAL MANUFACTURING SYSTEMS (CPMS)

Cyber-physical systems (CPSs) are enabling technologies which bring the virtual and physical worlds together to create a truly networked world in which intelligent objects communicate and interact with each other [3].

Together with the internet and the data and services available online, embedded systems join to form cyberphysical systems. CPSs also are a paradigm from existing business and market models, as revolutionary new applications, service providers and value chains become possible.

DOI: 10.7251/ZRSNG1501087V

The merging of the virtual and the physical worlds through CPSs and the resulting fusion of manufacturing processes and business processes are leading the way to a new industrial age best defined by the INDUSTRIE 4.0 project's "smart factory" concept, [5].

The deployment of CPSs in manufacturing systems gives birth to the "smart factory". Smart factory products, resources and processes are characterized by CPSs; providing significant real-time quality, time, resource, and cost advantages in comparison with classic manufacturing systems [3].

High levels of automation come as standard in the smart factory: this being made possible by a flexible network of CPSs - based manufacturing systems which, to a large extent, automatically supervise manufacturing processes.

IV. CUSTOMER DRIVEN PRODUCT DEVELOPMENT – DESIGN AND MANUFACTURING

An emerging trend in development of new products is to include customer requirements as a full-fledged partnership. This is called Customer driven product development, which encompasises Customer Driven Design (CDD) and Customer Driven Production (CDP). Understanding the customer needs and/or developing one is a two-way action. Basic principle is to involve and interact each participant in development process as a unique team. To avoid weak links in overall process, an effective communication chain must be developed. Experience, information and knowledge must be equally shared and promoted between members. To achieve this, design and management team must define methods and support tools to identify potential customer needs as functional requirements of future product so they can be transformed into technical specifications – e.g. product structure, behaviour, and so. Compared to design, production team, project management and teams from other research areas defined through development process, customers may have a different perspective upon product functionality and behaviour. Question is how to collect, distribute and analise customers informations and opinions in order to update and support other members of development process? Customer ideas and opinions may or not be easily accepted by other development teams. What one customer may like, the other one may not. Therefore, capturing customer perspectives and avoiding conflicts throughout whole development process is not an easy task. An appropriate channel must be defined as valuable feedback based on customer ideas in strengthening business values of small and big companies. All datas must be streamed into one base, from which decision-making tools and methods can be used to provide on-time problem solving decisions. Frequent surveys, interviews and other quality and quantity methods must be applied to gather and define the experience of customers during development process – from idea to endlife of new product. Voice and customer demand create an value identification for business company. Positive customer experience reflects on product sale e.g. presents an important part of product launh in market arena, among competition.

Proposed concept of consumer support system - Frequent information update about process results and progress will be provided for optimal time, space usage and activities performance,

- Once informed, end users are able to bring decisions and feedback on their experience in results exploitation, capacities and quality of it,
- End users must be willing and prepared on time to accept and exploit new product, confirming expected comfort,
- Total costs of infrastructure (supply chain), R&D, operating, maintenance and most important end user costs will significantly decrease from the beginning of process results implementation up to further development of new system performances.

Awareness of end users is most relevant for any development process to succeed. With this kind of support platform, end users will be able to communicate directly with all team members.

Expected results - Mutual motivation and relationship preservation,

- Online, technical and system guarantee support,
- Sharing duties and information's in results dissemination,
- Maximal quality of system implementation,
- Excellent end users experience.

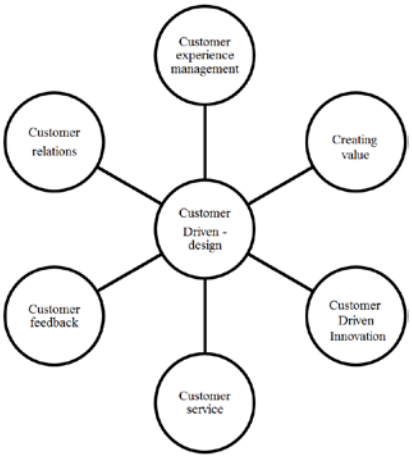

Figure 4. Customer Driven Design and Production

V. DECISION MAKING SUPPORT SYSTEMS – AN OVERVIEW

Creativity is a phenomena, creating something valuable - idea, work, solution etc. Taking in consideration relation between creativity and intelligence, mental and neurological processes, type of personality and creative capabilities, mental health through education, term of creativity, intelligence and innovation have been discussed by great number of scientific research areas - psichology, cognitive sciences, education, philosophy, teology, sociology, lingvistics, business studies i economy. To create a new product – technical system, thinking process must be in accordance with engineering knowledge, techniques and methodology rules and goals. Result of such process is idea which presents the core of the product development process. For team of experts – engineers, in product development, idea finding process can be highly complexed. Idea searching process must be permanent, undependent of social, economic, political and other needs and circumstances and characterized by certain properties and

DOI: 10.7251/ZRSNG1501087V

ruled by certain navigation, giveing general ideas which are being tactically solved and tranformed into optimal one. Sucesfull navigation dependes of team work and creativity. Team should consist of inventive individuals with experience, conflict tolerance and wide knowledge spectra.

Idea geneartion methods are used as sophisiticate tools and decision making support in product development process. Depending of research areas involved in process and team structure of members, different methods can be applied creating stimulus working conditions providing higlhy efficient results. The range of proposed methods is increassing together with experienced review of all advantages and shortcomings of each method and/or technique.

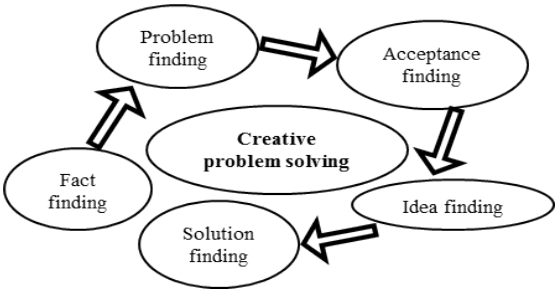

Figure 5. Creative problem solving method – basic steps

Methods are generally based on few steps - fact finding, problem finding (defining), idea finding, solution finding, and acceptance finding. Process, skills, attitudes, behaviour, tools integration depend on defined communication tool or language for keeping up the step with development process. How one inventive individuall can come up to idea is still a mistery, which once resolved can make development process an effective creation process with mnimal investment costs and time. To avoid conflicts, leaders of each team may define an Creative Problem Solving Process (CPSP) Framework, to provide efficient and on-time reaction and adaptive behaviour to trends and potential problems. Main challenge is to make a bridge between new ideas proposal and productive thinking, e.g. to avoid confrontations among members thinkings. One goal can be decomposed on several ones providing conditions for each individual to express its creativity. Training skills may reduce shortcomes even at giffted individuals. Seeing a big picture is to lead people through a common process or method of finding and defining problems, solving them, and implementing the new solutions. Missing a one is failure to observe and consider details. Multidisciplinary team in order to solve complex problems simultaneously, must learn how to value the preferences of others creating motivation at the same time.

VI. CONCLUSION

The sustainability of industrial development and long-term success requires substantial changes throughout decision-making process over many domains and a high degree of knowledge and capacity by associated experts. Well-developed strategy can determine the configuration of resources, processes and systems that an organization adopts to deal with the competition existing in their environment. It requires decisions about which businesses functions should be performed and in which markets with a clear vision. Promotion and knowledge exchange on scientific, industrial and intermediate level as cross-border services of project results can be achieved to maximally cover EU space and capacity utilization. Strengthening the European industrial technology base, thereby creating growth and jobs in Europe, can create need for higher number of employees and/or opening of new industrial facilities.

VII. REFRENCES

[1] Majstorović Vidosav and Živković Srdjan, “Integration of IT and production technologies in digital environment” (in serbian: Integracija proizvodnih i informacionih tehnologija u digitalnom okruženju), Edition: Advanced quality methods, JUSK Belgrade, ISBN 978-86-89157-03-1, 2015.

[2] Majstorović Vidosav, „Manufacturing innovation and Horizon 2020 – developing and implementation of New Manufacturing“, Proceedings in Manufacturing Systems, Volume 9, Issue 1, 2014, 3−8, Romanian Academy, București

[3] Majstorović Vidosav, Mačužić Jelena, Šibalija Tatjana, Živković Srdjan, „Cyber-physical manufacturing systems – manufacturing metrology aspects“, Proceedings in Manufacturing Systems, Volume 10, Issue 1, 2015, 9−14, Romanian Academy, București

[4] EUROPEAN COMMISSION, „Factories of the Future, Multi-annual roadmap for the contractual PPP under HORIZON 2020“, EFFRA (Europian Factories of the Future Ressearch Association), http://www.effra.eu/attachments/article/129/Factories%20of%20the%20Future%202020%20Roadmap.pdf, (Accesed 20.10.2015)

[5] Jay Lee, Behrad Bagheri, Hung-An Kao, „A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems“, Manufacturing Letters (Elsevier), Volume 3, January 2015, Pages 18–23, doi:10.1016/j.mfglet.2014.12.001

[6] Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[7] K. Elissa, “Title of paper if known,” unpublished.

[8] R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.

[9] Rakov, V. A., and M. A. Uman (2003), Lightning: Physics and Effects, Cambridge Univ. Press, New York.

[10] Mitchell M. Tseng, Xuehong Du, „Design by Customers for Mass Customization Products“, Annals of the CIRP, Volume 47, 1998, Pages 102-106, doi: 10.1016/S0007-8506(07)62795-4

[11] John J. Cristiano, Jeffrey K. Liker, Chelsea C. White, „Customer-driven Product Development Through Quaity Function Deployment in the U.S. and Japan“, Journal of Production Innovation Management (Elsevier), Volume 17, 2007, Pages 286-308

[12] Hanu Kärkkäinen, Petteri Piippo, Markku Tuominen, „Ten tools for customer-driven product development in industrial companies“, International Journal of Production Economics (Elsevier), Volume 69, 2001, Pages 161-170

[13] Basadur Min, „Leading others to think innovatively together: Creative leadership“, The Leadership Quarterly (Science Direct), Volume 15, 2004, Pages 103-121, doi: 10.1016/j.leaqua.2003.12.007

[14] Roni Reiter Palmon, Jody J. Illies, „Leadership and creativity: Understanding leadership from a creative problem-solving perspective“, The Leadership Quarterly (Science Direct), Volume 15, 2004, Pages 55-77, doi: 10.1016/j.leaqua.2003.12.005

[15] Basadur Min, „Training in Creative Problem Solving: Effects on Ideation and Problem Finding and solving in Industrial Organization“, Organizational Behaviour and Human Performance, Volume 30, 1982, Pages41-70

DOI: 10.7251/ZRSNG1501087V