INNOVATIVE APROACHES IN THE AUTOMOTIVE PRODUCT DESIGN AND DEVELOPMENT

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Abstract

Mechanical engineering and especially the automotive industry, is facing the advanced challenges arising from global changes in the technical, economic and social environment, both today as well as in medium term perspective. There is accelerating the need for products with higher added value, based on new knowledge from research. The responsible and continuously innovative approach, aimed to increase the level of innovation, as well as the quality of innovation process, is for the European countries the only possibility, how to compete with both mass production of low-cost countries and continuous economic boom, technological and knowledge level of BRICS countries. Submitted article analyzes trends and innovative approaches to Product Design, with a primary focus on the automotive industry.

Key words: Product Design, lean approach, agile approach, knowledge intensive service, innovation

INTRODUCTION

Need to face the new challenges arising from global changes in the technical, economic and social environment creates the pressure on reducing the innovation cycles and increasing the overall quality of the innovation process. The integration of innovative tools and knowledge-intensive services in the innovation process now allows smaller subcontractors to pursue an active innovation policy at a reasonable cost, which leads to a situation, when active innovation policy ceases to be the domain of "big players" in the industry and is slowly becoming a common part of any corporate strategy.

The practice of SMEs, particularly in the field of automotive suppliers, shows that there is an uprising trend of using the innovative tools and methods, in combination with wider utilization of outsourced knowledge-intensive services. This is the right time not only to think about the innovation, but also to innovate. It is important to keep the costs low and assure the positive cash-flow. However, to focus only on these problems is not enough. The organizations that will succeed are only those which are sufficiently agile and find new and better ways to satisfy the customers. The cost control is imperative, the innovation is obligatory.

PRODUCT DESIGN AND DEVELOPMENT IN THE AUTOMOTIVE INDUSTRY

The automotive industry is currently under enormous economic and political pressures, and companies are responding in radically different ways. This combination of pressures and responses is transforming the industry. From economic pressures such as high raw materials prices (e.g., steel and petroleum) and countries offering low-cost labour to responses such as outsourcing, industry consolidation, and assembly flexibility, no organization can afford to remain static in any of its operations. Product development is under the same pressures as manufacturing to produce exciting, innovative, cost-effective designs in a short period of time.

It is important to recognize that the automobile is becoming more complex. Market and social forces are driving the industry to create vehicles with higher levels of performance. This applies not only to their traditional purpose of safely transporting drivers and passengers, but also to the driving experience itself. Technology changes are occurring in every aspect of the vehicle. This situation creates complexity not only because the systems themselves are complicated, but also because the interaction between the systems is often difficult to understand and predict. Further, while the market forces demand these systems in the product, they must be designed and produced at lower cost. Besides the market forces mentioned above, additional factors are driving the industry to structural changes. The industry is getting more efficient, and market share is shifting between companies. This factor has led to overcapacity in the industry, which in turn leads to consolidation. Further, in an effort to lower cost, companies are outsourcing the manufacture (and to some degree the design of subsystems) to suppliers. These suppliers are generally distributed worldwide; they are quite competent and have a lower cost structure.

LEAN vs. AGILE APPROACH

The best way to eliminate the losses that don't add value within the process of product design and development is to apply the "lean thinking" philosophy. Since "lean" business cannot produce "bold" products, the Lean Design and Lean Product Development methods get into concern.

Chances to dramatic reductions of costs during the product design are [1]:

- Reduction of direct material costs: platform components and material, simplifying of design, reduction of useless waste, samples, prototypes, etc.
- Reduction of direct costs on experiments and testing: simplifying of design – design for lean manufacturing and assembly, reduction of part count, adaptation of product tolerances to operational possibilities, process standardizing, etc.
- Reduction of operational costs: minimum impact on reconfiguration of manufacturing processes and systems, modular design, standards for modifications according to customer's demands, better utilization of manufacturing capacities and human resources
- Minimizing development costs: platform of design strategies, lean QFD, Six Sigma, design of experiments, value engineering, and others.

Acceleration of product development process affects three basic lean principles [1]:

1. Preference of projects that have high value for company in terms of long-time direction of business
2. Concentration of development activities: perform the work tasks in the shortest time possible, and minimum moving of project documentation between individuals and departments. That can be achieved with simultaneous solving and strong IT support.
3. Application of knowledge basis from the existing products and technical experiences portfolio in order to support design of new product. It means to make use of appropriate expertise, learn more than until now and update the knowledge base with development-relevant data from suppliers, competitors, customers, and partners.

Trend, referred to as the "agile manufacturing" represents the ability to survive and prosper in a competitive environment of continuous and unpredictable changes. It means to respond quickly and effectively to changing markets, produce goods and services according to customer needs via maintain the continuous product innovation, manageable number of product variants, fulfilling the unpredictable requirements of customers, shortening product life cycle and respond to significant fluctuations in sales [2].

Agile production is different from the lean in the sense that lean production is oriented on the repetitive manufacturing environment with focus on high-volume and low mix, since the agile production is applicable to low-volume and high mix. It is suited to an environment where configurable or specialized products offer a competitive advantage [3].

TRENDS AND INNOVATIVE APPROACHES IN THE AUTOMOTIVE INDUSTRY

The speed of change with the increase in structural complexity brought about through the global economies creates a challenge for organizations to overcome their inherent inertia and respond. While becoming lean was the necessity of the past decade and still is today, it is not sufficient. Agility and the strategies that enable agility is the new paradigm at all levels of the enterprise and the value chain. Lean is simply one enabler to agility; a lean organization is able to respond more quickly to change. Manufacturing has shown how adding flexibility to a lean manufacturing process can reduce capital investment costs and enable a company to be more responsive to the rapidly changing market demands [4].

Thus, as the industry and individual organizations are experiencing and managing these tremendous changes, product development, too, is changing. Organizations are adopting a number of different strategies to become more lean and agile in product development. They are: increasing the number of carry-over parts and subsystems, increasing the use of modular designs, increasing the use of CAE and simulation, and increasingly designing globally for global manufacturing.

There is no strategy that is viewed to be superior to others; different organizations are focusing on different aspects of all of these strategies. However, these strategies are not deemed as important as some of the more fundamental ways in which product development is changing. The major changes and trends in product development are [4]:

a. From the **process perspective**, increasing:

- design process discipline (i.e., following a specified product development process),
- math-based engineering (CAE and simulation),
- global product design (design is done globally),
- number of carry-over parts or subsystems
- in-house modular designs / portfolios,
- product design for global manufacturing (manufacturing is done globally),
- outsourced modular designs / portfolios,
- variations of final product design.

b. From the **supplier capabilities** perspective:

- Providing lowest cost product / service.
- Full design and testing capability.
- High level of experience in the automotive field.
- Technological innovation (product, manufacturing, etc.).
- CAE / CAD / CAM capabilities (employee skill level & technology sophistication).
- Systems integration capabilities (system interaction expertise, full service support, "black box" capability).
- Proximity of rapid prototyping/reverse engineering/testing capabilities (i.e. within 1 day travel).

c. Transitioning to a greater **use of virtual tools** (ordered descending according to importance – impact ratio):

- Computer based tools for conceptual design.
- Rapid prototyping / physical prototyping.
- Product simulation technologies (crash, heat flow, dynamics etc.).
- Designed experiments (DOE).
- Simulation of manufacturing and assembly activities.
- Competitive benchmarking.
- Parametric design tools.
- Quality Function Deployment.
- Customized in-house software tools.
- Computer aided tolerancing / variation analysis.
- Manual drawings / sketches.
- Clay models.
- Virtual reality.
- Artificial intelligence /expert system/ neural network.

d. **Outsourcing** more to global suppliers

e. Focusing on **Design for Manufacturability** and **Design for Reliability and Durability**

f. **Involving** the suppliers, providing the **knowledge-intensive business services (KIBS)**

The result of these changes in product development is the need for close collaboration and improved communication both within and between organizations. The greatest enabler of collaboration is the creation of new internet-based electronic communication tools. Electronic communication is the biggest factor contributing to product development success.

DEVELOPMENT WITHIN THE FRAME OF THE PROJECT OF CENTER OF EXCELLENCE

At the Technical University of Košice, there was established the Product Design laboratory, within the frame of project "Center for research of control of technical, environmental and human risks for permanent development of production and products in mechanical engineering", where are used 3D scanners MicroScribe G2 and FARO Laser Scanner Platinum Arm in combination with software Rhinoceros, PolyWorks and Autodesk Maya 2012.

Reverse engineering belongs in the field of innovation among the first established knowledge-intensive services. Together with the advancing development of technology and utilizing of 3D scanning, the reverse engineering is becoming an important tool for accelerating the product innovation cycles and increasing the potential of lean approach and agility of development processes in Product Design. Thus, activities within the project, mentioned above, offer KIS-type services are based on professional experience and accumulated knowledge that are applied to provision of services to partners, and these services are focused on adoption and implementation, as well as the joint development of innovative solutions, based on specific parameters, according to actual requirements.

Combined with other available tools (e.g. Goldfire Innovator software, existing available knowledge base and capacities to build the platform for knowledge transfer network) the Laboratory of Product Design can on its own provide the whole

packages of knowledge-intensive services, corresponding the well-known demands (as defined in various studies and forecasts, e.g. [5] and [6] for Product Design in general and [1], [7], [8] and [9] especially for the automotive industry), for example:

- **Business consulting package**: market analyses, competitive intelligence, business audits, search of business opportunities, innovation IT support, feasibility studies, business plans, preparation of joint ventures, expertise for the local development programs and others.

- **Product design & development package:** research for product innovation (material, structural, patent and licensing services), design services, reverse engineering, construction development, prototyping, testing of prototypes, preparing products for mass production (technological feasibility).

- **Manufacturing base design package:** technological research, technology transfer, designing the tools and production lines, logistics solutions, design and optimization of the assembly processes and workplaces, power systems, complex projects of workshops and plants, etc.

CONCLUSION

There are three main benefits of engineering outsourcing: cost reductions, increased flexibility and access to complementary competencies. The crucial role of knowledge intensive engineering services in automotive R&D is to support innovation and to maintain the innovation level. University research and development centres have the engineering capabilities, technical base, laboratories, and specific know-how and are prepared to work with practice to perform the innovative projects "on-demand" in the form of supplying the knowledge services.

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