ENGINEERING SERVICES BASED ON KNOWLEDGE INTENSIVE SOLUTIONS FOR THE AUTOMOTIVE INDUSTRY

Ing. Štefan Babjak, PhD.
Technical University in Košice, Faculty of Mechanical Engineering, Mäsiarska 74, 040 01 Košice
e-mail: stefan.babjak@tuke.sk

Ing. Andrea Lešková, PhD.
Technical University in Košice, Faculty of Mechanical Engineering, Mäsiarska 74, 040 01 Košice
e-mail: andrea.leskova@tuke.sk

Abstract
This article deals about mapping of the challenges of engineering knowledge intensive services based on outsourcing that offers to OEM and automotive suppliers a number of benefits. There are identified three main advantages in area of outsourced engineering services: increased flexibility, cost reductions and access to complementary competencies. The crucial role of knowledge intensive engineering services in automotive R&D is to support innovation and to improve the innovation level.

The demand on automotive innovation is stronger than ever. University research and development divisions have the engineering capabilities, experts and scientists, laboratories, technical base, 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 to autoindustry.

Key words: automotive industry, engineering activities, knowledge intensive services outsourcing.

INTRODUCTION
To demonstrate the importance of engineering services in this paper, we chose the automotive industry, which has a number of innovations, and it is characterized by the dynamic product development, processes of design of new parts, automotive components, modules, or entire functional systems of the car.

There are different reasons for wider use of knowledge services in the form of external outsourcing ordered in companies operating in the automotive industry and supporting such design innovations. Among them, the most significant regards are: the individualization of customer demands, reducing the product life cycles, sophistication and increasing complexity of products, dynamics, variation and flexibility in the technical, economic and social sphere, the potential of high-tech electronics and effort to reduce the costs particularly through outsourcing. In the global market of services, there is a lot of room for intermediaries who deliberately seek the new knowledge and transfer it to their clients in the form of innovation consulting.

Such a service solutions are provided in two main forms:
- **Consulting**: identification of innovation potential in the product lifecycle; development of product design, harmonization and optimization of manufacturing processes or selected sub-processes, followed by foresight – roadmap for further steps.
- **Implementation**: in the fields of collaborative product development, product data management supported IT service, production and visualization that are specifically tailored to the requirements of the automotive industry.

Important engineering services, requiring intensively generating the knowledge and constant updating, are also the services for product design and development. Providing of these services in the field of research and product development is so called high-tech knowledge intensive services. These are services with high added value.

THE CHALLENGES FOR OUTSOURCED SERVICES IN THE AUTOMOTIVE
The specific challenges for the growth of the outsourcing services are following [1]:
- Development, manufacturing and logistics need to be better integrated, while product life cycles are reduced and time-to-market is minimized.
- Market and product requirements are changing continuously – process complexity and cost pressure is rising all the time.
- Strong and rapidly occurring sales fluctuations require increased flexibility in production.
- Heterogeneous IT environments and high maintenance costs for legacy systems are causing unnecessary and increasing IT costs.
- The requirement for global networking is growing continually because the share of added value from the automotive manufacturers themselves is decreasing.
- The holistic planning, implementation, control and on-going improvement of major manufacturing processes and resources require the methodical implementation of a ‘digital factory’, including IT-based tools for well founded management decision-making.
The ever-increasing demand for comfort and safety in cars is resulting in more and more electronics. It is scarcely possible to have innovations without electronics, and this also applies of course to software. More commoditized components such as interior and exterior components are already sourced from specialized Tier 1 suppliers that provide combined capabilities engineering and manufacturing. Both vehicle manufacturers and suppliers are facing increasing pressure on development costs and must leverage engineering outsourcing to benefit from gains in flexibility and efficiency. Development activities are being outsourced in automotive more and more.

At figure 1 is presented model of engineering networking between OEM and suppliers in the automotive industry.

Most frequent outsourced knowledge services in automotive industry based on engineering are e.g.:
- Product idea and concept design
- Product design
- Product engineering and testing
- Product development and manufacturing
- Product sales and support.

There are specified main benefits of engineering services outsourcing [2]:
- Flexibility: it provides companies with access to a large pool of engineering resources and enables them to quickly build up, reduce or refocus their resources. In times when a large number of vehicle programs need to be completed, external engineers can be hired for specific projects;
- Cost reductions: engineering services provider enables OEM clients to reduce their own R&D workforce as some – typically less complex – tasks are completed by external engineers who usually work for lower salaries;
- Access to additional competencies: the current trend toward powertrain electrification is a good example. Powertrain electrification is a major challenge for automotive companies and requires them to build up significant additional engineering resources. They must accomplish their "regular" workload of program development and handle the additional R&D for electrification. Cooperation with an engineering services provider can solve this challenge.

And on the contrary, the possible disadvantages are:
- Potential loss of know-how and intellectual property is the most prevalent; as industrial companies begin to bring into their R&D organizations external engineers who will leave once a project is finished, the accompanying know-how will also leave the organization if no preventive measures are taken;
- The day-to-day cooperation between internal and external engineers can create additional "hidden costs" (e.g. for travelling, IT systems, communication) that further diminish the achievable cost reductions.

Fig. 1: Key players in automotive networking in term of engineering and R&D activities. Source: [2]
The utilization of engineering services is applicable in all spheres of transportation industry, and for all key members in this chain, as is schematically shown on figure 2.

- Services for virtual design and experimental product development, computer 3D modelling, animation and simulation.
- Reverse engineering, digitizing.

Outsourcing gives companies access to highly experienced and skilled talents with knowledge of local needs and who speak the local language. Today, the OEM companies more often want to develop products in emerging markets, for emerging-market consumers, driven by emerging market developers [3].

OVERVIEW OF TYPICAL KNOWLEDGE SERVICES IN THE AUTOMOTIVE

Portfolio of selected knowledge services that are often used by automotive producers in the outsourced form can be defined as follows [4]:

- Expert services and innovative solutions for investment projects, project management.
- Consulting in specialized management systems (e.g. CRM - Customer Relationship Management, ECM - Enterprise Content Management, MIS - Management Information Systems, APS - Advanced Planning and Scheduling, etc.).
- Fabrication of models or samples and Rapid Prototyping.
- Testing in simulated and real conditions, technical analyses.
- Business services aimed at integration into supply chain management (SCM) and logistics network.
- Design of manufacturing technologies and processes, technology upgrading, optimization of material and information flows.
- Consulting services for hardware and software systems and applications, services for the processing of information databases, programming of automated equipment.
- Comprehensive services - optimizing manufacturing operations in order to gain the quality systems, safety and environmental certificates.
- Services - audits, studies and forecasts, e-learning and training of human resources, and so on.

The main areas of KIS utilization within the frame of product lifecycle are shown on fig. 3 and can be described, as follows:

1. Product design and technology development: these services range from concept development, to analysis and design, simulation, prototyping and production,
testing and product lifecycle management solutions.

2. Process engineering: these include the use of various tools and techniques to achieve efficiency through optimization of plant (production-delivery facility) set-up and operational costs.

3. Plant design and automation: starting from plant layout and design for the optimized production or delivery process, these services extend through development of automation systems for monitoring and managing production activities and also to facilitate organizations make faster decisions.

4. Plant operations and maintenance: these services include monitoring, managing and maintenance of plant, equipment and the associated automation systems.

5. Process assessment and re-engineering: these are techniques to reduce operational inefficiencies through continuous performance assessment of the process and re-engineering them.

Integration of KIS into the business processes in the context of product development and production design and planning enhances the quality of business processes in various dimensions.

Significant impact on the improvement and support of engineering has computer science and computer technology. Continuous progress in this area shows in advanced CAx systems, whose implementation in product development and production systems is becoming a prerequisite for competitiveness and innovation ability of enterprises. This area also heavily involves the specialized knowledge service providers.

Many IT providers offer the automotive industry a custom, proven portfolio of premium quality IT solutions and services, and hence the optimization of relevant business processes.

Summing up, engineering services outsourced to OEM mean lower development costs, quicker time-to-market, more efficient global collaboration, improved compliance with laws and directives, reduced IT complexity and hence significantly also higher customer retention.

OPPORTUNITIES OF THE UNIVERSITY IN THE FIELD OF KIS

Technological design is a fundamental activity in the preparation, innovation, modernization and reconstruction of production and range of new products. Faculty of Mechanical Engineering is able to provide for the industrial sector engineering services KIS – type within the frame of production design and design of manufacturing systems, such as [6]:

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- Design proposals, construction of products, nodes, components, material composition, selection of materials, calculations of strength characteristics, models, tests, variants, drawings;
- Conceptual design of production technology: ordering of manufacturing processes, documentation, parameters of manufacturing operations, optimization of technological modes;
- Designing the structure of the production equipment: machinery, tools, fixtures, manipulators, robotic equipment, installation, compatibility of manufacturing equipment;

Fig. 3: Roles of the engineering and KIS within the product lifecycle. Source: author’s adaptation
- Design of workplaces and plants: capacity calculations, layouts, linking the workstations through material and information flow, optimization of manufacturing, operational, transportation and storage areas and spatial distribution of equipment in terms of ergonomics, work safety and energetic conditions, simulation of operation, removing the conflict and critical conditions, bottlenecks;
- Operational management: planning, scheduling of batches, timing of production, organization and management of work performance, productivity improvement programs, programs of NC technology, economics and efficiency of production.

An overview of the whole range of knowledge services is shown in table 1.

The Department of Technologies and Materials in Technical University of Košice has specialized laboratories for providing and supporting the engineering knowledge intensive services reflecting the needs of automotive industry in three main areas [7]:

- Pre-production business services:
  - Innovation intelligence, competitive intelligence, with IT support through the Goldfire Innovator platform, innovation networking etc.
- Product design, reverse engineering and prototyping (both conventional and Rapid Prototyping):
  - CAD and surface modelling (Maya, Rhinoceros and various CADs), exact measuring, 3D scanning and reverse engineering (FARO Arm and Polyworks Inspector), two rapid prototyping machines using FDM technology, designers’ workshop oriented on carbon fibre-based composites.
- Material science and manufacturing technologies.

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<th>PORTFOLIO OF SERVICES FOR INDUSTRIAL PRODUCTION</th>
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<tr>
<td>1. Pre-production services</td>
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<tr>
<td>1.1 Business consulting</td>
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<tr>
<td>Package of services: 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 an others.</td>
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<table>
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<tr>
<th>1.2 Development of products, modules, components and parts</th>
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<tr>
<td>Package of services: research for product innovation (material, structural, patent and licensing services), design services, construction development, prototyping, testing of prototypes, preparing products for mass production (technological feasibility).</td>
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<th>1.3 Designing the manufacturing base</th>
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<td>Package of services: technological research, technology transfer, designing the tools and production lines, logistics solutions, power systems, complex projects of workshops, plants, factories and so on.</td>
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<th>2. Production services</th>
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<td>2.1 Custom manufacturing of technological equipment and investment supplies</td>
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<tr>
<td>Package of services: Manufacturing of tools, machines, production lines and other equipment, ensuring delivery of technology (financial services, leasing), business services, installation, training of personnel, services for the delivery of technology.</td>
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<th>2.2 Production services (manufacturing of components and aggregates)</th>
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<tr>
<td>Package of services: consulting services for manufacturing (quality control, optimization, modernization, revitalization and others), logistics (transport, storage), production cooperative services in selected technologies.</td>
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<th>2.3 Commercial services</th>
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<td>Package of services: Sales of products for companies and people (sales and leasing services), marketing and business services especially abroad, business brokerage services.</td>
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<th>3. Post-production services</th>
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<tr>
<td>3.1 Operation of products</td>
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<td>Package of services: modifications (design, increasing of utility parameters, adjusting to the new features), service, parts refurbishment, overhaul, sales of spare parts and accessories.</td>
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<th>3.2 Disposal of products and technology equipment at the end of life cycle and recycling of materials</th>
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Tab. 1: Example of available KIS at the Faculty of Mechanical Engineering, TU of Kosice
• Plastics processing, sheet metal forming and bulk forming, machining (both conventional and NC), testing of mechanical properties of materials, wear and friction testing, tribology and adhesive bonding, light and electron microscopy and metallography (preparation of metallographic samples, chemical surface treatment, chemical etching, corrosion testing, studies of macrostructure and microstructure, fracture areas and contact surfaces), welding and defectoscopy, surface evaluation and treatment, plasma spraying of coatings, blasting and coating.

• Design and optimization of the assembly processes and workplaces.

Activities of university departments offering 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 on the joint development of innovative solutions, based on specific parameters, according to actual requirements.

CONCLUSION

Knowledge-intensive services contribute significantly to the improvement and acceleration of product, process and organizational innovation processes and the transfer of experience, best practices and solutions. A functional system of transfer of innovation based on knowledge-intensive services is characterized by the mutual interaction of subjects, involved into commercialized research and development (universities, research organizations, technology transfer agencies, consultants, educational institutions, SMEs, etc.) that perform the screening of new knowledge and systematically seek the information that could be commercially evaluated and thereby stimulate the innovation activities in automotive enterprises.

Knowledge services for automotive sector focuses on engineering represented solutions: from product design through all engineering disciplines, from e.g. digital planning to vehicle production.

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