ROLE OF EXPERIMENTAL RESEARCH IN PRODUCT DEVELOPMENT – STATE OF THE ART AND VISION

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1. Introduction

Product development is a complex process based on the knowledge from various areas and on a great volume of data. Transformation of an enlarged knowledge base into technical system is the basic definition of product development and design. The development level of technical system follows the level of current knowledge. However, theoretical background in the form of discoveries of fundamental principles is missing. This space has to be filled by experimental data and empirical knowledge.

Design process consists of product synthesis with an objective to transform knowledge and data into technical system and of product analysis with the aim to collect the necessary data, predominantly experimental. Design for X is an approach with separate objectives in order to increase various indicators of product quality and collect mentioned data. In Fig.1 some of Design for X objectives are presented.

Design for user is aimed to identify user needs and exploitation conditions that define the level of quality indicators such as reliability level, vibration and noise level etc. Design for stress, reliability, vibration, noise etc., identifies relations between various effects at these indicators and in reverse direction, are used as design constraints in order to define design parameters of technical systems. Experimental data and corresponding methods are the basis for the realization of these activities.

Significant increase of knowledge level in the form of theoretical discoveries and inventions has to be verified by or based on experiments. This point of view represents by itself the locomotion of scientific and technical development. According to TRIZ theory this development can be evolutionary or revolutionary. Evolution uses existing fundamental knowledge, experiments and small steps knowledge improvements in order to increase the development level of technical systems and to develop new. Great fundamental discoveries such as in the field of power sources, nanotechnologies and areas alike, provide possibility for technical revolution. This means replacing existing technical systems with new ones, change human skills and habits, economic disturbances and then, after all this, steady evolutionary development. Current situation can be identified as long period of evolutionary development based on discoveries from the end of 19th and the beginning of 20th century. It is expected that the discoveries of new power sources supported by nanotechnologies can produce expansion of new technical systems, technologies and human activities. Current situation is also characterised by an expansion of new design methods and tools as well as by the lack of new products necessary for further development of the economy. In such situation experimental research can be a good way for providing significant discoveries and inventions.
2. Experimental Results

Fields of experimental research oriented to product development and corresponding experimental results can be structured as presented in Fig.2. Measurement of physical values provides possibility to identify inner and outer features and processes in and out of technical systems or samples. As the numerous processes inside materials and systems (technical and biological) are yet unknown, this measurement can identify and discover them. Some of the important measurements are the following. Measurements of load, stress or strength, using mechanical, electro resistant, piezoelectric, optical or similar technology is one of them. Measurement of motion indicators (displacement, speed of displacement and acceleration) using inductive and piezoelectric principle. Also it is necessary to include measurement of temperature and pressure and make difference between measurement of physical values in rigid body and in fluids.

Laboratory testing of samples and technical system components is extremely important part of experimental work for product development and design. Test rigs provide possibilities for simulation of selected working conditions, measurement of physical values and identification of features and processes which are the subject of the testing process. This is a wide field of testing principles and experimental results that need detailed analyses impossible to give in a short presentation.

Testing for exploitation and environmental condition indicators implies direct measurement of physical values at technical or biological systems in operational (living) environment. Selection of representative conditions and corresponding data processing methodology provides experimental results important for the new product development which are adapted to operation environment, insensitive to this condition varying (robust design), to user needs and environment, etc. Numerous examples of experiments and results will illustrate this experimental field with more details and indicators.

Design for stress, for reliability, for vibration, for noise, for user etc. are based on experimental results carried out by testing in laboratory or in exploitation conditions. Laboratory testing provides possibility for detailed and in depth analysis with collection of great amount of data. Exploitation testing is very often limited by test duration and provides experimental data that defines relation between the technical system, environment and exploitation conditions.

3. Conclusion

Product development and design need different data and knowledge regardless of whether the theoretical bases are explored or not. In current circumstances the only possibility is experimental research in order to collect the data or to identify theoretical background. Effect of various influences in complex relations can be identified using models and adapted testing procedure for separation of certain effects in laboratory conditions. Additionally experimental results are unavoidable for checking of numerical and analytical results. Also, developed technical systems have to be tested in order to avoid eventual design or production errors. Review of various cases will support this presentation.

4. Acknowledgements

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5. References