Experimental modeling methods in Industrial Engineering

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Dynamic approaches to a management system of the present industrial practice, forcing businesses to address management issues in-house continuous improvement of production and non-production processes. Experience has repeatedly demonstrated the need for a system approach not only in analysis but also in the planning and actual implementation of these processes. Therefore, the contribution is focused on the description of the modeling in industrial practice by a system approach, in order to avoid erroneous application of the decision to the implementation phase, and thus prevent any longer applying methods "attempt - fallacy".

Key words: *structuring, modeling, scientific experiment*

Introduction

Constantly increasing demands for experimental modeling of engineering processes across the board allows fulfilling of very powerful computers. Despite these facts, it is extremely important to find and verify the mathematical model, which actually corresponds to reality. This arduous journey allowing for a statistical analysis of observed values of the reference phenomenon. Understanding the statistics of our efforts is that we will facilitate decisions about the correctness of our hypothesis. The work, which must then be made to reduce the following:

- find sufficient statistical information for decision making,
- formulate reasonable requirements and issues that we want to get answers.

In industrial engineering, empirical study of the models will change the conventional way of thinking and replace it with the issue of creation of mathematical models [6, 9, 10,11].

Industrial Engineering as a hierarchic structure

In the industrial engineering, we are talking about its structure. This means, that a man and his natural abilities, eventually multiple measuring and observing instruments and devices, is able not only to define the single element, but is able to define its other parts. These parts will be referred to as elements. In addition, we can distinguish between elements and their relationships, therefore, links and interactions mediated by them. This means, that individual elements can be meaningfully and purposefully connected each and creates new services [4].

Understanding Industrial Engineering as a structure allows:

- investigate system as set of elements, links and interactions between them,
- create system from the elements by its effective and purposeful interactions.

In terms of industrial engineering, basic unit is a system (producing or providing services) that can be created by assembling components and investigate, describe whether the model as a set of elements and links between them. System is thus an object, that can be given in distinctive level of investigation or as a file created by its parts, their links and interactions existing between them. Element of the system on a certain level, any part thereof, which may define a distinctive level. At this level, each part is defining whole system.

Structuring system, as mentioned above, means that the body itself can identify and investigate the set of elements and links between them. Structured as well characteristics of the body, allowing the distinctive level to distinguish the different expressions and execute individual effects. Properties throughout the system are intended by properties of individual elements and their mutual joining. Elements of the system determine its character.

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By the current level of distinctiveness it is possible to define any real service as a large number of elements and attributes that can solve the problems of real bodies. It is not possible without accepting the rest. Therefore, when there is a choice of solutions and essential for solving of a particular problem to important elements. This approach essentially means that the problem is solved for the abstract service, which consists of only a limited number of essential elements and characteristics of the original unit. Thus we come to the concept of the system.

The concept of the system is often used as a synonym for the system. Currently, the concept of the system-specific meaning defined range of definitions in different levels. Systems theory extends to many disciplines, in which the integral use of computers requires that the unconscious creative activity gradually becoming aware and algorithmic, suitable for computer processing.

The system is thus an abstract object associated with the system, which is purposefully designed for troubleshooting system. It is built of formalized patterns and characteristics of the system, the essential linkages and interactions. It is therefore purposefully simplified system and expressed through the concepts and variables to the problem of the original system can be solved primarily think-operations. The object is the system under investigation and describing structured. Creating a system assigned object is the most prudent step in addressing the problem at the current level of technology. The system must include all relevant rules formalized the elements and characteristics. A simpler system is fundamentally flawed; complex system is unnecessary, inefficient and in extreme cases wrong again, because it leads to inefficiency or insoluble in concrete terms.

System approach

If we are accessing objective reality by consciously created systems for material bodies and through them to solve problems, we are talking about a system approach [7].

The system approach is considered as a way of thinking, way of solving the problem, or course of action which has the following characteristics:

1. Sequence are conscious, descriptive and formalized activities. This differs from the intuitive or emotional discussions, in which system elements can be included, but are developed and managed consciously and cannot be explicitly described.
2. Objects (services, problems, properties, methods, etc.) are seen in a structured, it means as a set of elements, relationships and interactions between and among the surrounding objects. The system approach must be monitored and fully respect the interdependencies and linkages in the activities and negotiations.
3. Objects are investigated purposefully, which means that the systems set up to investigate objects and problem-ring, the main principle of distinction is significant and insignificant for the efficient set of distinctive capabilities.
4. Objects are considered complex, which means that the phenomena they are applied, elements or features with significant influence to solve the problem, irrespective of whether these factors are outside the department or self-interest. This approach is therefore interdisciplinary nature of the team and in all spheres of solutions and negotiations.
5. Objects are viewed hierarchically. It is created leveled structure where there are structures and overrule the subject with the corresponding evaluation, classification, quantification and priorities.
6. The behavior of the target object is monitored - and the solution behavior is assessed only in terms of sub-element behavior solved, but primarily in terms of objectives hierarchically superior system.
7. The addressing is focused on the making of the algorithms to the solution, which could be implemented independently of individual bargaining. It is not therefore a solution of isolated problems, but the creation of algorithms to the mass element and its application to a particular case.
8. Oriented objects are investigated, monitors the input - output, cause - effect, partial solution - a solution so superior.
9. Attention is focused on leveled balance. Treatment is purposefully oriented to the individual sub-effective solutions to near level.
10. Objects are examined at the time as dynamic systems considering possible variations in order to anticipate (predict) the future or reconstruct their behavior in the past.
11. Indispensability of the system approach emphasizes the human factor in the efficiency and progressiveness heuristic approaches, and non-standard situations.

Purposeful human activity is in general understood as a system performance, decision-making and creative activities aimed at addressing problem situations.

The main problem is relationship between problem and solver of the problem, when investigator must decide on the approaches of the solution and about the choice of the optimal process for achieving that objective.

There are two principle approaches to the problem solving:

- Direct solution, where the problem is being solved by the chosen procedure. If the procedure leads to the goal, the problem is resolved. If doesn't, one must begin with another procedure again. This is a trial "attempt - fallacy".
- Indirect solution - instead of the formulated problem is solved another problem that is easily manageable. Through this solution is obtained primarily formulated to deal with the problem. In technically such a procedure is called modeling solutions.

Application of modeling in industrial practice

Addressing the technical and engineering problems in industrial engineering is filling work graduates of technical colleges. In any empirical modeling it is necessary to idealize the problem by introducing a set of assumptions. Thus, the case will be called idealized analysis model.

Computational model must contain all the elements of a real case, which is essential for the assessment. The expectation that the more accurate the calculation model is, then the result is more accurate would be met, with sufficient precision necessary inputs and with the same accuracy of numerical calculation is made. Refining the computational model in general and in particular the calculations are limited possibilities of the calculation method. There may be numerical instabilities and computational processes to the accumulation of errors. Gain accuracy, refine the computational model can be discarded numerical errors and the uncertainty of input data [4].

The parameters characterizing the real case are always random variables. Scattering some effects may have a negligible impact; others may have in terms of variance a significant impact on the reliability of outputs.

Thinking of arbitrary parameters is given particular knowledge of statistical characteristics for all the necessary parameters. In some cases, the variance of random variables is so small, that it is not essential for the calculation and it is not advisable to be taken into account in the calculation. According to the randomness of the parameters of the model we can distinguish models of computation:

- Deterministic - the unpredictable occurrence does not contemplate,
- Stochastic - unpredictable occurrence is considered.

For example, knowledge that the properties of the surface components are given by the nature of the working surface into geometric computing model does not include, however, have significant effects on some borderline states.

Each node is composed of mutually connected elements or contributory. Contact elements are complex, so almost always requires significant simplification. However, the conditions act as contact boundary conditions. Computational model of contact is thus the solution to mathematical calculation model boundary conditions.

Although the last three decades is very much extended the application of numerical methods, computational solutions to complement and explain the experimental results and modeling techniques. However, it is necessary to recognize that valuable results and generalizations are achieved only through detailed analysis of the phenomenon studied and that thorough theoretical training measurements are almost always reduces the necessary scale tests (which significantly contributes to reducing costs, but to save time). The experiment requires expect of handling of theoretical methods of measurement and evaluation techniques personal skill and care, also.

Professor Kassay in his monograph of enterprise and entrepreneurship indicates that the use of scientific knowledge has particular economic importance. "Natural enterprise" can bring partial results, but not in the long term. Enterprise growth is essential systematized arrangement and creation of management relations in accordance with enterprise features. The amount of oscillation and the factors affecting the environment require high skills. In addition to the scientific management, it is necessary to ensure product and technology innovations, matching and improved manufacturing processes. Therefore, the place of science in business is irreplaceable. In terms of utilization of scientific knowledge, just the fact that the owners or managers have many contacts with top scientists of various disciplines, is often a source of non-traditional ideas that are applicable in practice. Companies should establish their own scientific research departments, which ultimately assume they income. Just a few improvements are needed to take money back. The deprecation of science caused some frustration on the results of various consulting firms or advisers in academic departments, whose interest was the progress of the company, but especially in the privatization sale of certain general multiplex, theory-grounded practice, often equipped with scientifically active mathematical-statistical apparatus, and many of the terms foreign-denominated. Practically, the minimum can be used [2].

Sometimes, however, the acceptance of science as an instrument of progress is making a fundamental error when business managers succeed based on a theoretical basis, which is already outdated by new findings. There is considerable evidence that the relationship between the performance excellence of enterprises and new scientific knowledge is proven. It is known that the former theories of management were clear, and it is thereby attractive for managers. Currently the situation is completely different.

Ambiguous phenomena and paradoxes entrepreneurs often do not apply the expected precision "scientific formula" for new solutions to ensure successful business. Emerging companies are able to accept new events and manage paradoxes. It is also a character from a mechanical direction of thinking to holistic thinking, which also requires a shift from rational thinking to the social.

To a large business sustained vitality and sensitivity to change, the scientific and research management approach is necessary. However, professionalism in management is not only at the management of pragmatism. Practical rationality is linked with a deep knowledge of processes and phenomena in the enterprise, as well as exploitation through the latest development, which are appropriate to enhance the performance of individual processes, but also the entire enterprise.

Scientific experiment to industrial practice

Scientific experiment is justified in holding, because it is directly verifiable in practice. All the more so that desirable outcomes should not be in business research report, but the actual application of scientific knowledge, which may mean increased competitiveness. Finally, the company is purposefully drawn up a system where for its existence and development are crucial inventions and new ideas, those meanings must be controlled. Ideas are in turn the result of experience and acquiring new knowledge and scientific research studies. A concrete approach to the use of science in business as an operational research is made to identify the range of opportunities to enhance performance.

CHARACTERIZATION EXPERIMENTS	past	PRESENT
execution of work or physical model	hand, mechanization	automation, robotics
planning of an experiment	intuition, experience	planning simulation algorithms
management of an measurement	hand	computer
process measurement	at the elementary means of calculating	at higher-generation computers
transformation of the measurement results to the problem	theoretical model formalized verbal or in simple mathematical form	theoretical model, computer-oriented
interpretation of the results of the experiment on the problem	man	man, assisted by computer
importance of experiment for forecasting technological features building	predominant	in accordance with the conditions and possibilities of solving the problem of computer modeling
relationship of theory and experiment	predominates independence	system consists of direct and feedback
Measurement options	at times	

Fig. 1. Distinguishing features of the experiment.

Application of scientific knowledge in business and business requires numerous experiments and the search for new approaches or techniques.

Better results in innovation and product quality can be achieved through experimentation (eg. generate prototypes that are the subject of further reflection and experimentation, which will allow sufficient correction and improvement). Experiments are in companies applying as inexpensive learning, because of spending less money than in an inaccurate market research and its derivative programming. Therefore, the experiment is considered as the most powerful tool to stimulate innovation. Experimentation supports the formal nature of the enterprise systems. It is the company required orientation activities. They may be small experiments, and informal groups, where some issues in the company delivered. Experience shows that new scientific knowledge from the literature, consultation with leading scientists and senior managers of business leadership in confronting the market needs are significant contributors to the increase of business turnover. Moreover, the introduction of research ambitions in the enterprise is an opportunity for creative and motivating individuals to achieve a tangible result, which can be a significant undertaking.

Application of science in business indicates an urgent need to create an environment for permanent education. Everyone who wants to bring something new educates, by organizing brainstorming, workshops, consulting teams, virtually continuous discussions on marketing, customers and the needs of people. It is a process, which highest-level meta is displacement of the benefit to all employees and relevant environment [1].

It is therefore necessary to gradually prepare the ground for the learning organization and an environment able to change not only accept but also to implement an enterprise to flexibly respond to the stimuli surrounding area.

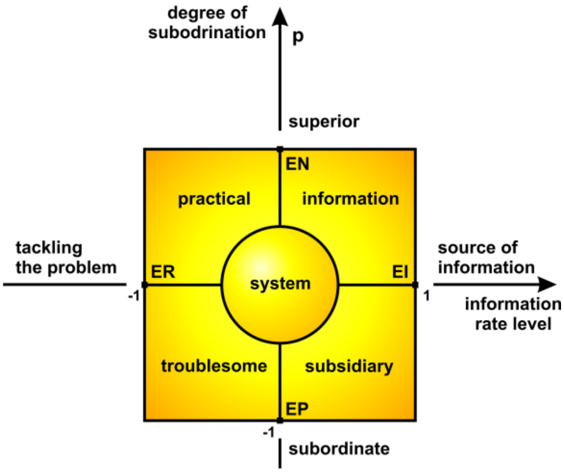

Fig. 2. Information-hierarchy level of experiment.

The specific knowledge and experiments can draw conclusions for all types of activities. Every company, which wants to survive, must become a laboratory for verification and implementation of new knowledge, which ultimately represents the symbiosis of science and practice. Specific experience in individual enterprises but also experiments may be a rational basis for a more thorough investigation and find solutions.

Conclusion

By studying the methods of industrial engineering in collaboration with universities we can discover possible methods by which production and administrative processes can be simulated to increase its productivity.

This also is why it is necessary to ensure the educational departments of universities and scientific process, Industrial Engineering field of study, had very close links with practice, where the methods of experimental modeling are directly feasible in these "laboratory research" departments.

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