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## SYNERGIC AND DEVELOPMENTAL MULTIDISCIPLINARY IN MAINTENANCE OF COMPLEX TECHNICAL SYSTEMS IN ONLINE ENVIRONMENT

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**Abstract:** The paper deals with multidisciplinary in the maintenance and management of complex technical systems. This primarily refers to maintenance or technical diagnostics, which is increasingly becoming part of the management technological process. In addition, business activities, especially commercial activities, are integrated into this joint process, and with the development of IT technologies, everything becomes integrated into a joint management process. It is hypothesized that complex technical systems in the business and market sense are not spatially limited by state borders, so there is a need for cooperation in the production and development goal. This enables them to develop IT technologies, especially the Internet. With the goal of mutual cooperation between several business organizations that have technical systems, a model of joint relations with the public is proposed as a common strategic need and business interest. The subject of continued research can be artificial intelligence, which can serve as software that provides new solutions for optimizing business processes, especially based on changes in production inputs.

**Keywords:** technical system, diagnostics, process, management, PR

### INTRODUCTION

The development tendencies of the world economy are the creation of a large number of small companies and a smaller number of large, particularly technical systems. A fundamental feature of larger technical systems is the increasing involvement of technique and technology, which requires sophisticated forms of management and maintenance. The development of technique and technology, especially informatics, enabled a high degree of automation of complex technical systems. In addition, such economic entities are not limited by their business and market locally, but also by the state. This particularly applies to technical systems that complement each other in their production programs. In such complex technical systems, there is a special emphasis on their flawless maintenance, which is technical diagnostics. This means that continuous controls enable the smooth flow of the technological production process, so technical diagnostics is increasingly becoming part of the management process of production and operation of the technical system.

If information flows are converted into functional relationships, then, with appropriate hardware and software solutions, the complete production and business process can be managed with the goal of optimization. For example, by adjusting and controlling mathematical relations or functions, set such forms of production functions that the capacities enable minimum costs per

product unit, or the lowest cost prices. Subsequently, this process can be connected to similar processes in other technical systems, so experiences from the field of production, system maintenance and development can be exchanged.

Based on the development of hardware and software solutions, a hypothesis is put forward about the multidisciplinary joint activity of several technical systems. In this sense, the goal is not only production and development technical cooperation, but also marketing, especially cooperation in the field of public relations. With the development of technique and technology as well as economic relations, relations with the public are becoming an increasingly important strategic managerial activity. This especially applies to complementary technical systems whose operations and market are not limited by state and other obstacles.

In terms of content, the management and maintenance of the production and technical system is first proposed. The next procedure is the modeling of the mathematical process in accordance with the technical flows. This is a prerequisite for the application of appropriate hardware and software in order to adapt everything to computer control. A virtual connection between several technical systems can be achieved with special software used to communicate with each other or via video conference for joint communication.

Due to the fact that the activity of public relations (or PR) has become not only a marketing but also an important strategic managerial one, a model in which several technical systems participate is proposed.

This achieves the technical-economic multidisciplinary of the complete system, which is the main goal of this work. As a continuation of the research, there can be artificial intelligence, which can be used to provide software solutions based on information about imputation changes in order to set the capacities of individual phases with the goal of minimum cost prices, but also other business and market assessments and decisions.

### CHARACTERISTICS OF COMPLEX TECHNICAL SYSTEMS AND THEIR MAINTENANCE

In terms of this consideration, the basic question arises as to what is specifically meant in this case by the phrase technical systems. The definition of technical systems starts from several facts. A technical system is a series of interconnected components that transform, transmit or control materials, energy and information with a specific purpose. In any system, the way its components work together is as important as their performance and individual characteristics [9].

Therefore, technical systems are the result of human creativity. They are also called goal systems because of their purpose set by man as a creator. These systems do not appear by themselves, but regularly within the framework of organizational or production systems.

According to the definition, technical systems represent a set of constituent parts, their relations and special features, which are structured in such a way as to ensure the foreseen work procedures and execution appropriate functions in a certain time and conditions. Every technical system has the following types of components, which are often used as categories for process analysis. [1]

- Material components. In this category comes the raw material necessary to start the process, the energy used for its transformation and the technical equipment (technology) that enable action on it.
- Agent components. People involved in the process, who give it load Culture, values, skills, knowledge, and play a vital role in their interaction with the system, as operators, supervisors, regulators, controllers, etc.
- System structure. This refers to the specific way in which other system components are arranged and interconnected. Based on this,

it is possible to identify two types of processes: management and transformation. The former control the process, and the latter are the ones who actually perform the work.

- Process results. Results are objects and actions obtained at the end of the process, regardless of whether they are desired (successful process) or not. It is possible for two technical systems that have similar components and structures to give different results. In terms of hardware Fig 1. shows an example of a complex technical system that has three phases of operation and each phase has four operations.

Figure 1 shows an example of the functioning model of a complex technical system that consists of three production phases, and each phase has three work operations. Technical solutions can be used to control certain energy and information flows in each operation, which can be adjusted for management using measuring transmitters, converters, amplifiers, translators and other hardware and software options. In the technical sense, this is solved by a PLC (Programmable logic controller), i.e. a digital electronic device that uses program memory to remember commands that order the execution of specific functions, such as logic functions, counting, time measurement, and calculation in order to manage different types of processes and devices through digital and analog input-output modules.[2]

The development of technique and technology, especially informatics, today enables far more complex hardware and software informatics that enable monitoring and management of all elements of the process as well as its maintenance and technical diagnostics.

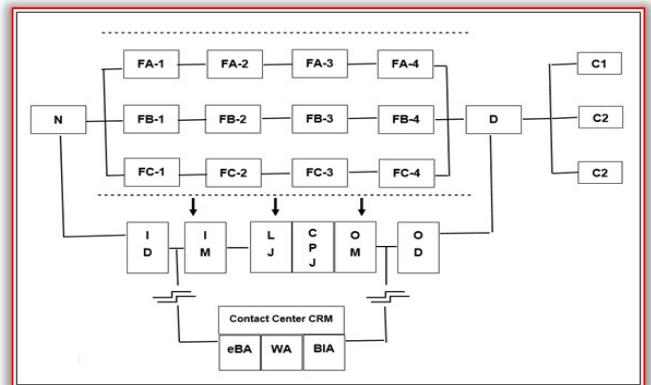


Figure 1. Functioning of a complex technical system

Legend: N-procurement, FA 1-4 first phase with 4 operations, FB1-4 second phase, FC1-4 third phase, D-distribution, CK1-C3 customers, ID - input device, IM - input module, CRM - software for customer and environment management, eBA - e-business applications, WA - work applications, BIA - business intelligence applications, OM - output module. OD - output device

Figure 1 shows the functioning of a complex technical system of three phases and twelve operations. In all important places there are detectors connected to the computer via converters, transmitters, amplifiers and other necessary hardware devices. The obtained data is processed and displayed in the control center. The complexity of the hardware and software enables the monitoring of the necessary technical control variables as well as those that are managed with technical diagnostics. Connection using CRM enables remote management as well as communication with other companies for maintenance-diagnostics and complementary complex technical systems. CRM is a set of software methods for managing relationships with clients (Customer Relationship Management). [3]

In essence, it is about conducting electronic business, by understanding the behavior and needs of business partners, using appropriate communications. The system has a contact center with which it maintains connections with customers or clients as well as other systems. The connection is supported with the help of the Internet or galvanic access, and one-sided connections via websites, social networks or video conference are also possible. Within the contact center, business e-applications, work e-applications, database and business intelligence applications are stored with the maintainer. This system is harmonized and upgraded to a complex technical system, and communication between technical systems and their environment is achieved using appropriate IT solutions.

### **PRODUCTION-MANAGEMENT FUNCTION OF A COMPLEX TECHNICAL SYSTEM**

After the technical system is adjusted in terms of hardware and software. Management of technical or IT processes is made possible by analog conversion of energy and information signals into a functional relationship. All technical quantities are converted into mathematical causally dependent ones, so the following functions can be created:

- Relationship of product quantity in time,
- Ratio of costs per product unit (cost price) and capacity utilization.
- Monitoring of technical parameters in accordance with processes in individual stages and operations of production.

When all flows are translated into mathematical relationships, then the complete production,

technical and IT process can be managed in order to optimize it.

The given example of a complex process shows production functions, i.e. the dependence of individual product costs (cost price) in a certain time. This is technically possible with a sufficient number of detectors that at all times show such parameters that the appropriate software converts into costs. In the figure, it is assumed that this system has a large number of processes and thus production functions. By combining them, a joint production function is obtained, where the individual costs are finally obtained at certain times in order to determine the optimal capacity (lowest cost price), but the other costs related to maintenance also move along. This refers to energy consumption, rate of wear and tear of rotating devices, overheating, etc.

These costs are something new that needs to be monitored and diagnosed. Of course, this complete system can also use more modern IT technologies in which the signals that follow the flow of production functions can be processed. This can be linked and reconciled with measurement and other maintenance-related data.

Accordingly, a software-hardware solution in a technical sense can enable the management of the production function (cost price) and the diagnosis of data related to maintenance. The continuation of the development approach is an online connection that enables maintenance management where no distance and other limitations (state borders) are an obstacle to successful cooperation.

The aforementioned synergistic approach can be particularly effective when exchanging information with business partners regardless of their location. This can be various development, technical and marketing information. On this occasion, the starting point of consideration is the joint PR of several companies that deal with the maintenance of complex technical systems. The reason for this cooperation stems from the fact that these are companies that must follow the latest technical and technological achievements in order to effectively perform the maintenance function, which in such cases is actually technical diagnostics as a very sophisticated form of maintenance. In addition, when it comes to complementary technical systems, the appropriate hardware and software solutions enable joint access to relations with business partners and clients. In this sense, it is first necessary to organize a model of technical

diagnostics and system management, and then harmonize with this a model of mutual cooperation and relations with common customers and the rest of the business public.

### **TECHNICAL DIAGNOSTICS OF COMPLEX TECHNICAL SYSTEMS**

The term diagnosis is known and related to the field of medicine where the disease or the cause of the disease is determined. Something similar applies to technical systems, and in any case it is about some kind of recognition, evaluation and conclusion. In this case, it is specifically about determining the state of a technical system. From a broader perspective, it is about monitoring the change in state by measuring the appropriate parameters according to the type and complexity of a technical system. [4] Technical systems where technical diagnostics are performed can be construction objects, machines and equipment as well as installations, as well as agricultural equipment and IT hardware or software.

The peculiarities of technical diagnostics are best derived from the following definitions:

- Technical diagnostics, as an integral part of the condition-based maintenance model, should determine the technical condition of a component and/or system with a certain accuracy at a certain moment in time. [5]
- In its essence, technical diagnostics represents a technical discipline that deals with monitoring the state of correctness of machines, equipment, devices and plants. [6]
- Technical diagnostics, as an integral part of the maintenance process according to condition, should determine the technical condition of a component part of the system with a certain accuracy at a certain point in time - a science that deals with recognizing the technical condition of the system. [7]

In this case, we have an example of a complex technical system, where technical diagnostics includes the following activities:

- Testing of machines, equipment and installations, i.e. the complete production process.
- Testing the functioning of the complete information hardware.
- In particular, examination of IT diagnostic software, and especially production and software related to external communications.

This schedule of activities allows determining the functioning and management of multiple information processes. First of all, we can mention the fact that comes from the progress

of the development of technique and technology. It is actually about the fact that the maintenance of complex technical systems, especially technical diagnostics, grows into a management process that has wider implications, as support for the management process but also for other commercial or marketing activities. The first is the process of technical diagnostic information. In parallel with this, the management process of the production function takes place, and certain cost-quantity optima are achieved. On top of that is the CRM process, which establishes communication with complementary technical systems and their common environment, i.e. the public. In this way, a synergistic effect is achieved because technical-production and marketing information are exchanged, all with the goal of common interests. In modern business, special attention is given to public relations as a very important strategic activity, especially for complex technical systems.

### **A MODEL OF COOPERATION OF MULTIPLE TECHNICAL SYSTEMS WITH SPECIFIC OBJECTIVE OF IMPROVING PR WITH THE SUPPORT OF INTERNET TOOLS**

Complex technical systems at regional levels do not have to be in competition with each other. They have in common that they are complex and that they can organize technical diagnostics in a similar way, but they also have similar problems and needs. In addition, complex technical systems can be complementary to each other and create conditions for cooperation, especially in the domain of development and marketing. On this occasion, the starting point will be public relations, because this is an activity in full development, especially with complex systems. In this sense, it should be noted that most of the technical diagnostics activities can be carried out online, so there is an opportunity for synergistic action. It is the technical capabilities that are installed for the needs of on-line technical diagnostics that enable relations with the public to develop.

Given that in modern business, especially complex technical systems, PR is increasingly becoming a strategic activity, then technical diagnostics should be used for synergistic action in order to improve marketing, especially public relations. Considering the process of technical diagnostics, especially with complex technical systems, it can be seen that it is a function of the production and complete business process. In fact, the information process of maintenance or



technical diagnostics is an integral part of the production and business process, but with the development of modern software it can be expanded and connected to the information processes of marketing, especially with public relations. This is extremely important in modern management because it enables mutual communication with different subjects of the technical system environment.

Public relations or PR is an activity that appeared as one of the tools of modern marketing, but it is increasingly taking on a strategic role, especially with larger or complex technical systems. The activities of the PR function derive from the definition itself, and a few examples are listed below, such as:

- Public relations represent a form of communication that, if carefully planned and implemented, ensures the long-term goals of creating a positive image that is created on the basis of long-term planned good relations with different groups of the public: consumers, employees, suppliers, stockholders, the government and other formal and informal groups in society. [8]
- Review The Public Relations Society of America (PRSA) defines public relations as “a process of strategic communication that builds mutually beneficial relationships between an organization and its public”. [9]
- Public relations is a management function that establishes and maintains mutually beneficial relationships between an organization and the various publics on which its success or failure depends. [10]
- Public relations is a management function that helps establish and maintain common lines of communication, understanding, acceptance and cooperation between the organization and its public; In addition, public relations help in getting to know and react to public opinion, define and emphasize management's responsibilities to serve the public interest and the successful implementation of 8 changes, serving as a system for getting to know and predicting trends. Public relations is a function whose basic tools are research and ethical communication. [11]
- Public relations as a strategic management process builds mutually beneficial relationships between the message exchange function that focuses on influencing the management of production and business processes, that is, on behavior in the company. In addition, it

affects the management function, which emphasizes communication with the public in order to include feedback in decision-making. [12]

- The previous definitions refer to the essential elements that determine public relations activities, which include the following:
- Relations with the media - The media play an important role in the formation of public opinion, as they can inform business partners and clients and contribute to the creation of the company's image in the public.
- Relations with the market - The market represents the public with whom you need to communicate carefully, because the company is dependent on the market, that is, those who buy your products and services. That's why it is necessary to listen to any market and find out consumer preferences through research and adapt to the results of these researches in order to constantly adapt to the needs of the market. The ultimate goal is to create a long-term partnership with consumers.
- Relationship with the state administration and local self-government - Communication relationships with the authorities are very important for every large and complex company, such as cooperation and direct and indirect lobbying. In addition to the market, every organization also depends on its public institutions that grant work permits, pass laws, adopt procedures, and regulate market movements. In this aspect of public relations, it is necessary to follow events on the political and social scene and to adapt to the course of these events in time for the benefit of your client. More specifically, these activities relate to monitoring relevant political, legal and other key issues and to the collection of information on the activities of public institutions, all for the purpose of adapting communication to that public.
- Internal communication - Internal communication includes all communicative activities between management and employees, because a company can have an ingenious product or service, but if the person in charge of selling that product leaves a negative impact, it is very likely that there will be problems in sales. In order to avoid such a scenario, it is in the interest of employers to have satisfied employees who will transfer motorcycle companies to customers in the right way. Therefore, it is

important to inform, educate and motivate employees so that they can represent the company to the public. This is achieved through various meetings, intranet and communication conversations, i.e. internal communication.

- Corporate communication-For very complex economic systems, corporate communications include all important communication processes that contribute to the defined tasks in profit-oriented economic units, and which especially contribute to the fulfillment of internal and external coordination of activities as well as the alignment of interests between the company and its stakeholders [13]
- Investor relations- Better known as financial public relations, investor relations is a type of PR that tries to increase the value of a company, strengthen the confidence of shareholders and thus reduce the cost of capital and make the company or its shares attractive to investors, financial analysts, banks and funds.
- Relationships with complementary complex technical systems-This type of relationship is needed for mutual information on common topics such as; product development, technology maintenance, common market problems and other business interests.

Based on the determination of activities, it can be concluded that public relations, especially with complex business systems, are part of strategic activities, so it is logical that information technologies should be used to connect maintenance and production process software with public relations software as part of strategic activities. In this sense, the development of information technologies is a facilitating circumstance because everything can be organized online or virtually.

Virtual communities, or online communities, are used for various social and professional groups that interact via the Internet. This does not necessarily mean that there is a strong bond between members, although Howard Rheingold, author of the book of the same name, mentions that virtual communities are created “when people continue public discussions long enough, with enough human feeling, to form networks of personal relationships”[17]. In this case, effective mutual virtual communication is possible by establishing and organizing a video conference. Video conferencing is communication through which, in real time, sound and moving images

are exchanged between two or more locations, thus enabling participants to hold a business meeting or training “live”.

## DISCUSSION

If the previous content is analyzed, it can be seen that the goal of this paper is the proposal of a hardware-software solution, by means of which technical and business IT flows are combined. Regardless of the fact that this is just some kind of conceptual solution, the development of technique and technology is certainly going in that direction, especially when it comes to managing complex technical systems. The starting point is technical diagnostics, which includes a large number of detectors of different physical sizes that provide a picture of the flow, state and changes in the technical system. Using linear and non-linear trend methods, detector pulses can be converted into mathematical expressions. For example, such as the dependence function of production costs per unit of product for each operation in the production function. The software solution controls and adjusts capacity values with the goal of minimum production costs per product unit, i.e. cost price. The continuation follows towards the creation of a virtual network by means of which complex technical systems and their maintenance companies can communicate. In this sense, companies for maintenance or technical diagnostics are usually not in competitive relations, but on the contrary, they have many reasons for development cooperation. The technical systems themselves, which are usually marginally dislocated, and especially if they are productively complementary, can synergistically communicate in order to develop products, organization and other improvements. To this can be added the joint activity of public relations, which, with the development of economic relations, becomes not only a part of marketing but an extremely important strategic managerial activity. The proposal presents conceptual solutions of a virtual model of joint relations with the public as evidence of the possibility of multi-disciplinary IT management. Regardless of the fact that the two-way communication has been achieved with the aforementioned proposal, the research remains to be continued with the aim of feedback management. The continuation of this topic can go in the direction of artificial intelligence research. According to one of the artificial intelligence (UI), according to the English

acronym AI, from Artificial Intelligence), a part of computer science (informatics) that deals with the development of the ability of computers to perform tasks that require some form of intelligence, i.e. to be able to navigate in new opportunities, learn new concepts, draw conclusions, understand natural language, recognize scenes, etc. [14] Due to the aforementioned possibilities, artificial intelligence or software that, based on, for example, changes in imputation values, will offer such dependencies of costs on capacities, which will ensure the lowest costs per product unit, or cost price. In addition, by monitoring the market situation, it is possible to generate effective marketing activities. In any case, the integration of technical, business and marketing IT flows can increase the efficiency of complex technical systems.

### CONCLUSION

Based on the presentation of the previous content, several conclusions can be drawn. First of all, it is the justification for constantly looking for opportunities to increase the efficiency of all types, especially of production complex technical systems. In addition, it is extremely important to explore the possibilities of applying the development of IT technologies in the production, business and marketing system. In this work, the goal and hypothesis of the work was exactly the IT multidisciplinary. By showing the proposed model in its conceptual form, the need and possibility of realizing IT multidisciplinary is visible. Technical possibilities are presented as mathematical simulations of technical processes in order to optimize economic relations in production. This can enable cost optimization as an essential goal of any production process. To this, the virtual unification of public relations activities was proposed as a joint activity and the need of several complex technical systems. In the end, the need and possibility for continuing research was opened, which is the inclusion of artificial intelligence in the substantive process. There are almost no restrictions for this, and the purpose of artificial intelligence would be to make conclusions and suggestions. Based on all technical, business and marketing information, artificial intelligence can make relevant proposals or orders for certain new moments in the processes. This can be caused by a change in input data in the business process, problems in functioning and maintenance, but also new

proposals within the marketing mix as well as new approaches in public relations.

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