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SYNERGY-BASED APPROACH TO ORGANISATIONAL QUALITY

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Abstract: *The present paper is focussed on the research of human behaviour in the quality assurance environment where product development planning, design and resource management, product realization and its analysis are concerned. The driving force behind this research is to find an effective approach to fight against the so-called bad engineering. To solve the above described problem the research method first presumes composing a representative database of human shortcomings in the framework of quality assurance. The results side of the research looks for a synergy-based approach to the TQM in order to make effective use of the information on human behaviour to raise the capability of the company to prepare ISO certification and recertification.*
Keywords: quality management, product quality, product development, design structure matrix technology, synergy allocation.

1. INTRODUCTION

The goal of the present research is to initiate a framework for the effective use of the information on human behaviour to empower the quality assurance activities. It seems that one of the possibilities is to involve a new paradigm – the synergy-based approach to quality management. The synergy-based approach makes it possible to collect design parameters, market conditions and human factors under one umbrella. The main difficulty here is probably the seemingly unmatchable character of synergy and quality and difficulties in their quantitative evaluation.

Firstly though, it is necessary to define the concept of “synergy” used in the present context. Linguistically the word “synergy” defines the situation where the summary effect at the integration of different technologies or processes due to their mutual empowering is greater than their sum. Sometimes it is called the 2+2=5 effect. So there is “something” that makes integration successful and it is called positive synergy. However, sometimes we are also the witnesses of unfortunate integration and for symmetry it is appropriate to call it negative synergy [1]. It is quite natural that at solving a task all activities must be aimed at attaining the maximum positive synergy and pressing down the unfortunately accompanying negative synergy.

The main difficulties related to the quality dimension are associated with the matter that it is at the same time a perceptual, technical and market-driven concept. The quality paradigm is changing and the procedures to deal with “perception”, “value”, “feeling” and “mind-set” have become a modern field of research activities [2]. The technical side of product quality continues to be a key driver of the product development process and more attention is paid to improving the upstream activities of the product development process to ensure that quality is built in the product. At the same time quality and reliability problems of non-safety-critical products have changed into market driven factors. In order to strike a high level of reliability, and therefore low service dependability, the cost of the product rises and it is difficult to sell. If the dependability is too high, the level of warranty costs rises, the service network must be expanded and the reputation of the organisation may suffer. As a result, the quality level is optimized in market competition.

The use of the Total Quality Management (TQM) and ISO 9000 standard series should guarantee good quality. In the 90s there was a heated dispute in business media over the problematic impact of TQM on the financial performance of enterprises. The analysis provided by Singhal [3] is based on the evaluation of TQM investments benefit of 600 quality award winners in the USA. They were compared with the firms of the similar size from the same industry and it gave a positive answer and it is proved that quality award winners outperformed the benchmarks on almost every performance measure.

In this context a question about synergy and quality interrelations crops up. The goals and nature of their assurance are quite close to each other and it is clear that all that is made for increasing the synergy brings along the attaining of the better quality. In the previous research an attempt has been made to compile and analyse the quality-synergy relations using the Design Structure Matrix (DSM) technology [4] where the matrix was compiled from 20 indicators of quality and synergy. As it was followed from the analysis, the proposed quality and synergy correlation is quite strong: on the medium level 67% and 10% have a strong correlation.

So, the present research has sufficient grounds to use the synergy-based approach to the organisational quality of producing companies and to look for the framework to avoid bad engineering. According to the above-stated facts the present research has two main problems to solve: to study experimentally the role of human faults and mistakes in quality assurance and to develop a suitable framework to help companies to prepare for certification and recertification.

2. RESEARCH OF HUMAN SHORTCOMINGS IN QUALITY ASSURANCE

As one can see that the quality management system is mostly based on human behaviour, it is appropriate, at first, to go deep into human activities in the quality management context. The 10-year database of human behaviour is compiled where the results of more than 200 production companies' real quality management systems certification processes are analysed.

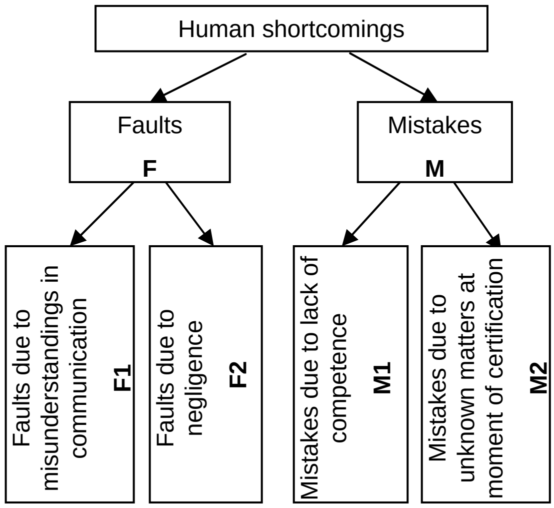

Fig. 1. Classification of shortcomings at quality assurance

However, it is appropriate, at first, to specify the terms used in the further analysis. On a large scale (see Fig. 1) all the revealed shortcomings can be divided into faults **F** and mistakes **M.** Faults are wrong decisions that have no justification. Communication misunderstandings between the client and the design team or the members of the design team belong to the faults' category **F1**. To the category of faults **F2** belong all shortcomings connected with negligence. Faults may be treated as a result of negative synergy in teamwork or negative synergy in a person's inner communication.

Mistakes have a far more complicated nature. To this category belong wrong decisions **M1**, caused by lack of core competence in quality assurance systems. Another category of mistakes **M2** is conditional and is caused by unknown matters at the moment of certification and they may be resolved in further activities of quality assurance.

In Fig. 2 the results of the statistical analysis of human shortcomings at quality management are presented. During the phase of product development planning (line PDP) the typical faults **F1** are as follows: the responsibilities inside the organisation are not fully defined, the path and procedure of documentation confirmation are not clearly legitimated, absence of the overviews of clients' requirements, etc. Faults **F2** - valid instructions are not used, the introduced procedures are not followed, anarchy in the drawings system, etc. Mistakes **M1** - inadequate knowledge of legal acts, as a result of which the requirements set up are insufficient and therefore, cannot be followed. Mistakes **M2** are born on grounds of lack of future perspectives when the current procedures are outdated and better solutions are available.

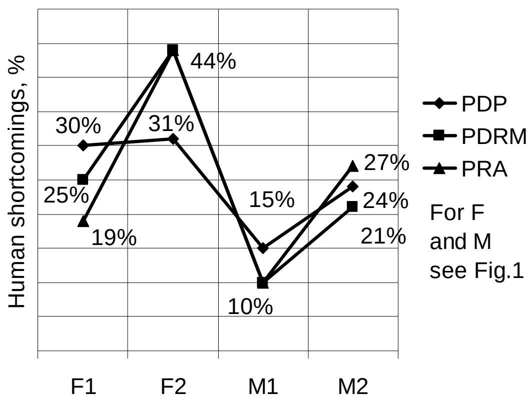

Fig. 2. Human shortcomings in quality management

The PDRM line in Fig. 2 shows the data of human shortcomings for the product design and resource management phase. The dominating deviations are: **F1** – professional instructions do not include qualification requirements, working environment does not correspond to standards, professional training plans are not followed, etc. **F2** – personal development talks are not provided, professional knowledge cards are not filled in, safety regulations are not followed, warning signs are absent, etc. **M1** – misleading warning signs, incompetence in storekeeping, etc. **M2** – the existing attestation systems are not used but at the same time new ones are introduced.

The PRA line in Fig. 2 presents an overview of human shortcomings for the realization and analysis phase. The typical deviations are: **F1** – the timing of measuring equipment verification is not established and the real situation is out of control, the client's requirements are not followed, etc. **F2** – safety regulations are not followed, internal audits are missed, suppliers' evaluations are not provided, etc. **M1** – in the procedures there are references to non-existent requirements, conformity documentation is absent, etc. **M2** – absence of market investigations, superficiality in the planning of future strategies, absence of risk analysis, etc.

At first sight, the provided analysis of human shortcomings in quality management seems to be too bureaucratic but it opens the full spectre of everyday human faults and mistakes that may lead to very serious problems in case of coinciding events. While having a closer look at the trends extending over the whole quality assurance process, it is seen that communication faults are reducing with time. However, at the same time the faults due to negligence are dramatically growing reaching to half of all the shortcomings in the last phase. The main reason here seems to be a trend to ignore the procedures and standards. The competence level seems to be stable but the mistakes addressed into the future seem to form too big a share of all the shortcomings.

It is quite instructive to provide a comparative analysis of the reasons of human shortcomings in different areas of engineering activities in the quality context. In Fig 3 there are compared different data on human shortcomings analyzed by the research team during the last dozen years [5]. In the next column from the quality assurance one (QA) the results of human shortcomings in the design and production of a serial product – light fittings (LF) – are presented. The scope of this database is 5 years and more than 700 descriptions of human and technical shortcomings are analysed. In the third column the data on human shortcomings for the design and application of equipment control systems EA are presented where the experiences of 13,000 cases were analysed. In the last column the data on the design and commissioning process of factory automation (FA) are presented. The basis for the last column is the experience of applying 5 large factory automation systems.

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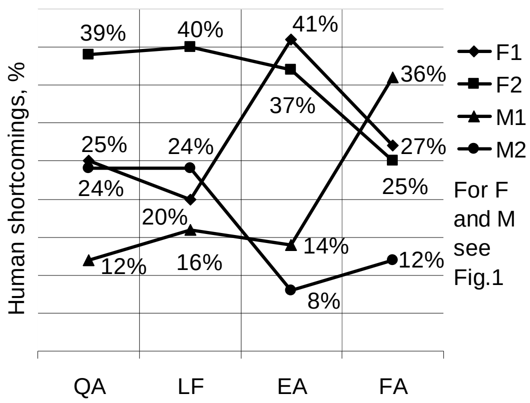

Fig. 3. Comparative analysis of human shortcomings.

As one can see the spectrum of human shortcomings in quality management is very close to real factory data that leads to the conviction about the universal nature of human shortcomings in a maturity company. However, in the area of equipment control the tasks are always varying and work so strenuous that the share of faults starts to dominate over the mistakes controlled by professionalism. In the more complicated area – factory automation – a lot of standard solutions are available and the share of faults is reducing but the role of mistakes **M2** is growing, as the prognosis of the processes character may appear to be wrong for the real conditions.

3. DEVELOPMENT OF THE SYNERGY-BASED TQM SUPPORT FRAMEWORK

The main goal of the search for the framework of quality assurance is to propose a framework helping to attain the maximum positive synergy of teamwork at the same time avoiding human shortcomings to prevent the growth of negative synergy. In any design and quality assurance process the main driving factor is the engineers with their experience, inherent faults-mistakes and competence. So, there is an obvious need to help the engineers to find a more optimal way to use their capabilities to avoid human shortcomings.
At first sight it seems that in case of quality assurance we have to choose between two classical ways – either the prescriptive/administrative or the descriptive/case-based approach. On the prescriptive/administrative side the results of the present research may be used to reduce human shortcomings, especially faults in human behaviour. The most important problem here is how to improve the synergy in teamwork to avoid the faults based on mutual communication. Nowadays information technology offers better on–line communication possibilities for dispersed teams and over time the share of this type of faults has to decrease. It is absolutely necessary to run a dated database so that all of the changes made in the systems would reach all of the people involved. It is possible to reduce most human casual negligence faults by checking the design process continuously using special design-checking tools, which help to uncover the most common deficiencies. At the same time it may be

appropriate to take unpopular measures to increase the responsibility of the personnel. On the mistakes side most of the problems are caused by lack of competence. To the newcomers in the production area it is recommended to rely more strongly on a consulting service in the beginning. Special attention must also be paid to the continuous upgrading of the personnel. It is most difficult to reduce the mistakes that occur due to the state of the used technology. At the same time these problems form a springboard for further research. The descriptive/case-based way is always useful if it is possible to find situations close enough to those in the company.

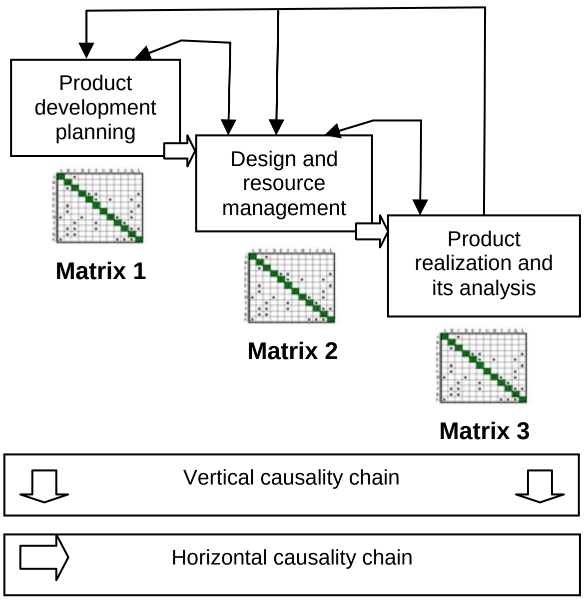

Fig. 4. The integrated model quality assurance

In fact, there should be an interactive and adaptive design environment between them. The successful separation of human and technical aspects at the design and application of systems automatization opens up new possibilities to move ahead on the way of the synergy-based approach to quality management. By integrating (see Fig.4) the technology of Design Structure Matrixes [4; 6] and the Theory of Domains [7] it is possible to involve time and competence dimensions in quality assurance. In other words, it is possible to develop a family of adaptive tools based on the level of competence and expert knowledge of the team and to synthesize their own roadmap algorithm to move ahead on the way of synergy-based integration [8]. The proposed model makes it possible to take into account both “soft“ parameters of integration – market conditions and human aspects. The synergy dimension is introduced to the DSM in the form of the evaluation of its integration power in parameters and processes on a 3-step scale [6]. The human shortcomings are introduced to the statistical probability evaluation of the time for iterations, reworks and learning.

A full exploitation of the possibilities of the proposed approach requires an experienced professional team and provides significant returns for a complicated system. The above-mentioned adaptive tools are developed for two levels: for the preparation stage of the certification and for the follow-up recertification. In reality it is necessary to compose 3 different matrixes (see Fig. 4) of different quality assurance activities. By using the mathematical tools [9] it is possible to schedule by levels the dispersed activities, grouping them into submatrixes of coupled tasks. Further it is possible to use the Latin Hypercube Sampling (LHS) and parallel discreet event simulation to incorporate the uncertainty of the expected duration of the tasks on three levels: optimistic, most likely or pessimistic.

It is highly qualified and time-consuming to compose a useful and suitable DSM matrix and this may be a great challenge to the team. Thus, simultaneous professional knowledge of product architecture, the product development process and organizational work is required. The low competence of the team results in an imperfect DSM where some important interactions may be absent or incorrectly evaluated.

4. CONCLUSIONS

It is shown that the quantitative characteristics of positive and negative synergy are suitable synergy and quality metrics for quality assurance systems. The synergy-based approach to TQM makes it possible to collect organisational parameters, market conditions and human factors under one umbrella. It is possible to develop adaptive tools based on the level of competence and expert knowledge in the company to synthesize their own roadmap algorithm to move ahead on the way of the synergy-based TQM. In such a way a suitable basis is developed to speed up the integration of still somewhat disunited quality assurance of a new product and organisational quality assessment and certification systems.

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6. ACKNOWLEDGEMENTS

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