Highlights of Russian experience in implementing ISO/TS 16949

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Abstract. The development and implementation of the enterprise management system in automotive industry based on technical specification ISO/TS 16949 is a rather complicated task for many production enterprises. Apart from a great number of various requirements to all stages of product lifecycle the specification embraces a big set of indispensable competences, and the lack of them makes it practically impossible to implement successfully the production management system. The article reviews the results of modeling the automotive enterprise management system based on the pyramid of competencies and programmed information support of product life cycle illustrated by new products and processes development and design stages.

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Introduction

The current development of automotive industry is closely connected with implementation of the international quality standard ISO/TS 16949, as well as with multiple additional specific requirements of automotive manufacturers. The standard implementation started at the end of 1990s worldwide. The second birth of the standard began in 2002 with publishing the version based on ISO 9001-2000. Nowadays the topicality of its application does not decline, quite the contrary, it grows up.

The problems of implementing this standard were covered in numerous researches and reviews, in Russia as well. In the beginning of 2000s the majority of experts conducted comparative assessments and analysis of the standard [1, 2], and described the experience of ISO/TS 16949 development and implementation at production enterprises. It is worth mentioning here the book describing the experience of developing and implementing the quality system at AVTOVAZ [3], and numerous articles generalizing the experience of enterprises and consultants, like the articles in Russian journals "Standards and Quality", "Quality Management Methods" and others. During the last 5 to 6 years more and more researches have been published containing assessments and studies of the ways to increase the efficiency of implementing ISO/TS 16949 [4, 5], and of resources conservation in implementing ISO/TS 16949 [6], studies on the benefits of joint application of ISO/TS 16949 and various improvement methods, like, for instance, "six sigma" [7], studies on the sufficiency of ISO/TS 16949 requirements for enterprise development [8], etc.

In Russia intensive implementation of ISO/TS 16949 began about ten years ago. Nonetheless, it has never produced any qualitative leap in the enterprise management efficiency, and more and more Russian suppliers face problems in obtaining orders from leading automotive manufacturers operating both in Russia and abroad.

On the one hand it is caused by the continuous growth of automotive producers' requirements, and mostly in regard to the quality of auto components at that. The suppliers are required to work in strict compliance with ISO/TS 16949, as well as with a number of specific requirements as defined by automotive manufacturers.

On the other hand the practical situation shows that a great number of companies having obtained the cherished certificate of conformity to ISO/TS 16949 requirements do not fully employ the potential of their quality management system (QMS) but just try to maintain the minimum required level in order to pass the inspection audits and recertification process.

Analysis of the causes

Why does it happen? We believe there is a number of reasons. The basic one is insufficient competence level among the employees of auto component suppliers. The problems arising with these enterprises at the stage of introducing the management system in compliance with ISO/TS 16949 requirements as well as at the stage of its development are substantially dependent on the general competence level of their employees, and particularly in the field of design, technology and management, including the quality managers. Implementing the quality system in compliance with ISO/TS 16949 is unconditionally essential for the enterprise, but all enterprises are different in their level of development at the start of restructuring their QMS. It so happened that by the time ISO 9001-2000 was adopted the Russian producer’s experienced substantial deficiencies in the competence of their engineering specialists in the field of quality management systems and methods, since they employed here mostly the specialists of quality services. The requirements of ISO/TS 16949-2002 issued a bit later substantially exceeded the requirements of ISO 9001-2000. Not all the companies managed to estimate the risks after adopting the ISO 9001-2000 version in their attempt to readjust their QMS for compliance with ISO/TS 16949-2002 requirements. It can be asserted that the requirements of ISO/TS 16949 are, so to say, just the top of an iceberg, the visible and obvious part of requirements to quality management systems in automotive industry. Within these requirements there are multiple references to various methods of ensuring quality and directed to defects prevention at all product lifecycle stages. Without correct and total application of these methods it is impossible to reach the target function of stable and high product quality. Each of these methods integrates its own requirements, application practices and rules causing the need of studying allied sciences.

Knowledge base

The structure of competences (knowledge and skills) in quality management system in automotive industry may be presented in the form of a pyramid (Fig.1).

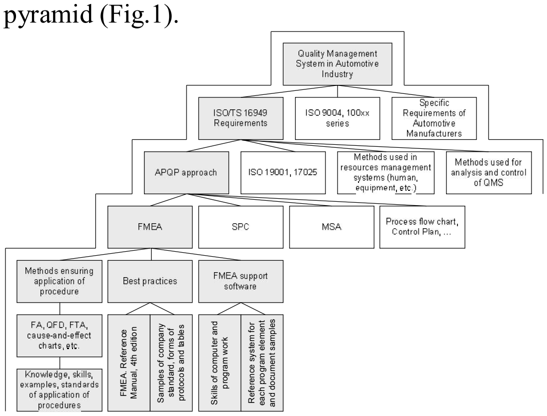

Fig.1. Pyramid of competences of QMS in automotive industry (fragment)

The fragment of the pyramid shown in Fig. 1 represents only part of the competences defining the methods of quality management. Each standard requirement needs explanations and comments as well as the presentation of best practices with the purpose of successful implementation and consequent application at the enterprise. Availability of these materials would allow the enterprise to assimilate much faster all necessary methods and more efficiently use them in future, and successfully support and develop the quality system. Those materials compile the basis for the "Knowledge Base" of the enterprise. However, the problem was that at the moment of ISO/TS 16949 appearance no one possessed such selection of materials, and even now only the disembodied elements exist, although similar works are under way in the world, for instance [9].

The stage of development and design of products and processes is full of various methods and therefore of competences, that is why this stage is most complicated in regard to the scope and depth of requirements to it. The basis for this stage lies in the approach stipulated in Section 7 and 8 of ISO/TS 16949, which every automotive manufacturer execute in their own way. For instance, the widely spread APQP system (Advanced Product Quality Planning) is recommended by a number of automotive manufacturers. GM and FORD issued their own supplements to the system. The alliance of RENAULT-NISSAN-AVTOVAZ employ a joint new product quality procedure – ANPQP (Alliance New Product Quality Procedure). The effectiveness of these approaches is beyond any doubt, it is implicitly confirmed by market success of these companies and by direct researches of experts, like, for instance, in [10].

APQP process embrace 5 stages executed in a serial-parallel way. The basic objectives of these stages and their reflection in ISO/TS 16949 paragraphs are presented in Table 1.

Table 1. Target functions of APQP and their compliance with ISO/TS 16949

Stage	Stage Objective	ISO/TS 16949 paragraphs
Stage 1 – Planning, development of concept and quality program	Provision of clear understanding of customer requirements and expectations.	7.1, 7.2.1-7.2.2, 7.3.1
Stage 2 – Product design and development	Comprehensive analysis of product design (prototype) and feasibility of development.	7.3.2 – 7.3.4, 7.3.7
Stage 3 – Processes design and development	Design and development of efficient production system ensuring the fulfillment of customer requirements and expectations.	7.3.2 – 7.3.4, 7.3.7
Stage 4 – Final preproduction (product and process validation)	Confirmation that product and process meet customer requirements prior to serial production startup.	7.3.5, 7.3.6, 8.2.3.1
Stage 5 – Production and continuous improvement actions	Product and processes quality support and continuous improvement.	7.5, 7.6, 8

The main thing in APQP is to direct all efforts to increase the efficiency of work in the area of quality. It can be reached by the following: coordinated and well organized serial-parallel activities of the units involved in product and processes development and preproduction, consistent and correct application of relevant methods of prevention, detection and elimination of problems at each stage (DFMEA – Design Failure Mode and Effects Analysis, PFMEA – Process Failure Mode and Effects Analysis, MSA – Measurement System Analysis, SPC – Statistical process control, etc.).

The priority here belongs to the proper organization of all design work and the high level of competences in employing methods of quality management. To reach the required competence level of the specialists it is essential to ensure the development of information technology (IT) in quality management. The software integrating the set of quality provision methods and the data base containing rank-ordered and easily accessible "Knowledge Base" is the most important element of any quality management system. To create such bundled software is quite a complicated task, and that is why the market offers a limited number of appropriate software packages, although certain elements have been used for a long time, for instance, the article [11] described full monitoring of production system based on SPC and logical methods.

Information technologies for quality control methods

In order to illustrate the importance of software support we will consider the saturation of APQP process with various methods and approaches. Within the scope of the system it is necessary to create a great number of documents referring to product and process development. These documents are quite hard and laborious to compile without employing the most up-to-date IT systems.

The demand for this or that software depends on a few factors defining the availability of: Russian (national) language interface, reference system on methodology, examples and samples of method application, edit ability for outputs (reports, protocols) for consumer needs, reasonable purchase cost and upgrade possibility.

As an example we will consider special-purpose IT systems offered by the market that can be applied within the scope of APQP (Table 2).

Table 2. Special-purpose IT systems for APQP tasks implementation

IT Systems	ISO/TS 16949 Methods	Performance Capabilities
Attestator	SPC, MSA	Analysis of condition and capabilities of technological and other processes using SPC methods (control charts, indices, histograms), MSA.
Minitab 16	SPC, MSA	Just a huge selection of various modules, from simple statistic assessments, analysis of variations, statistical process control, charts to experiment planning.
Quality Companion 3	FMEA, APQP	Big collection of software for product and process design, from the same producer as of Minitab 16.
QiBox	SPC, MSA, FMEA, APQP, ANPQP, PPAP	A single concept envelops all utilities required to meet the requirements of ISO/TS 16949 and tools for project management in compliance with new product quality management procedures.
STATISTICA Quality Control	SPC, MSA	Allow for performance of all technical stages of quality control and analysis of technological processes, planning production process experiments.
Wonderware QI Analyst Software	SPC	Real-time network SPC system, allows for application of all SPC toolbox and store information into the data base, and perform any type of reports.
Q-DAS	SPC, MSA	solara – MSA; procella – SPC; qs-STAT – process assessment; destra – statistics software package with multiple methods of statistical analysis
Windchill Quality Solutions Products	FMEA	Software comprising a program bar for analysis of reliability and risk management, that can be integrated into one system (FTA, etc.).
Xfmea	FMEA	Program facilitates data control and creating reports for all types of FMEA, also part of a quite large collection of programs for reliability analysis and risk management.
Byteworx FMEA Software with Control Plan	FMEA, Control Plan	For FMEA support, compatible with all standards, processes a built-in intelligent assistance system, data base for storing reference and supporting documents.

Model of enterprise development

More detailed demonstration of competences and software required for quality management system support at the enterprise can be seen in the quality loop (Fig. 2), demonstrating interrelation of product lifecycle stages. It is thoroughly demonstrated in corresponding paragraphs of ISO/TS 16949.

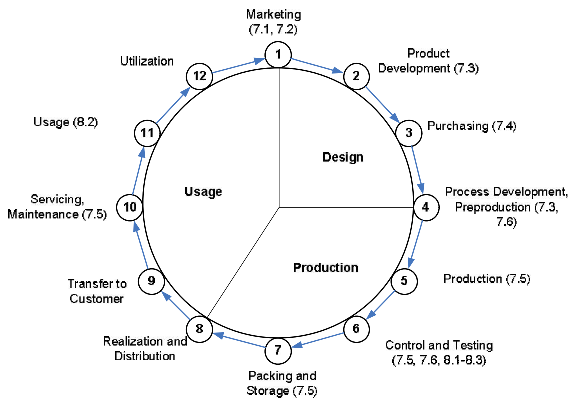

Fig. 2. Quality Loop

However, the chart shown in Fig. 2 is static, but it is the dynamics that is defining many marketing strategies of automotive manufacturers lying in improvement of generic (base) models or platforms. Thus, a much fuller concept of development model for any product can be presented in the form of 'quality helix' (Fig. 3), where the degree of product improvement is a step, and the helix will emerge due to customer satisfaction, i.e. the higher it is, the longer is the helix, which means the longer is the market life of the automobile.

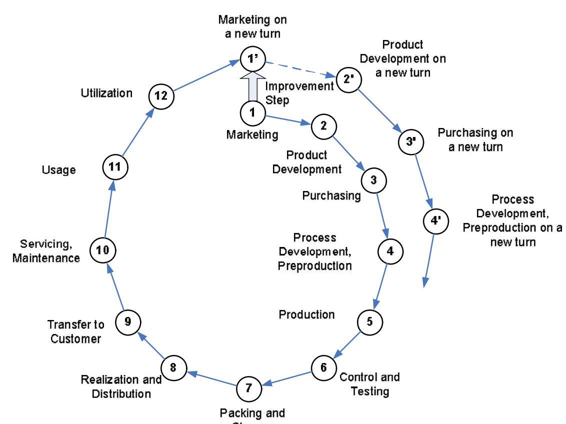

Fig. 3. Quality Helix

It is very important to differentiate the product development and the enterprise management system development. The development of the system depends on development of its integral elements, as well as of the interaction and control components. Product development is possible within the invariable system, so it is significant to obtain a new product as a result of developing the design, production, control and realization systems. Ideally the development of both the product and the system should move in parallel complementing one another, as a result we get a permanently upgrading innovative product, and that means outstripping market demand and maintaining a high level of company competitiveness.

Each element of the quality helix may be developed independently, i.e. their levels of development may vary to a big extent, or may not develop at all. Irregularity of elements development would tell on the general product development. The degree of development of separate elements in the quality loop and of the product itself may be assessed with the score point system and a radar chart.

Most variations take place at the stage of production being the longest stage and most invested – into new personnel, equipment, accessories and tools. Less variations are at the design stage, but it is usually rather short compared to production and the changes here are rare although they are often more complex being quite labour intensive and high-tech.

Information support system

Every stage of product or service lifecycle is accompanied by diverse information circulating both inside the organization, between its divisions, and outside, between the company's suppliers and consumers, and also other interested parties.

On the other hand, the information penetrates the whole system of organization management within the framework of quality, environmental and labour safety management subsystems, as well as other traditional subsystems – engineering, financial, legal and others. Advanced organizations do their best to obtain and possess IT systems in order to support the abovementioned subsystems. At the same time it is worth mentioning that most advanced and accessible IT systems are financial management, legal data and production management systems. The IT systems to support quality management and the like are not so widely spread.

Considering the above the task of widening the element base of quality spiral gains currency. The structure shown in Fig. 3 has to be supplemented with component software to support product and system development.

The information about the system and the product circulates in all processes and at all lifecycle stages. As a result we get one more quality loop that might be called an information loop. Both loops are integrated forming a dual structure. When we present the organization development model taking into account the product development and the program information support, we obtain the organization development code. Such codes may pose the basis for standardization and become the foundation for future standards.

Starting from the 2000s the big corporations involved in software development have been marketing IT systems providing information support of product lifecycle. We are talking about Product Lifecycle Management (PLM) technology. PLM may be called the information strategy of system unification. At present the systems of Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Supply Chain Management (SCM), Product Data Management (PDM) and Production Process Management operate jointly by means of Product Lifecycle Management (PLM) system.

The examples of these systems may be found among Oracle PLM; Autodesk PLM 360; Siemens PLM Software Products; LOCMAN:PLM (ASCON); Alfa (Informkontakt), etc.

In recent years the developments and researches in the field of PLM have been conducted on a large scale. In mid-2000s a number of specialists [12] conducted researches of PLM systems linking them to knowledge management systems at the enterprise. And [13] studied and described the conceptual basis of the product lifecycle IT model. In [14] the authors offered a new concept of building up a PLM system ensuring interaction of diverse systems and complex information management in product design and production. A more complete analysis of PLM systems application from the point of view of quality standards is described in [15]. A detailed review of literature regarding PLM is presented in [16].

In recent years more flexible PLM systems have been researched and developed embracing maximum allowable amount of functions and stages in enterprise management [17].

However, it is worth mentioning that not all lifecycle stages are provided with PLM information support in full measure. Namely, the methods mentioned in Table 1 are not executed in the software, but PLM systems are rapidly developing and very soon they are expected to possess the required support. Even now we can see the PLM+ systems supporting project management, resource planning, circulation of engineering and office documents, dynamic scheduling, etc. Gradually the systems will embrace all sorts of activities (QMS processes) and the system development specialists will lack competences in the field of management, particularly in quality management.

Conclusions

Hence the profound competences required for development and execution of QMS in automotive industry, as well as the realization of up-to-date development modules using appropriate IT software complexes would allow the production enterprises to develop, implement and support their management systems in appropriate condition. At the same time, special attention should be paid to prevailing informatization, which is bound to become the work strategy.

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References

1. Kartha, C.P., 2004. A comparison of ISO 9000:2000 quality system standards, QS 9000, ISO/TS 16949 and Baldrige criteria. The TQM Magazine, 16(5): 331-340.
2. Cassel, M., 2006. ISO/TS 16949 – Qualitätsmanagement in der Automobilindustrie umsetzen. Germany: Carl Hanser Verlag GmbH & Co. KG, pp: 363.
3. Godlevskiy, V.E. and G.L. Yunak, 2005. Quality management in automotive industry. Samara: Academic engineering center Inc., pp: 628.
4. Pai, F.-Y. and T.-M. Yeh, 2013. Effective implementation for introducing ISO/TS 16949 in semiconductor manufacturing industries. Total Quality Management & Business Excellence, 24(3-4): 462-478.
5. Ostadi, B., M. Aghdasi and R.B. Kazemzadeh, 2010. The impact of ISO/TS 16949 on automotive industries and created organizational capabilities from its implementation. Journal of Industrial Engineering and Management, 3(3): 494-511.
6. Yeh, T.-M., F.-Y. Pai and K.-I. Huang, 2013. The critical factors for implementing the quality system of ISO/TS 16949 in automobile parts industry in Taiwan. Total Quality Management & Business Excellence, 24(3-4): 355-373.
7. Liu, Ch.-H., 2009. Effect of ISO/TS 16949 on Six Sigma: The empirical case of Taiwanese automobile and related industries. Total Quality Management & Business Excellence, 20(11): 1229-1245.
8. Panyukov, D.I., 2008. Is it enough for the enterprise conform to the requirements of ISO/TS 16949 standard for competitiveness in the market for auto components? Proceedings of the Samara Scientific Center of Russian Academy of Science, S8: 94-100.
9. Wang, K.-J., V.-Sh. Jha, D.-Ch. Gong, T.C. Hou and Ch.-Ch. Chiu, 2010. Agent-based

knowledge management system with APQP: implementation of semiconductor manufacturing services industry. International Journal of Production Research, 48(10): 2913-2936.

10. Mittal, K., P. Kaushik and D. Khanduja, 2012. Evidence of APQP in quality improvement: An SME case study Evidence of APQP in quality improvement: An SME case study. International Journal of Management Science and Engineering Management, 7(1): 20-28.
11. Yacout, S., N. Rezg and F. Sylvestre, 2001. Implementation of a computer-based monitoring loop for quality control of production systems. Quality Engineering, 13(3): 399-409.
12. Ameri, F. and D. Dutta, 2005. Product Lifecycle Management: Closing the Knowledge Loops. Computer-Aided Design and Applications, 2(5): 577-590.
13. Shu, Q. and C. Wang, 2007. A conceptual framework for product lifecycle modelling. Enterprise Information Systems, 1(3): 353-363.
14. Kim, G.Y., J.Y. Lee, H.S. Kang and S.D. Noh, 2010. Digital Factory Wizard: an integrated system for concurrent digital engineering in product lifecycle management. International Journal of Computer Integrated Manufacturing, 23(11): 1028-1045.
15. Taisch, M., B.P. Cammarino and J. Cassina, 2011. Life cycle data management: first step towards a new product lifecycle management standard. International Journal of Computer Integrated Manufacturing, 24(12): 1117-1135.
16. Gecevska, V., P. Chiabert, Z. Anisic, F. Lombardi and F. Cus, 2010. Product lifecycle management through innovative and competitive business environment. Journal of Industrial Engineering and Management, 3(2): 323-336.
17. Hachani, S., L. Gzara and H. Verjus, 2013. service-oriented approach for flexible process support within enterprises: application on PLM systems. Enterprise Information Systems, 7(1): 79-99.

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