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ASPECT OF QUALITY IN CA SYSTEMS

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ABSTRACT
The paper deals with aspect of quality in computer support in production engineering and computer aided systems. There are a lot of methods and approaches belonging to quality area and to quality consideration. Beside individual CAQ systems it is possible to meet with many of methods extending the CA systems with quality aspects.
Keywords: CA systems, CAQ, quality, quality methods, quality techniques

1. INTRODUCTION

Economic pressures urge manufacturers to make more customised products of high quality, in smaller series, with shorter lead time and of course, without increased costs. Time is becoming rapidly the most strategic topic of companies. Costs are also important, more important are competitive price and the most significant are marketability of manufactured products.
In the manufacturing industry it is commonly stated that "Quality drives productivity". Improved productivity is a source of greater revenues, employment opportunities and technological advances. Most discussions of quality refer to a finished part, wherever it is in the process. Inspection, which is what quality insurance usually means, is historical, since the work is done. The best way to think about quality is in process control. If the process is under control, inspection is not necessary.
Therefore it is necessary to interest in quality aspects of all activities in framework of product lifecycle.

2. QUALITY

Quality has no specific meaning unless related to a specific function and object. Quality is a perceptual, conditional and somewhat subjective attribute.
Almost any productive organization mentions quality as one of its goals. On the face of it, organizations understand that releasing a high-quality product is the best strategy both for the short term and for the long term. Focusing on the quality of the product has an impact on the organization's reputation. At the same time it can help the organization save time and money in the long run, when developing new products and supporting old ones. The immediate result of the acknowledgment in the need to promote quality is introducing quality control (QC) elements to the development process.
There are many methods which can extend and continual improve CA systems in point of quality view. The next methods and technique are very popular and useful: SPC, Zero

Defects, Six Sigma, TQM, Theory of Constraints, Quality Management Systems, FMEA, tolerance analysis, standards ISO 9000, ISO 14000, etc.

3. COMPUTER AIDED SYSTEMS

Computer Aided (CA) known such as CAx is a summary term for various kinds of computer support and computer aided systems and technologies in area of design, analysis, process and production planning, scheduling, production, assembly, logistic etc. We can meet with the CAx in all activities in framework of product lifecycle. Several CA systems are essential for computer integrated manufacturing (CIM). The following CA systems present a backbone of computer integrated enterprise:

- CAD – Computer Aided Design,
- CAPP – Computer Aided Process Planning,
- CAM – Computer Aided Manufacturing,
- PPS – Production Planning Systems,
- CAQ – Computer Aided Quality.

This scheme is several years old and it presents CAx in the CIM concept. Current look on CIM is also based on this backbone, however it is extended with many of others CA systems supported logistics, testing, assembly, etc.

The modern CA systems and their integration are based on the following methods and concepts:

- Flexible manufacturing systems (FMS),
- Material/Manufacturing Resource Planning system (MRP, MRPII),
- Manufacturing Process Management (MPM),
- Enterprise resource planning (ERS),
- Direct Numerical Control (DNC),
- Product/Process/ Data /Development/ Management system (PDM, PDM II),
- Product Lifecycle Management (PLM),
- Quality Management System (QMS),
- Virtual and Rapid Prototyping.

QMS can be defined as set of policies, processes and procedures required for planning and execution (production, development, service) in their core business area of an organization. QMS integrates the various internal processes within the organization and intends to provide a process approach for project execution. QMS enables the organizations to identify, measure, control and improve the various core business processes that will ultimately lead to improved business performance.

4. VIEW ON THE COMPUTER AIDED QUALITY

CAQ is one of important and essential components of the CIM concept. It is possible to meet with computer support in quality in the following areas:

- CAQ as individual and separate CA system – systems especially based on mathematical and statistical methods and on the SPC methods, evaluating and prediction;
- CAQ as a module in some CA system – for example: module of tolerance analysis in CAD systems or measurement planning in CAPP system;

- CAQ as hardware - Coordinate-measuring machine with computer control and data processing;
- CAQ as mathematical methods – SPC: it is a method for achieving quality control in manufacturing processes. It employs control charts to detect whether the process observed is under control. Statistical process control uses statistical tools to observe the performance of the production line to predict significant deviations that may result in rejected products;
- CAQ as analysis methods – FMEA: it is a method that examines potential failures in products or processes. It may be used to evaluate risk management priorities for mitigating known threat-vulnerabilities;
- CAQ as norm: tolerancing: tolerance in engineering is the permissible limit of variation in a dimension or value of a parameter of a manufactured object;
- CAQ as part of quality strategy - Total Quality Management. It is a management strategy aimed at embedding awareness of quality in all organizational processes. Total quality provides an umbrella under which everyone in the organization can strive and create customer satisfaction. TQM is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction;
- CAQ as planning activity - Advance Product Quality Planning: APQP is a framework of procedures and techniques used to develop products in industry. It is a defined process for a product development system for factort /especially for automotive industry/ and their suppliers. APQP is to produce a product quality plan which will support development of a product or service that will satisfy the customer;
- CAQ as support for implementation of international standards - ISO 9001, ISO 14001, QS 9000, TS 16949.

Quality assurance ensured by computerized planning and monitoring and control of processes, parts and products throughout all phases of the product life cycle. Computer-aided quality assurance includes a quality report system from design to field performance and from shop floor to management.
Computer-aided quality assurance is the engineering application of computers and computer controlled machines for the definition and inspection of the quality of products.

5. QUALITY ASPECT IN CA SYSTEMS

It is unmistakable that quality is not separated area with local computerized support. Quality is idea how to improve satisfaction of customer. As there is influence on quality in all activities in framework of product lifecycle, therefore it is possible to meet with CAQ in all phases and areas such as product development, design, planning, scheduling, manufacturing, assembly and testing.
Next will be described very famous and important methods which are possible to meet in various CA systems. They provide tools for solving quality aspect especially in pre-production area.

5.1 Failure mode and effects analysis

The FMEA method is an analytical technique to ensure potential problems have been considered and addressed at both the design and process stage. It is a method that examines potential failures in products or processes. It is important method to evaluate risk management priorities for mitigating known threat-vulnerabilities.

FMEA helps select remedial actions that reduce cumulative impacts of life-cycle consequences (risks) from a systems failure (fault).
By adapting hazard tree analysis to facilitate visual learning, this method illustrates connections between multiple contributing causes and cumulative (life-cycle) consequences.
It is used in many formal quality systems such as QS-9000 or ISO/TS 16949.
The basic process is to take a description of the parts of a system, and list the consequences if each part fails. FMEA is most commonly applied but not limited to design (Design FMEA) and manufacturing processes (Process FMEA).

Design failure modes effects analysis (DFMEA) identifies potential failures of a design before they occur. DFMEA then goes on to establish the potential effects of the failures, their cause, how often and when they might occur and their potential seriousness.

Process failure modes effects analysis (PFMEA) is a systemized group of activities intended to:

- recognize and evaluate the potential failure of a product and process and its effect,
- identify actions which could eliminate or reduce the occurrence, or improve detectability,
- document the process,
- track changes to process-incorporated to avoid potential failures.

FMEA Analysis is very important for dynamic positioning systems.

The following software belong to known FMEA tools:

- ASENT FMEA Software - Raytheon's premiere Reliability and Maintainability tool suite. Includes a very powerful FMECA tool that combines FMECA, RCM Analysis and Testability Analysis,
- Byteworx - Powerful, cost-effective software for Failure Mode and Effects Analysis,
- FMEA-Pro - FMEA / FMECA software from Dyadem. An all-in-one software solution that provides corporate consistency and assists with corporate compliance,
- Isograph Software - Their Reliability Workbench contains a FMEA / FMECA tool,
- Item Software - FMEA/FMECA/FMEDA - Failure Mode Effects Analysis tool,
- Quality Plus - FMEA software from Harpco Systems,
- Relex Software - Offers FMEA tools & FMEA software with FMEA method to process FMEA and meet all functional FMEA standards for criticality matrix,
- XFMEA - FMEA software from ReliaSoft. Provides expert support for all types of FMEA.

5.2 Tolerance analysis

Tolerance analysis is one of the most important problems in the Computer aided process planning (CAPP) systems. The process planning deals with the selection of the processes and the determination of the process conditions. Selected operations and conditions have to be realised in order to transform raw material into a given shape. By reason that the machined part must fulfil the qualitative requirements, the tolerance analysis for the automated process planning is very important and needful.

5.2.1 Meaning of process planning for product quality

The aim of process planning is to convert the design specification into manufacturing instructions and to make products within the function and quality specification at the lowest

costs. The process planning activity has traditionally been experience based and has been performed manually. The CAPP is utilising the power of a computer to emulate the capabilities of an experienced planner.

Input for CAPP is a design drawing that involves:

- nominal geometry,
- tolerances,
- material and material properties,
- other performance specifications.

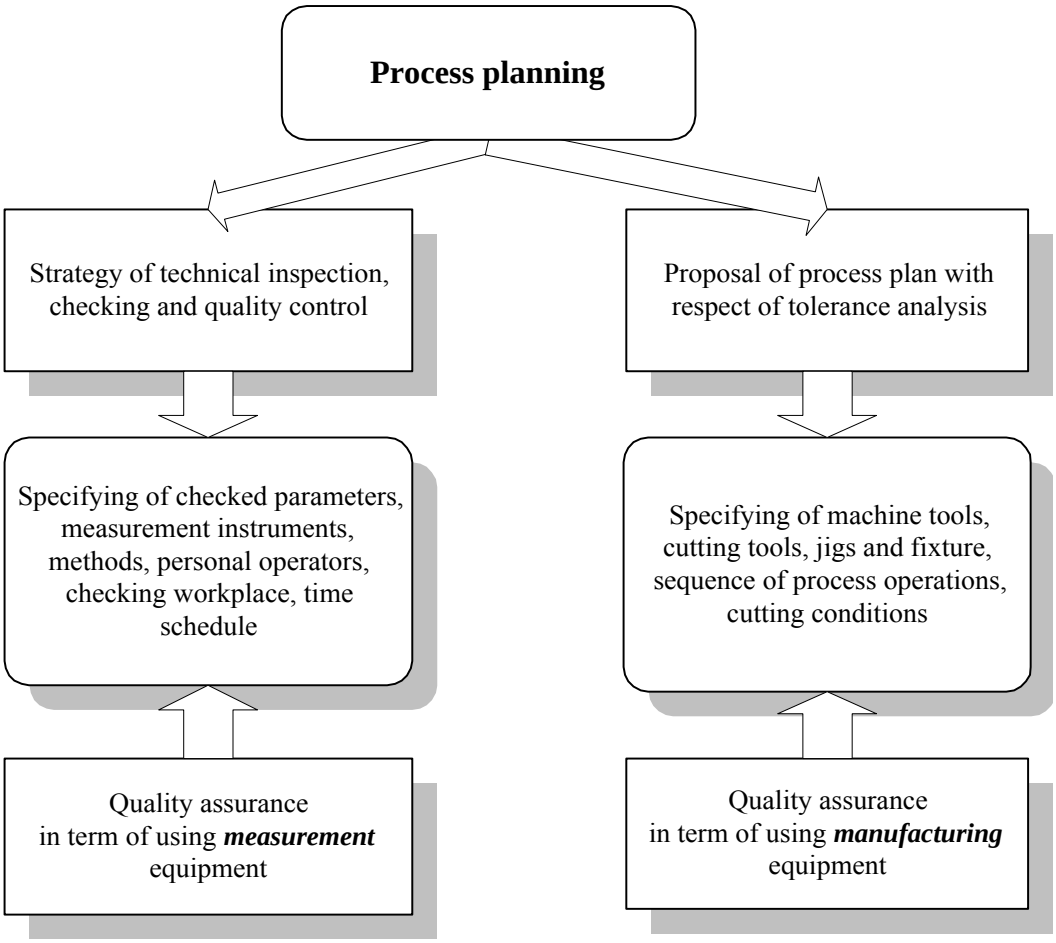

Figure 1: Measurement and manufacturing aspect in process planning

The process planning task is to convert the mentioned requirements to the instructions for manufacturing. Tolerances from the design drawing are dimensions on the final product. Final shapes and dimensions of the product come into existence during semi-finished part. Each of semi-finished parts can be manufactured in various levels of precision. As there is a heredity of properties, high precision of the final part must be take into consideration in previous semi-finished states of part. A good selection of machine equipment is not only way to performance of a required product quality. The selection of order of used machine equipment has also a great meaning for quality. The order of manufactured features on part has also a major significance. There is effort to manufacture the part with the smallest number of change of clamping. An ideal case consists of one clamping of the part and in realising of manufacturing at once. The selection of design features that are manufactured at

the same clamping and determining the sequencing of these manufactured features at the same clamping are consequently very important.

5.2.2 Meaning of tolerance analysis for computer aided process planning

Tolerance information and specifications from a design model should be used for selection of appropriate processes, machine equipment, cutting tools, fixture, manufacturing data and cutting conditions. Generally the CAPP system generates the process plan considering only shape and nominal dimensions. Economy and accuracy of production can be greatly improved using specified manufacturing dimension for positioning purpose. Afterwards it is possible to use for appropriate manufacturing part dimension less accurate machine tools. Alternatively with the same machine accuracy, products are made to closer tolerances. It will improve quality and product performance.

6. CONSLUSION

Quality control and quality engineering are involved in developing systems to ensure products or services. They are designed and produced to meet or exceed customer requirements. The quality is necessary to control and provide. It is possible to meet with separated CAQ systems with implemented SPC methods or with separated CAQ modules implemented in individual CAx system. Each of individual activities in framework of lifecycle needs individual approach. Therefore there are several quality methods implemented in various CAx systems. Consistent knowledge about these methods are assumption for quality control.

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