DIRECTIONS FOR SOFTWARE SUPPLIERS AND/OR CUSTOMERS APPLYING THE ISO 9001:2000 STANDARD. SELECTED ASPECTS OF PLANNING

Dr Karol Chrabański
The General Jerzy Ziętek Silesian Higher School of Management
in Katowice
ul. Francuska 14, Tel.: 603-977-445
e-mail :chrabanski@omi4.net, www.chrabanski.omi.pl

SUMMARY

The paper focuses on the issues of defining directions for software suppliers and/or customers applying the international ISO 9001:2000 software. Such directions can be found in the ISO/IEC 90003 standard. The whole question has been confined merely to the subject area of planning, with a particular attention paid to the product and process quality planning.

1. INTRODUCTION

The significance of good quality software for products equipped with that software or for organizations applying the software to support their functioning is unquestionable and indisputable – irrespective of the details related to the comprehension of the term "quality". It seems that especially planning processes are of fundamental importance for software suppliers and customers since they actually precede any activities taken. Correct planning contributes to the effectiveness of those activities and to their economic efficiency.

2. A "MAP" OF PLANNING ISSUES

The planning process is in a way "directly" referred to in numerous sections of ISO 9001:2000. When the standard structure is considered in the following two systems:

a) first – sections and subsections actually occurring, and
b) second – semantic understanding of the contents of individual sections and subsections, which in practice leads to separation of the following elements provided that they actually occur:
   - postulate
   - mode of postulate realization
   - other elements

then a specific "map" of the issues related to planning can be defined. For the time being, the aforesaid "map" does not hold good for such product as software since the ISO 9001:2000 standard is universal and inlcludes requirements addressed to quality management systems. The analysis of the "map" leads to the following conclusions at the present stage of consideration:

1. Only some sections of the ISO 9001:2000 standard refer to the subject area of planning.
2. When a semantic interpretation of individual sections of the standard is considered, it appears that only two standard sections include a complete set of types of contents (postulate, proposed mode of postulate realization, additional recommendations, if any, regarding the mode of postulate realization). This observation concerns the following sections of the standard:

a) planning of product realization – section 7.1,
b) design and development planning – section 7.3.1,

3. Other sections of the ISO 9001:2000 related to the subject matter of planning emphasise selected types of contents. They present:
   a) a combination of a postulate and a proposed mode of its realization as in the case of the following sections of the standard:

- design and development verification – section 7.3.5
- design and development validation – section 7.3.6
- control of production and service provision – section 7.5.1
- internal audit – section 8.2.2
- monitoring and measurement of processes – section 8.2.3

b) separate, individual types of contents, e.g. related to the proposed mode of postulate realization. This requirement is, for instance, fulfilled by the following sections of the standard:
   - general requirements – section 4.1
   - general – section 4.2.1
   - quality management system planning – section 5.4.2
   - monitoring and measurement of products – section 8.2.4

c) separate, individual contents, e.g. concerning the postulate. This requirement is fulfilled only by section 8.1 – "Measurement, analysis and improvement. General".

In February 2004, international standard ISO/IEC 90003 with the following title was issued for the first time: "Software engineering – Guidelines for the application of ISO 9001:2000 to computer software". The above standard provides guidance for organizations in the application of ISO 9001:2000 to the acquisition, supply, development and maintenance of computer software. The standard was prepared by Joint Technical Committee ISO/IEC JTC 1, Information Technology, Subcommittee S.C. 7, Software and System Engineering. The application of this international standard is appropriate to the software that is:

1. A part of a commercial contract with another organization;
2. A product available for a market sector;
3. Used to support the processes of an organization;
4. Embedded in a hardware product;
5. Related to software services.

Additionally, the following issues should be kept in mind while applying ISO/IEC 90003:

1. The standard defines problems that must be dealt with, irrespective of technology, life cycle models, development processes, sequence of actions and organizational structure as applied in an organization.
2. The guidelines presented in the standard together with a register of problems identified are supposed to be possibly complete, though not exhaustive.
3. In the cases where the scope of the organization's activities includes other areas than computer software development, the mutual relationships between elements of the organization's quality management system pertaining to computer software and the remaining aspects should be clearly documented within the framework of the quality management system as a whole.
4. Clauses (standard sections) 4, 5, 6 as well as a part of clause 8 of ISO 9001:2000 concern mainly the "global" level in the organization, though they also have some impact on the "project/product" level. Within the framework of each design or product developed, related parts of the quality management system can be adjusted so that they comply with the requirements specific for each project/product.
5. In the contents of ISO 9001:2000, the future tense is used to express a provision that is binding in relations between two or a greater number of parties, whereas the word "should" expresses a recommendation as regards selection between various options and the word "can" indicates a direction of admissible actions within the framework of limitations imposed by ISO 9001:2000. In the ISO/IEC 90003 standard, words "should" and "can" are interpreted analogously as in the case of ISO 9001:2000.

The analysis of ISO 9001:2000, carried out previously from the point of view of issues related to software quality planning, will now be supplemented with the recommendations provided in ISO/IEC 90003. The so obtained "imposition" of software quality related issues on the map of the quality subject area leads to the following conclusions:

1. Recommendations related to software quality planning are correlated to the guidelines of ISO 9001:2000 in the semantic part of the model, this part being defined in the enclosed table as "execution method".
2. Planning issues not referred to in ISO 9001:2000, section 7.5.3: "Identification and traceability", can be found in the detailed expansion of standard ISO 90003

The whole of the issues discussed above is included in Figure no. 1 that presents a map of problems related to quality planning in the context of requirements and recommendations of standards ISO 9001:2000 and ISO/IEC 90003.
In the above standards concerning quality management systems, planning processes are emphasised in at least two aspects:

1. Attainment of planned results
2. Continuous improvement of processes that allow to achieve the planned results

However, prior to making an effort of improving the aforesaid processes, each organization, in accordance with section 4.1 – "General requirements", should:

1. Intensify the processes acknowledged to be needed for the quality management system, including the processes of development, operation and maintenance of software;
2. Determine the sequence and interaction of these processes. Additionally, with regard to software – the sequence and iteration of processes in life cycle models needed for its development (e.g. waterfall model, incremental model, evolutionary model). It is recommended that the sequence and iteration of processes in quality and development planning, as based on a life cycle model, be defined. It is assumed that the life cycle model is a structure comprising processes, actions and tasks that are in the scope of development, operation and maintenance. The time scope of the structure includes the system life period from the moment of defining its requirements to the end of use;
3. Determine criteria and methods needed to ensure that both the operation and control of theses processes are effective;
4. Ensure the availability of resources and information necessary to support the operation and monitoring of these processes;
5. Monitor, measure and analyse these processes, and
6. Implement actions necessary to achieve planned results and to improve continually these processes.

Quality management systems define the requirements related to the documentation prepared (see section 4.2 "Documentation requirements" and section 4.2.1 "General"). The requirements should be understood as the documents the quality management system must contain (documented statements of quality policy and quality objectives, a quality manual, procedures and records required) as well as documents needed by the organization to ensure the effective planning, operation and control of processes, which is important from the point of view of planning. As regards the effective planning, operation and control of processes in respect of software, the documents may include:

1. Description of processes, including e.g. the processes identified during implementation (see section 4.1);
2. Descriptions of instructions and/or templates applied (as formally approved by decision of a respective body);
3. Descriptions of life cycle models applied;
4. Descriptions of tools, techniques, technologies and methods, e.g. general requirements identified during implementation as set forth in section 4.1 of the standard;
5. Technical issues, e.g. standards or documents for coding, design and development as well as testing;
6. Documents prepared in relation with the configuration management process (referred to below in section 7.5.3.2 "Configuration management process")

3. PLANNING IN RESPECT OF SOFTWARE

As it has been mentioned before, planning in respect of software may concern both the organizational level and the project/product level (see section 5.4.2 "Quality management system planning"). Recommendations of ISO/IEC 90003 regarding the quality management system planning at the organizational level may include the following groups of activities:

1. Defining respective life cycle models applied for the types of projects undertaken by the organization, including the manner in which the organization normally implements software life cycle processes;
2. Defining software development working products, including:
   a) documents pertaining to requirements, specifications to be fulfilled by the software,
   b) documents pertaining to the software architecture design,
   c) documents pertaining to the detailed design,
   d) software code,

e) software user's documentation.

3. Defining contents of software management plans, which include:
   a) software design management plans,
   b) software configuration management plans,
   c) software verification and validation plans,
   d) software quality assurance plans,
   e) training plans.
4. Defining the manner in which software engineering methods are adjusted to the organization's projects within the life cycle framework;
5. Identifying the tools and the environment where software there is:
   a) developed,
   b) operated, or
   c) maintained.
6. Defining conventions in respect of software language application, e.g. code rules, software libraries and structures;
7. Identifying any renewed software applications while taking into consideration section 7.5.4 "Customer property"

Additionally, at the characterised organizational level, the organization's management representative (it is advisable that in case of a software manufacturing organization, the management representative has experience in the field of software development) should consider each change in the life cycle model which could have an impact on the quality management system and guarantee that such changes do not threaten the quality management system control.
Software quality planning at the product level is set forth in section 7 of the ISO 9001:2000 standard called "Product realization". It is divided – within the framework of ISO 9001:2000 – into subsections which are presented in more details in the ISO/IEC 90003 standard (bold-faced here).
Finally, the structure of this section will be as follows:

7. Product realization
   - 7.1 Planning of product realization
     - 7.1.1 Software life cycle
     - 7.1.2 Quality planning
   - 7.2 Customer related processes
     - 7.2.1 Determination of requirements related to the product
       - 7.2.1.1 Customer-related requirements
       - 7.2.1.2 Additional requirement determined by the organization
     - 7.2.2 Review of requirements related to the product
       - 7.2.2.1 Organization's concerns
       - 7.2.2.2 Risks
       - 7.2.2.3 Customer representative
     - 7.2.3 Customer communication
       - 7.2.3.1 General
       - 7.2.3.2 Customer communication during development
       - 7.2.3.3 Customer communication during operations and maintenance
   - 7.3 Design and development
     - 7.3.1 Design and development planning
       - 7.3.1.1 Design and development planning
       - 7.3.1.2 Review, verification and validation
       - 7.3.1.3 Responsibilities and authorities
       - 7.3.1.4 Interfaces
     - 7.3.2 Design and development inputs
     - 7.3.3 Design and development outputs
     - 7.3.4 Design and development review
     - 7.3.5 Design and development verification
     - 7.3.6 Design and development validation
       - 7.3.6.1 Validation
       - 7.3.6.2 Testing
     - 7.3.7 Control of design and development changes

7.4. Purchasing
- 7.4.1 Purchasing process
  - 7.4.1.1 Purchased products
  - 7.4.1.2 Purchased product control
- 7.4.2 Purchasing information
- 7.4.3 Verification of purchased product

7.5 Production and service provision
- 7.5.1 Control of production and service provision
  - 7.5.1.1 Production and service provision in software
  - 7.5.1.2 Build and release
  - 7.5.1.3 Replication
  - 7.5.1.4 Delivery
  - 7.5.1.5 Installation
  - 7.5.1.6 Operations
  - 7.5.1.7 Maintenance
- 7.5.2 Validation of processes for production and service provision
- 7.5.3 Identification and traceability
  - 7.5.3.1 Overview
  - 7.5.3.2 Configuration management process
  - 7.5.3.3 Traceability
- 7.5.4 Customer property
- 7.5.5 Preservation of product

According to the ISO 9001:2000 requirements, the organization should:
1. Plan and develop processes needed for product realization (here: software);
2. Ensure cohesion of product realization planning with requirements of other quality management processes as set forth in section 4.1 of the standard;
3. Define the following while planning the product realization:
   a) quality objectives
   b) product requirements
   c) needs related to:
      - establishing processes
      - documents
      - product specific resources
   d) product-specific actions required, concerning:
      - verification
      - validation
      - monitoring
      - control and tests
   e) product acceptance criteria
   f) records needed to provide evidence that:
      - the realization processes fulfil the requirements of section 4.2.4 (Control of records), and
      - the product resulting from the processes realized also fulfils the requirements of section 4.2.4.

4. PRODUCT REALIZATION PLANNING AS PER ISO/IEC 90003

Product realization planning has been provided with more details in ISO/IEC 90003 through introduction of details concerning:
1. Software lifer cycle, and
2. Quality planning

As regards the issues related to software life cycle, standard ISO/IEC 90003 presents in details:
1. Processes, actions and tasks. They must be planned and realized with the use of life cycle models as appropriate to the type of project, while taking into consideration:
   a) scale,
   b) complexity,

c) safety,
d) risk, and
e) integrity.

2. The context of application of ISO 9001:2000. The standard is to be applied irrespective of life cycle models applied, and the purpose of the standard is neither to indicate any particular life cycle model nor a process sequence.
3. Design and development can be an evolutionary process and procedures may therefore need to be changed or updated as the project progresses, after consideration of changes to related activities or tasks. Then the following actions must be taken:
   a) Consideration should be given to the suitability of the design and development method for the type of task, product or project and the compatibility of the application, the methods and tools to be used.
   b) For products where failure may cause injury or danger to people, or damage or corruption of property or the environment, design and development of such software should ensure definition of specific design and development requirements that specify desired immunity from, and response to, potential failure conditions.
   c) The expected result of software development planning consists in a definition of what products are to be produced, who is to produce them, and when they are to be produced (see 7.3.1).
   d) Software quality planning at the project/product level should result in a description of how specific products are to be developed, assessed or maintained.

5. PRODUCT REALIZATION PLANNING AS PER ISO/IEC 90003

Software quality planning at the project level – in the extended version – should address the following:

a) inclusion of, or reference to, the plans for development (see 7.3.1);
b) quality requirements related to the product and/or processes;
c) quality management system tailoring and/or identification of specific procedures and instructions, appropriate to the scope of the quality manual and any stated exclusions (ISO 9001:2000, 1.2);
d) project-specific procedures and instructions, such as software test specifications detailing plans, designs, test cases and procedures for unit, integration, system and acceptance testing (see 8.2.4);
e) methods, life cycle model(s), tools, programming language conventions, libraries, frameworks and other reusable assets;
f) criteria for starting and ending each project stage;
g) types of review, and other verification and validation activities to be carried out (see 7.3.4, 7.3.5 and 7.3.6);
h) configuration management procedures to be carried out (see 7.5.3);
i) monitoring and measurement activities to be carried out;
j) the person(s) responsible for approving the outputs of processes for subsequent use;
k) training needs in the use of tools and techniques, and scheduling of the training before the skill is needed;
l) records to be maintained (see 4.2.4);
m) change management, such as resources, timescale and contract changes.

Quality planning can also occur in an abbreviated form. It is particularly useful to clarify limited quality objectives for limited-purpose software. Examples of limited-purpose software include:

1. Proof-of-concept demonstration prototypes;
2. Research computations used only by the designer;
3. Interim solutions lacking features such as security or full operational performance that will be implemented in future outputs;
4. One-time data analysis reports.

Limited-purpose software should be tested in ways that are consistent with its planned use to reduce the possible occurrence of unintended omissions and errors.

Design and development planning – according to section 7.3.1.1 – should address the following items, as appropriate:

a) the activities of requirements analysis, design and development, coding, integration, testing, installation and support for acceptance of software products; this includes identification of, or reference to:
   1) activities to be carried out;

2) required inputs to each activity;
3) required outputs from each activity;
4) verification required for each activity [as 7.1.2 g) – see also 7.3.5];
5) management and supporting activities to be carried out;
6) required team training [as 7.1.2 k)];

b) planning for the control of product and service provision;
c) the organization of the project resources, including the team structure, responsibilities, use of suppliers and material resources to be used;
d) organizational and technical interfaces between different individuals or groups, such as sub-project teams, suppliers, partners, users, customer representatives, quality assurance representative (see 7.3.1.4);
e) the analysis of possible risks, assumptions, dependencies and problems associated with the design and development;
f) the schedule identifying:
   1) the stages of the project [see also 7.1.2 j)];
   2) the work breakdown structure;
   3) the associated resources and timing;
   4) associated dependencies;
   5) the milestones;
   6) verification and validation activities [as 7.1.2 g)];
g) the identification of:
   1) standards, rules and practices and conventions, methodology, life cycle model, statutory and regulatory requirements [as 7.1.2 d) and e)];
   2) tools and techniques for development, including the qualification of, and configuration controls placed on, such tools and techniques;
   3) facilities, hardware and software for development;
   4) configuration management practices [as 7.1.2 h)];
   5) methods of controlling nonconforming software products;
   6) methods of control for software used to support development;
   7) procedures for archiving, back-up, recovery, and controlling access to software products;
   8) methods of control for virus protection;
   9) security controls.
h) the identification of related planning (including planning of the system) addressing topics such as quality (see 7.1), risk management, configuration management, supplier management, integration, testing (see 7.3.6), release management, installation, training, migration, maintenance, re-use, communication and measurement;
i) documentation control including document/record archive and distribution.

Planning should be reviewed periodically and any plans amended if appropriate.
A document defining design and development planning and any of these related topics may be independent document, a part of another document or composed of several documents.
As regards section 7.3.6: “Design and development validation”, standard ISO/IEC 90003 specifies:
a) validation – 7.3.6.1
b) testing – 7.3.6.2

Specific testing for software includes establishing, documenting, reviewing and implementing plans for the following:
a) unit tests, e.g. stand-alone tests of software components;
b) integration and system tests, i.e. tests of aggregation of software components (and the complete system);
c) qualification tests, i.e. tests of complete software products prior to delivery to confirm the software meets its defined requirements;
d) acceptance tests, i.e. tests of complete software product to confirm the software meets its acceptance criteria.

As regards section 7.5.3 “Identification and traceability”, the following subsection of the ISO/IEC 90003 standard, already referred to above, is worthy of notice: 7.5.3.2: “Configuration management process”. The process should include the following:

a) planning of the process including defining activities, responsibilities and the tools to be procured;
b) identifying uniquely the name and versions of each configuration item and when they are to be brought under configuration control (configuration identification);
c) identifying the versions of each software item which together constitute a specific version of a complete product (base line), including re-used software, libraries, as well as purchased and customer supplied software;
d) identifying the build status of software products under development, delivered or installed, single or multiple environments, as appropriate;
e) controlling simultaneous updates of a given software item by two or more people working independently (configuration control);
f) providing coordination for the updating of multiple products in one or more locations as required;
g) changes resulting from a change request or problem – from initiation to release (configuration status accounting);
h) providing configuration evaluation (status of verification and validation activities);
i) providing release management and delivery.

REFERENCES

1) K. Chrabański: Wskazania praktyczne przydatne w trakcie realizacji wyrobu programistycznego w oparciu o wymagania systemu zarządzania jakością zgodnego z międzynarodowa normą ISO 9001:2000 ["Practical Indications Useful for Software Product Realization Based on Quality Management System Requirements Conformable with International Standard ISO 9001:2000"], (in:) Celina M. Olszak ed. "Społeczeństwo informacyjne" vol. II, Silesian Higher School of Management in Katowice, Katowice 2004
2) PN-EN ISO 9001:2000 "Quality management systems. Requirements"
3) International Standard ISO/IEC 90003: Software engineering Guidelines for the application of 9001:2000 to computer software. First edition 2004.02.15.

Figure 1: Map of the planning related subject area in the context of requirements and recommendations of International Standards ISO 9001:2000 and ISO/IEC 90003