

## Software Product Quality Practices

### Quality Measurement and Evaluation using TL9000 and ISO/IEC 9126

**Witold Suryn<sup>1</sup>, Alain Abran<sup>2</sup>, Pierre Bourque<sup>3</sup>, Claude Laporte<sup>4</sup>**

Department of Electrical Engineering, École de Technologie Supérieure (ÉTS)  
Montréal, Québec, Canada, H3C 1K3

([aabran@ele.etsmtl.ca](mailto:aabran@ele.etsmtl.ca), [wsuryn@ele.etsmtl.ca](mailto:wsuryn@ele.etsmtl.ca), [pbourque@ele.etsmtl.ca](mailto:pbourque@ele.etsmtl.ca),  
[claporte@ele.etsmtl.ca](mailto:claporte@ele.etsmtl.ca))

Fax: +1 (514) 396 8684

<sup>1</sup> Witold Suryn is the executive co-editor and co-editor of ISO/IEC 9126, ISO/IEC 14598 and ISO/IEC SQuaRE series of standards

<sup>2</sup> Alain Abran is the Secretary of ISO/IEC JTC 1/SC7 and Co-Executive Editor, SWEBOK Project

<sup>3</sup> Pierre Bourque is

<sup>4</sup> Claude Laporte is

**Abstract.** This paper presents a combined, high level quality view of TL9000 Handbook and ISO/IEC 9126 in the process of defining, measuring, evaluating and finally achieving appropriate quality of user-centered software product.

In its practices-related part this paper discusses the benefits, which the use of TL9000 product operational (in-the-field) quality measures can bring to setting up, measuring and evaluating the quality of the software product being developed, through its entire life cycle.

**Keywords:** software product quality, operational quality, quality measures, quality evaluation, standards.

#### 1. Identification of quality requirements

For the users, a software product more and more often corresponds to a black box that must effectively support their

business processes. In consequence of this natural approach business needs become a driving force of quality software product development. This in turn requires that operational quality and satisfaction of using a software product set the framework for software product development effort: at the beginning of the development process to elicit business-related software product quality requirements, while at the end - to allow a rigorous evaluation. This *business view of quality* is illustrated in Fig.1

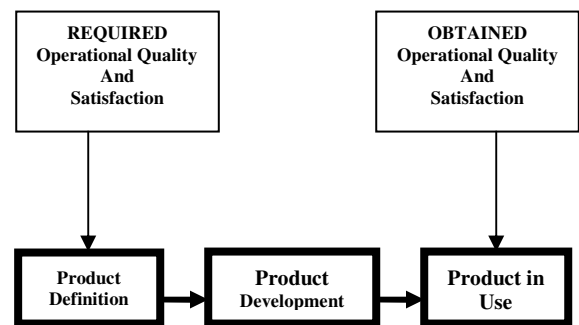
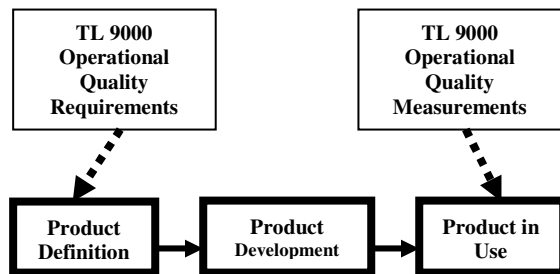


Fig. 1 Business View of software product quality

Identifying quality requirements that can be elicited, formalized and further evaluated in each phase of full software product lifecycle thus becomes a crucial task in the process of building a high quality software product.

The QUEST Forum's TL 9000 Handbooks are designed specifically for the telecommunications industry to document the industry's quality system requirements and measures. The TL 9000 Quality System Requirements Handbook [1] establishes a common set of quality system requirements for suppliers of telecommunications products: hardware, software or services. The requirements are built upon existing industry standards, including ISO 9001. The TL 9000 Quality System Measures Handbook [2] defines a minimum set of performance measures, cost and quality indicators to measure progress and evaluate results of quality system implementation.

TL 9000, applicability in software product lifecycle is illustrated in Fig.2.

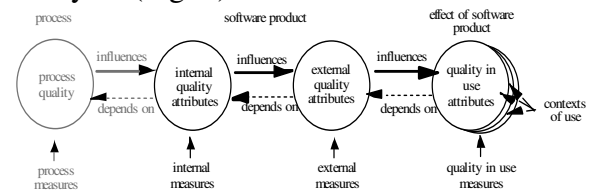


**Fig.2 Applicability of TL9000 standards in software product lifecycle**

In parallel the ISO/IEC Subcommittee 7 (SC7) on system and software engineering has developed set of quality standards for the full development process. These standards take the initial quality requirements into account during each of the development phases,

allowing the quality planning, its design, monitoring and control.

Software product quality can be evaluated by measuring internal attributes (typically static measures of intermediate products), or by measuring external attributes (typically by measuring the behaviour of the code when executed), or by measuring quality in use attributes. The objective is for the product to have the required effect in a particular context of use. To produce these effects measurement and evaluation of the quality of software product has to be present during all its lifecycle (Fig. 3).

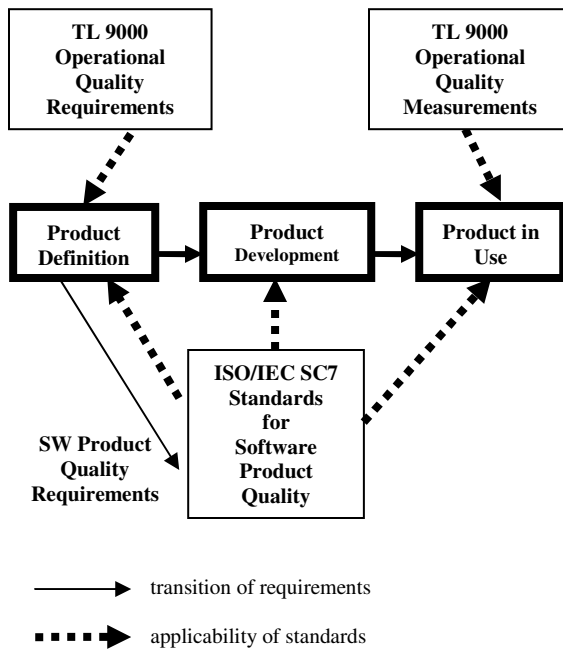


**Fig.3 ISO/IEC 9126 Quality in lifecycle**

Moreover, the proper quality measurement and evaluation methodologies have to be present and applied. ISO/IEC 9126 series of standards [3, 4, 5, 6] offers both broadly recognized quality models and appropriate measurements together with scales and measurement methods. ISO/IEC 14598 series of standards [7, 8, 9, 10, 11, 12] is a complementary set offering the support for software quality evaluation processes.

Figure 4 presents how these ISO/IEC standards integrate to the TL9000.

The practical use of these two combined sets of standards requires however a much more detailed view and, in order to define, plan and implement the quality, the precise identification of applicable standards and their particular documents for each phase of software development process.



**Fig.4. Integration between TL9000 and ISO/IEC SC7 standards**

The ISO/IEC standards being further considered are:

- ISO/IEC 9126 series - Software and System Engineering – Software Product Quality Metrics. 1999-2002 [3, 4, 5, 6]
- ISO/IEC 14598 series – Software and System Engineering – Software Product Evaluation. 1996-2002 [7, 8, 9, 10, 11, 12]

## 2. Quality measurement and evaluation practices

For the simplicity of the following discussion the practical steps to follow correspond to software life cycle phases proposed in ISO/IEC 15288 [13].

**Discovery Phase.** In this phase three sets of requirements have to be identified and defined:

- Functional and non-functional requirements of the product (out of the scope of this paper)
- Operational quality requirements, and
- Quality in Use requirements

It is important to note here, that according to the model of quality in software life cycle defined in ISO/IEC 9126-1 [3] the requirements of Quality in Use contribute to specifying External Quality requirements, which in turn contribute to specifying Internal Quality requirements. This indicates that the attributes of Quality in Use have the direct impact on technical and technological decisions that (will) have to be taken when the development process starts. This requires that Quality in Use characteristics be analyzed, applicable measures identified and target values for each of them assigned. The ISO standard to be applied to complete this task is ISO/IEC 9126 – Part 4: Quality in Use Metrics [6]. The characteristics to be analyzed are:

- effectiveness
- productivity
- safety, and
- satisfaction

Quality in Use requirements help define success criteria of the new software product however alone they will not assure the product’s long term success in the market. Such a success is achieved when Quality in Use comes together with, among the others, fulfilled operational quality requirements.

Again, this requires that operational quality requirements be analyzed, applicable measures identified and target values for each of them assigned.

TL 9000 – Quality Management System Measurement Handbook [2] identifies

four (4) categories of requirements and/or measurements applicable to software products:

- common measurements – referring to number of problems reported, response time, overdue problem responsiveness and on-time delivery
- hardware and software measurements – referring to system outage
- software measurements – referring to software installation and maintenance
- service measurement – referring to service quality

The final set of quality requirements and their targeted values, comprising of both operational quality and Quality in Use requirements will then become the major milestone and contributor in the definition of functional and non-functional requirements of the future software product with the *user perception of the software product quality* already “sewn” into the overall definition.

**Requirements Analysis Phase.** In this phase the applicable quality requirements define external and internal quality attributes of software product to be developed.

The ISO standards applied in this phase are:

- ISO/IEC 9126 – Part 2: External Quality Metrics [4], and
- ISO/IEC 9126 – Part 3: Internal Quality Metrics [5]

It has to be stressed here, that the attributes of both external and internal quality being defined in this phase make direct descendants of quality requirements previously set up in the

Discovery phase, so the critic rule of traceability in software engineering is being conserved.

**Implementation Phase.** This phase as the first in the whole life cycle creates a *product* that can be measured and evaluated. The created product is intermediate and changes many times before becoming a ready-to-use solution, but exactly due to this fact it is critical to measure and evaluate its quality. Every iteration with measured and evaluated quality produces indications yielding further improvements. Measurement, documentation and evaluation of Internal Quality (and, if needed, External Quality) attributes defined in Requirements Analysis phase are supported by the procedure below:

- Measurements of Internal and External Quality attributes. Documents to be used: ISO/IEC 9126 – Part 2 and 3 [4, 5]
- Documentation of measurements. Document to be used: ISO/IEC 14598 – Part 6 [12]
- Evaluation of the quality of the intermediate products. Documents to be used, depending on the position of the evaluating entity: ISO/IEC 14598 – Part 3: Process for Developers [9], Part 4: Process for Acquirers [10] or Part 5: Process for Evaluators

The results of measurements of Internal and External Quality attributes are compared with target values assigned to them in previous phases and the conclusions are feed backed to development teams as the corrective measures of improvement.

**Verification Phase.** The product is integrated and stakeholder’s functional,

non-functional and External Quality requirements have to be satisfied in this phase. The process of the evaluation of External Quality requires a similar procedure as Internal Quality evaluation in the previous phase and is being similarly well supported by standardization instruments.

The results of measurements of External Quality attributes are compared with target values assigned to them in previous phases. The resulting conclusions may be feed backed as the corrective measures of improvement. The feedback may be directed to different phases of the process depending on the level of the severity of discrepancies between required and obtained External Quality.

**Validation Phase** moves the software product to the business level, where the user validates its usefulness for conducting his business, usually with no regard to technicalities. This means that Quality in Use requirements have to be satisfied “here and now”. The process of the evaluation of Quality in Use requires the same procedure as External Quality evaluation and is being equally well supported by standardization instruments. The only difference is in using ISO/IEC 9126 – Part 4 [6] instead of ISO/IEC 9126 – Part 2.

The results of measurements of Quality in Use attributes are compared with target values assigned to them in previous phases. The resulting conclusions may be feed backed as the corrective measures of improvement. The feedback may be directed to different phases of the process depending on the level of the severity of discrepancies between required and obtained Quality in Use.

**Operation and Maintenance Phase** is the phase where software product is finally evaluated in terms of operational quality and Quality in Use.

Operational quality measurements require data, which to be representative have to be collected over relatively long period of time. In this case the procedure uses TL 9000 Quality Management System Measurements Handbook [2] in order to perform needed calculations and evaluate obtained operational quality. Depending on the area of measurement and evaluation the results can be used immediately, f.e. for improvements of the service quality, or in next round of product development, if the evaluation indicates weaknesses of the product being in the field.

Applying measurements and evaluation of Quality in Use in Operation and Maintenance phase proves it very sense especially in cases of large and complicated software products. Validation phase, where Quality in Use is being measured and evaluated for the first time makes a relatively short period with limited exploration opportunities (as f.e. limited number of users) while Operation and Maintenance phase offers natural circumstances with unlimited time and exhaustive conditions of exploitation. Thus the important question in this case would be “how long?”

The structure “product-user” usually reaches its level of stability after few months of exploitation so it makes sense to conduct Quality in Use measurements and evaluation through the similar period. Further measurement efforts would not most probably deliver substantial data due to the “routinization” of interaction between the user and the product. The

measurement and evaluation procedure for Quality in Use in Operation and Maintenance phase would be the same as proposed for Validation phase. The evaluation results can be useful both immediately (*evolutional* role of maintenance process) and in long term perspective, when new product or its release will be considered.

### 3. Applicability considerations

- The process discussed in part 2 of this paper omits Architectural Design phase, Integration phase and Transition phase. The reasons for not considering these phases come from the fact that ISO/IEC standards address them poorly or do not address them at all.
- Both TL9000 and ISO/IEC standards offer the *process support* for identification, definition, measurement and evaluation of software product quality. In case of TL9000 Quality Management System Requirements Handbook [1] the support processes are located on the corporate level. In case of ISO/IEC standards the support is placed on measurement process management level and is being offered through ISO/IEC 14598 – Software Product Evaluation – Part 2: Planning and management [8]

### Bibliography

[1] TL9000 Quality Management System Requirements Handbook, Release 3.0, QuEST Forum 2001

[2] TL9000 Quality Management System Measurements Handbook, Release 3.0, QuEST Forum 2001

[3] ISO/IEC 9126 – Software and System Engineering – Product quality – Part 1: Quality model. 1999-2002

[4] ISO/IEC 9126 – Software and System Engineering – Product quality – Part 2: External Quality Metrics. 1999-2002

[5] ISO/IEC 9126 – Software and System Engineering – Product quality – Part 3: Internal Quality Metrics. 1999-2002

[6] ISO/IEC 9126 – Software and System Engineering – Product quality – Part 4: Quality in Use Metrics. 1999-2002

[7] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 1: General overview. 1999-2002

[8] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 2: Planning and management. 1999-2002

[9] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 3: Process for developers. 1999-2002

[10] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 4: Process for acquirers. 1999-2002

[11] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 5: Process for evaluators. 1999-2002

[12] ISO/IEC 14598 – Software and System Engineering – Software Product Evaluation – Part 6: Documentation of evaluation modules. 1999-2002

[13] ISO/IEC 15288 - Software and System Engineering – Life Cycle Management – System Life Cycle Processes. 2002