Implementing integration of quality standards CMMI and ISO 9001 : 2000 for software engineering

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Summary. In this paper, we present how to integrate several processes using a common reference frame offering various viewpoints. This step is applied to the integration of two standards of quality - ISO 9001: 2000 and CMMI - in order to generate a multivues quality reference frame allowing a certification relative to the two standards. This reference frame takes into account the structure imposed by ISO and the recommendations of CMMI. The implementation of this reference frame is accompanied by the application of the organzational improvement model IDEAL (relative to the implementation of CMMI). This paper is based on the work completed within a software engineering company (SYLIS). Both human and cultural aspects of the company are considered in order to mitigate the problem of acceptability.

Key words: Quality standards, CMMI, ISO 9001 : 2000, enterprise modeling, business process, reference frame.

1 Introduction

ISO 9001 : 2000 requires that an organization's processes undergo continuous improvement even after ISO 9001 : 2000 certification has been achieved. CMMI provides an organization with a means to accomplish further process improvement. CMMI is a very detailed set of documents that contain many more of the basic concepts for process improvement than can be found in ISO 9001 : 2000. Our paper presents the implementation of these quality standards in a unique reference frame allowing us to obtain certification for both

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standards.
The remainder of this paper is organized as follows: Section 2 gives a brief explanation of CMMI and ISO 9001 : 2000. Section 3 introduces our proposal of integrated model. Section 5 presents the implementation of our model. Finally, section 6 provides our conclusions.

2 State of the art

2.1 CMMI or how to increase the maturity of processes

In the current marketplace, there are maturity models, standards, methodologies, and guidelines that can help an organization improve the way it does business. However, most available improvement approaches focus on a specific part of the business and do not take a systemic approach to the problems that most organizations are facing. For example, there are many maturity models available such as the Software Engineering Institute's (SEI's) Capability Maturity Model for Software (SW-CMM), which focuses on improving software, and the Electronic Industries Alliance's (EIA's) Systems Engineering Capability Model (SECM), which focuses on systems engineering. By focusing on improving one area of a business, these models have unfortunately perpetuated the stovepipes and barriers that exist in organizations.

Capability Maturity Model Integration (CMMI) provides an opportunity to avoid or eliminate these stovepipes and barriers through integrated models that transcend disciplines. CMMI consists of best practices that address product development and maintenance. It addresses practices that cover the product's life cycle from conception through delivery and maintenance. There is an emphasis on both systems engineering and software engineering and the integration necessary to build and maintain the total product [6].

CMMI integrates old models developed in the Nineties. This need for integration appeared in order to make speak the same language and use common processes engineers of multiple disciplines attached to the same project of development: SE (Systems Engineering), SW (SoftWare), SS (Supplier Sourcing) and IPPD (Integrated Product and Process Development).

CMMI regroup 25 "Process Area" (PA). There are two different representations of the CMMI: the staged representation and the continuous representation [1], [14].

CMMI Staged Representation

The Staged Representation focuses improvement on the process capability an organization can expect to attain; however, this expected capability (or ability to function in a mature manner) is contained within maturity levels or stages. There are five maturity levels, as shown in Fig. 1, with each level providing the foundation for further improvements. This representation provides a roadmap for sequencing the implementation of groups of process areas.

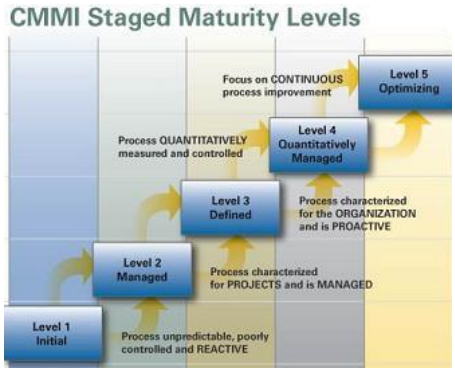

Fig. 1. CMMI Staged Representation

Fig. 2. CMMI Continuous Representation

CMMI Continuous Representation

The Continuous Representation has the same basic information as the staged representation, just arranged differently. The continuous representation, as shown in Fig. 2, focuses process improvement on actions to be completed within process areas, yet the processes and their actions can span different levels.The continuous representation provides maximum flexibility for focusing on specific process areas according to business goals and objectives [13].

In our case, we focused on Staged Representation in order to improve all the PAs and not to restrict our work to particular ones.

2.2 ISO 9001 : 2000

ISO 9001 : 2000 is a necessary requirement for a quality management system. It is a part of the ISO 9000 family that consists of ISO 9000 (Fundamentals and Vocabulary) [10] [12], ISO 9001 (Requirements) [9], ISO 9004 (Guidelines for Performance Improvements) [11], and ISO 19011 (Guidelines for Quality and Environmental Management Systems Auditing). ISO 9001:2000 is an abstract and is a sparse document that can be applied to any category of business. When it is to be applied to organizations in the software industry, ISO 9001 can be further interpreted by using either ISO 9000-3 or TickIT . To achieve an ISO certification, organizations must be compliant with every clause of ISO 9001 : 2000. Compared with ISO 9001 : 2000, ISO 9004 : 2000 is not a requirements document. Rather, it is a document that provides guidance for further process improvement. ISO 9001 : 2000 and ISO 9004 : 2000 are similar in terms of both the structure and terminology that they use in order to facilitate their application as a consistent pair [9] [11] of standards.

3 Proposal of an integration model

3.1 Model description

Each quality model, standard and corpus of knowledge describes a part of company activities with its own level of precision and specificity. Their scope is different (as shown in Figure 3). So one model can describe non existing activities in the company and forget some existing and implemented activities. So usually a model does not cover integrally enterprise activities. The precision level of the description depends on the model.

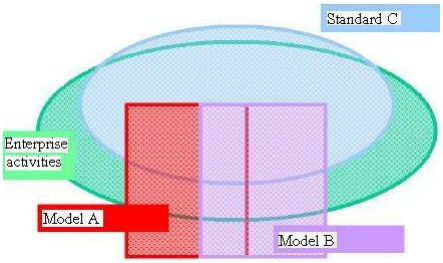

Fig. 3. Models scope compared to enterprise activities.

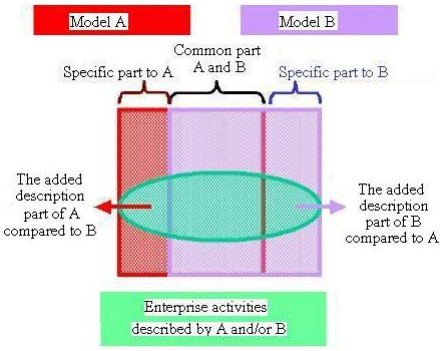

Fig. 4. The common/specific description of enterprise activities.

Generally, we find within two models the description of common and specific activities to each model (as shown in Figure 4). These two descriptions can be implemented or not in enterprise activities.

3.2 The multi-model approach

We propose four steps in our multi-model approach to integrate different quality models:

Step 1 : Models choice

- What are objectives and requirements? Increase customer satisfaction, productivity...
- What are envisaged models? CMMI, ISO 9001 : 2000, ITIL...
- Which the budget? X...
- What are resources? Young people, experimented, consultants, significant number...

By answering these questions, we can determine coherence between considered models and enterprise needs and resources. This step permit us to choose the adequate models to implement.

Step 2 : Analysis of models synergy

Once the models are chosen, we compare those standards. This comparison points to both similarities and differences. Fortunately, the synergy between the frameworks can be exploited and the weaknesses of one can be supplemented by the strengths of the others. To analyze models synergy, we implement a mapping between models. This mapping should determine :

- Levels of abstraction between selected models,
- Treated functional sectors,
- For each element of a model, its relation with elements of other models,
- A level of correlation, in order to qualify each relation.

Step 3 : Construction of integrated model

This step will allow us to:

- Resolve all contradictions in the relations between the elements of models,
- Avoid unfolding of work by consolidating the elements with relations of inclusion and identity,
- Maximize the synergy potential by combining complementary elements.

On the basis on this step, we create a theoretical integrated model valid for any enterprise wanting to implement two models A and B.

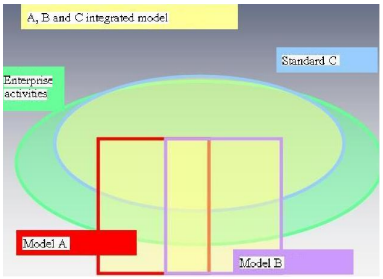

Fig. 5. The integrated model.

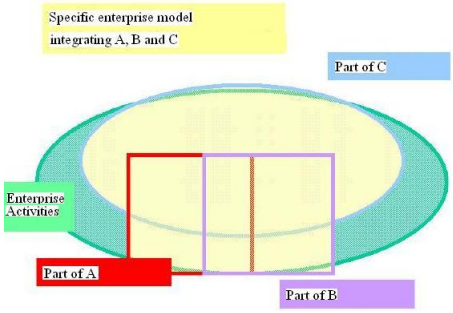

Fig. 6. The specific integrated model.

Step 4 : The adaption of the integrated model to the enterprise context

This step will allow us to retain from each model only relevant elements with enterprise activities (as shown in Figure 6) and objectives of quality project and to adapt the theoretical integrated model to human and cultural context of the enterprise.

4 Implementation of the reference frame

4.1 The case study multi-model approach

Figure 7 shows the case study multi-model approach, presented in previous section.

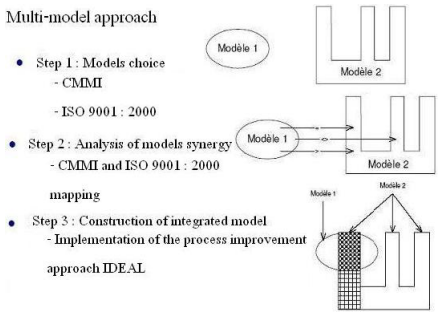

Fig. 7. The case study multi-model approach.

4.2 CMMI and ISO 9001 : 2000 mapping

Basing on CMMI and ISO 9001 : 2000 synergy [4] [5], we implement a mapping in order to determine:

- CMMI practices treated par ISO 9001 : 2000 chapters.
- ISO 9001 : 2000 chapters treated par CMMI practices.

4.3 Implementing enterprise quality reference frame

Implementing the specific integrated model

As shown in Figure 8, we implement a cartography of enterprise processes. This cartography shows the enterprise processes and CMMI PAs. It shows also the level of integration of CMMI PAs in or cartography. PAs : DAR, IT, OEI, ISM et RSKM are not treated by ISO 9001 : 2000. All the rest of PAs are localized in our ISO procedures.

Enterprise processes and quality standards mapping

We implement a mapping between enterprise processes and our quality standards implemented. So for an enterprise process, we can find all CMMI PAs and ISO procedures treated by this process and vice versa.

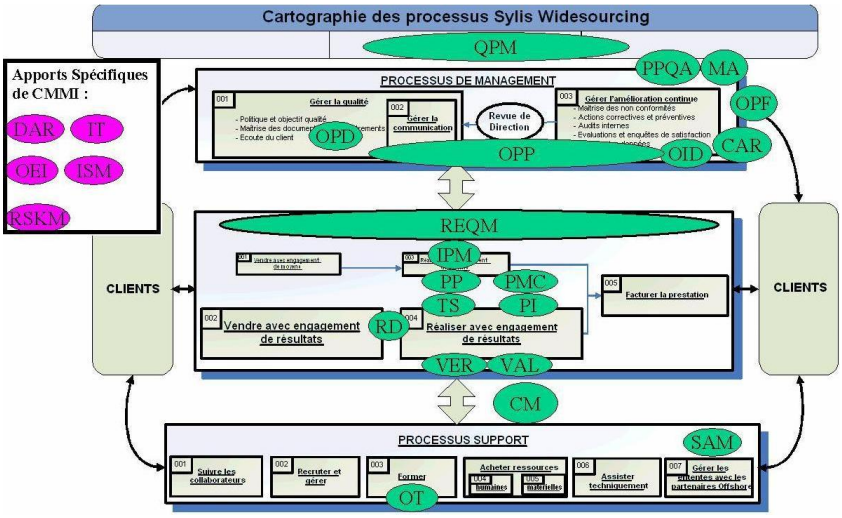

Fig. 8. Entreprise's process cartography including CMMI's PAs basing on ISO 9001 : 2000 representation.

4.4 The human aspects for acceptance

Since the company has its own methods and ways of work, we feared that the integrated model will not be used. So, we dealed with the problem of acceptance. Thus, we began by classifying the personnel of the company in two categories:

- *The allies:* They approve work and are convinced of its utility and the need on the implementation of such model in the company.
- *The recalcitrants:* They are a little bit hostile to the implementation of such a model because :
  - Usually, they do not use methods of estimation.
  - They have their own models.

We concentrated our efforts on this second part of the personnel. We chose the strategy of persuasion through presentation to show the advantages of the adopted model compared to classic quality standards and by discussing with them to know which are their waitings and if there are things to modify.

5 Conclusion

To implement CMMI in an ISO 9001 : 2000-certified organization efficiently and effectively, both the common and different parts of the ISO 9001 : 2000 standards and CMMI documents must be identified. ISO 9001:2000 requirements can be mapped to CMMI practices [5]. However, the following limits have been identified in this mapping process:

1. A requirement of ISO 9001 : 2000 can be mapped to many CMMI practices. Conversely, a CMMI practice can be mapped to many ISO 9001 : 2000 requirements. These mappings are useful for comparing these two frameworks, but they may cause confusion during the decision-making process.
2. It is difficult for organizations to understand and apply these mappings during CMMI implementation because they only describe the degree of the correlation between ISO 9001 : 2000 and CMMI without providing any explanation of these mappings.
3. The structure and words that are used by CMMI are not familiar to ISO-certified organizations, which makes it more complicated for an ISO 9001 : 2000-certified organization to implement CMMI.

We are working now on mitigating these limits and the implementation of more than two quality standards on the same reference frame.

References

1. Richard Basque. "CMMI un itinraire flch vers le Capability Maturity Model Integration". 2004. Dunod.
2. Boehm, Barry W. "Software Engineering Economics". 1981. Prentice-Hall.
3. Boris Mutafelija, Harvey Stromberg. *Exploring CMMI- ISO 9001 : 2000 Synergy when Developing a Process Improvement Strategy*. 2003. Bearing Poing and Hughes Network System.
4. Boris Mutafelija, Harvey Stromberg. *Systematic Process Improvement Using ISO 9001:2000 and CMMI*. 2003. Artech House.
5. Boris Mutafelija, Harvey Stromberg,. *Mappings of ISO 9001:2000 and CMMI Version 1.1*. Available from: `http://www.sei.cmu.edu/cmmi/adoption`.
6. Mary Beth Chrissis, Mike Konrad, Sandy Shrum. "CMMI: Guidelines for Process Integration and Product Improvement". 2003. Addison Wesley Professional.
7. Dennis M. Ahern, Aaron Clouse, Richard Turner. *CMMI Distilled: A Practical Introduction to Integrated Process Improvement*. Second Edition. 2003. Addison-Wesley.
8. Frank Vandenbroecke. *Combiner CMM et ISO 9001 - 2000 pour l'amélioration de processus ?*. N-Tech Belgium.
9. International Organization for Standardization (ISO), "ISO 9001:2000: Quality Management Systems Requirements". Beuth, Berlin, 2000.
10. International Organization for Standardization (ISO), "Quality Management SystemsFundamentals and Vocabulary, ISO 9000:2000", 2000.
11. International Organization for Standardization (ISO), "Quality Management SystemsGuidelines for Performance Improvements, ISO 9004:2000", 2000.
12. Ketola, J., Roberts, K., "ISO 9000:2000 in a Nutshell", 2000, Patton Press, Chico, CA.
13. Margaret K. Kulpa and Kent A. Johnson. "Interpreting the CMMI: A Process Improvement Approach". 2003. Auerbach Publications.
14. Software Engineering Institute (SEI). "CMMI version 1.1 CMU/SEI-2002-TR-012". 2002.