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The Second World Congress for Software Quality (2WCSQ)

– Software Quality for the Coming New Millennium –

PROCEEDINGS

Pacifico Yokohama Conference Center (Tokyo Bay Area)

September 25th(Mon.) – 29th(Fri.), 2000

Organized by

Union of Japanese Scientists and Engineers (JUSE)
American Society for Quality , Software Division(ASQ Software Division)
European Organization for Quality, Software Group (EOQ Software Group)

Supported by

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IMPROVING THE QUALITY OF THE MAINTENANCE PROCESS[1]

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Abstract.

Although Maintenance is the most costly and conflicting stage of the software life cycle, most of the enterprises do not possess methodologies to carry out this process. High quantities of techniques, methodologies, models, etc. have been proposed to improve the quality of new developments, but they are not useful for maintaining existing ones, due to the different (and divergent) activities involved in both processes.

In this work we present the approach of the maintenance process proposed in MANTEMA, a methodology for software maintenance that integrates all the activities related to this process. The goal of MANTEMA is to convert the software maintenance into a controllable and measurable process through the identification and clear definition of all the elements (software, documents, persons, tasks...) which participate in maintenance.

MANTEMA has been developed by our research group and Atos ODS, a French multinational among whose main business activity is the outsourcing of software maintenance. MANTEMA is based upon the ISO/IEC 12207 International Standard, which has been tailored by us incorporating some additional activities related to maintenance outsourcing.

Keywords: *Outsourcing and Quality; International Standard and Quality.*

1. INTRODUCTION.

In spite of software maintenance is the most costly and conflicting stage of the software life cycle /13/, most organizations do not follow any methodology for the execution of this process, although they use someone for new developments /12/. Moreover, maintenance will continue growing and will become the main work of the software industry /10/, and novel products and technologies need to increase maintenance efforts so in corrective and perfective (for hypertext maintenance, for example, as reported in /3/), as in adaptive (for adapting old applications to new environments, as client/server /9/).

This fact, joint to the "wrong reputation" of maintenance tasks (it is considered as a heavy, little creative process) and to the habitual hurries by concluding them, provokes maintainability of software decreases after each intervention. Loss of maintainability implies increasing costs in future modifications.

Then, it seems necessary to endow organizations of methodological techniques that permit to convert the maintenance it into a controlled and measurable process, that make possible the continuous improvement of the process and of the product.

In this work we present MANTEMA, a methodology for managing software maintenance developed between our university and Atos ODS, a multinational organization among whose primary business activities is the outsourcing of third-party software maintenance. Atos ODS is applying the methodology to various large banking customers.

[1] This work is partially supported by the projects *MANTIS (European Union/CICYT 1FD97-1608)* and *MPM, Mejora del Proceso de Mantenimiento (Ministerio de Industria y Energía, Iniciativa ATYCA, TA15/1999; Spain).*

This work is organized as follows: in section 2 we explain how MANTEMA methodology approaches software maintenance process. Section 3 is an exposition of our conclusions and our current and future lines of work.

2. MANTEMA METHODOLOGY AND SOLUTIONS FOR MAINTENANCE.

MANTEMA /14/ approaches entirely the problem of software Maintenance, putting special attention to the reduction of the costs of all its activities. In literature, we found different dissertations about how to solve the maintenance problems, being able to include them in two large groups /1, 2, 4, 17/:

1. Technical solutions.
   - Reengineering
   - Reverse engineering
   - Restructuring
2. Management solutions.
   - Management of quality (use of standards, for example)
   - Resources
   - Structured management
   - Documentation of the changes

There are multitude of proposals for the first group of solutions ("technical"), and every year new proposals are published in the most important conferences on software maintenance (Euromicro/European Conference on Maintenance and Reengineering, International Conference on Software Maintenance, etc.). In general, these proposals constitute techniques to be used for the maintenance (specially reengineering and restructuration) of very concrete systems, as relational databases, conversion of non object-oriented programs to the object-oriented paradigm (from C to C++, for example), identification of objects in Cobol programs, etc.

There are not, however, many "Management solutions" proposed or, at least, there are not enough full "Management solutions" to solve this problem. In MANTEMA we provide a methodology which integrates solutions of the last four types of management solutions. We must not forget that software project management is one of the most important topics for software quality /11/.

In this section we expose the set of management solutions for the maintenance problem used in MANTEMA.

2.1 Management of quality (standards, etc.).

The MANTEMA methodology is built from the ISO/IEC 12207 International Standard /8/. This IS considers the Maintenance to be one of the primary processes of Software Life Cycle, jointly with the Acquisition of the product, service or software system, the Supply, the Operation and the Development processes. There are also two additional sets of processes ("Organizational" and "Supporting" processes), and an special process, called "Tailoring", that serves to adapt the international standard to each concrete case.

In ISO/IEC 12207, each process is split into a set of activities, and each activity into a set of tasks. The construction of this maintenance methodology has been carried out applying the Tailoring process to the ISO/IEC 12207 Maintenance process /15/.

Very briefly, during the Tailoring process a selection of the processes, activities and tasks of ISO/IEC 12207 that are going to be used in the concrete case of application of the IS must be realized. Furthermore, new tasks, activities and processes may be incorporated.

In outline, after the application of the Tailoring process, a new and "big" Maintenance process constitutes the centre of MANTEMA methodology, around which rotates all MANTEMA elements. Really, in MANTEMA we define only the Maintenance process, because we either reject or integrate the rest of processes of ISO/IEC 12207, as Figure 1 shows:

MANTEMA does not detail the manner of execution of the non-integrated processes,

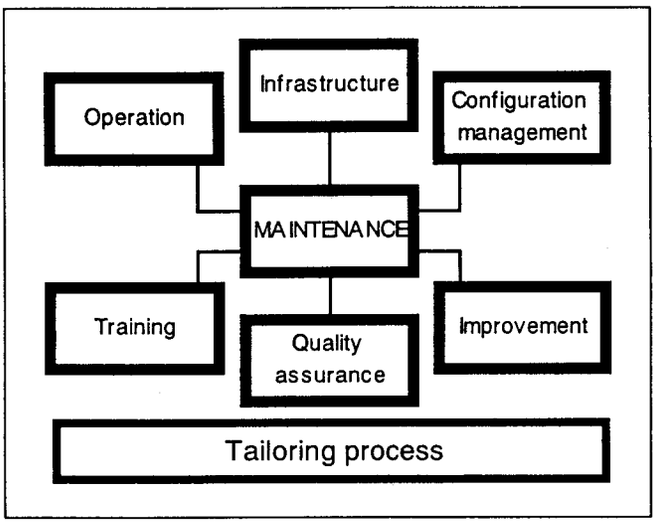

Figure 1. Processes in our methodology.

which are the "satellite processes" of Figure 1. Maintenance process structure follows the same processes design line of ISO/IEC 12207, since we divide it into activities and tasks.

As an example of the processes integration, and due to its growing importance, as /18/ shows, in MANTEMA we specifically take in consideration the activities that should be accomplished to formalize an contractual relationship of Maintenance (outsourcing). In this manner, the Acquisition and Supply processes of ISO/IEC 12207 are integrated in the set of initial and final activities and tasks that are executed in the Maintenance process of MANTEMA. Such activities and tasks are related to the procedures that both the acquirer and provider organizations must execute (study of the software by the acquirer, study of the risk, viability, etc.). Some of these tasks are modifications of existing tasks in ISO/IEC 12207, while other are new and they have been incorporated to the methodology because thus it has been necessary.

2.2 Resources: to use experimented personnel instead of new

The convenience of employ experimented human resources for every software maintenance has been repeatedly manifested by diverse authors /10, 13/. Moreover, every day has more importance to take into account organizational aspects of software processes in their implementation /5/ and, for /6/, quality is absolutely influenced by people.

In MANTEMA, the three possible organizations involved in maintenance are defined /15/. Depending on the case (whether there is or is not outsourcing relationship, for example), two or even the three organizations may coincide in just one:

1) *Customer organization*. This organization corresponds with the Acquirer defined in ISO/IEC 12207. We define it as the organization which owns the software and requires the maintenance service.
2) *Maintainer*. The organization which supplies the maintenance service.
3) *User*. The organization that uses the software.

Several profiles are also defined for every organization (for example, there are three profiles in the *Maintainer*: *Maintenance request manager*, who receives each Modification Re-

quests and decides its type of maintenance; *Scheduler*, who plans the queue of accepted modification requests; *Maintenance team*, the group of people who implement the accepted modification request). At the beginning of the maintenance process, real persons must be mapped with these profiles. In this manner, the responsible people of every maintenance task will be always identified. Also some of these profiles may coincide in only one person: for example, maybe the *Maintenance request manager* also plans the queue of accepted maintenance requests, being in this manner the *Scheduler*.

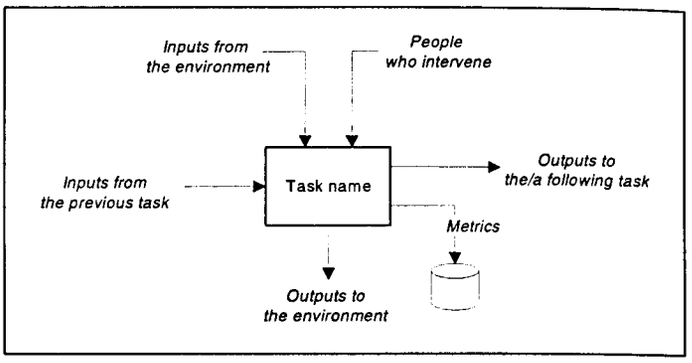

Figure 3. Generic structure of a task in MANTEMA.

2.3 Structured management.

As already it has been said, the Maintenance process of MANTEMA is split into a set of activities, that at the same time are subdivided in tasks.

Furthermore, fruit of the ideas exposed in the literature /7, 8, 17/, as well as of the experience of Atos ODS, several types of maintenance should be distinguished in this process. The following two types of maintenance are defined in MANTEMA:

- *Planneable maintenance*: we include into this type *non-urgent corrective* maintenance (there is an error in the software which does not block the normal operation of the system), *perfective*, *preventive* and *adaptive*.
- *Non-planneable maintenance:* to preserve the same terminology, we put here the *urgent corrective* maintenance (an error blocks the normal operation of the system).

Different flows of actions are defined for every type: there are several tasks which must be executed before and after modification interventions. With this consideration, MANTEMA may be seen as the following multistage graph:

Each node in Figure 2 is defined as a set of activities, and every activity as a set of tasks. In order to authomatize the Maintenance process, it is important to define rigidly every one of the tasks which compose our process. Then, a closed structure is defined in MANTEMA for

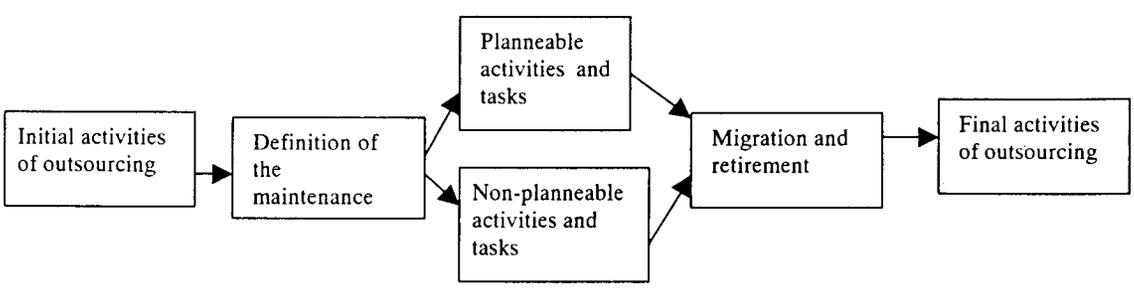

Figure 2. Structure of the MANTEMA Maintenance process.

every task (Figure 3). At a lower level of abstraction, Figure 2 could be redrawn as the concatenation of tasks (see Figure 4).

As it is observed in Figure 3, for every task we define its inputs (programs, documents, etc.), that will be taken from previous tasks or from the environment; its outputs, that will be go directed also to other tasks or to the environment; the responsible persons and the metrics

to be collected. This structure allows an easy transformation of MANTEMA to a logical design, susceptible of being modelled on a computer system.

Furthermore, MANTEMA defines, for every task, what techniques can be used to execute the task (they will be "technical solutions" of those mentioned at the beginning of section 2) and the interfaces with other needed processes (that will be some of the shown as "satellites" in Figure 1).

Recollection of several metrics is also recommended for every task, since this one is the best and most objective manner to keep the control of the process. To keep product metrics is important, since they will allow to know the evolution of software along the maintenance process. This aspect has special importance when there is an outsourcing relationship, since the Maintainer may acquire a commitment of "progressive preventive maintenance", in the sense of decreasing, for example, the mean cyclomatic complexity of the modified programs.

2.4 Documentation of the changes.

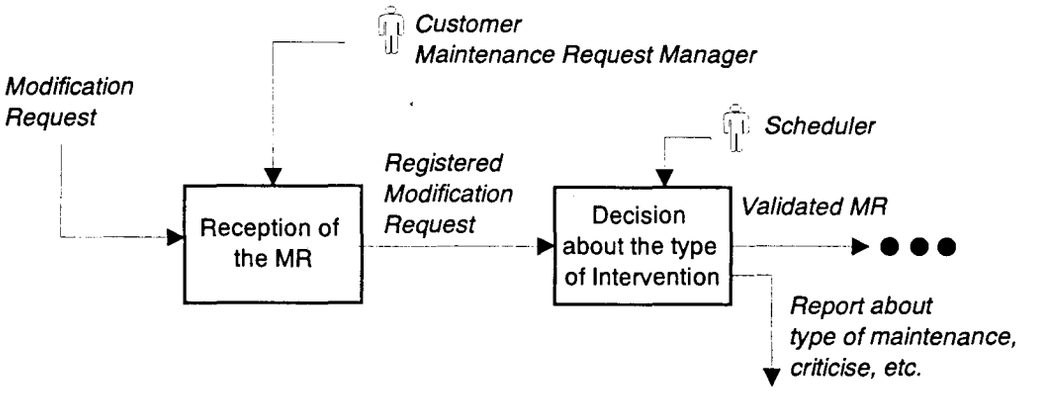

Figure 4. Concatenation of two different tasks.

The last kind of "management solutions" mentioned at the beginning of this section was the "Documentation of changes". In Figure 3 we saw that input and output products were defined for every task. Many of these products are constituted by maintenance documents, whose templates are completely defined in MANTEMA.

3. CONCLUSIONS.

In this paper have presented MANTEMA, a methodology for managing and improving the maintenance process which has been built taking the ISO/IEC 12207 as a basis. MANTEMA helps organizations to manage the process with adequate quality levels, since it approaches the process considering different aspects of management solutions for software processes.

4. REFERENCES.

/1/ Arnold, R. (1992). Software Reengineering, IEEE Press.

/2/ Bennett, K.H.; Martil, R. y Zuylen H.V. (1990). A Model of Software Reconstruction. Centre of Software Maintenance. Durham, UK.

/3/ Brereton, P., Budgen, D. & Hamilton, G. (1999). Hypertext: the Next Maintenance Mountain. *Computer,* 31(12), 49-55.

/4/ Chikofsky, E.J. y Cross, J.H. (1990). Reverse Engineering and Design Recovery: A Taxonomy. *IEEE Software,* 7(1), 13-17.

/5/ Fuggetta, A. (1999). Rethinking the models of software engineering research. *The Journal of Systems and Software,* (47), 133-138.

/6/ Cillies, A.C. (1992). Software Quality. Theory and Management. Chapman & Hall Computing, UK.

/7/ IEEE (1992). *IEEE Std 1219-1992, Standard for Software Maintenance*. The Institute of Electrical and Electronics Engineers, Inc., NY:EE.UU.

/8/ International Standard Organization/International Electrotechnical Commission (1995). ISO/IEC 12207. Information Technology: Software life cycle processes.

/9/ Jahnke, J.H. and Wadsack, J. (1999). *Integration of Analysis and Redesign Activities in Information System Reengineering.* Proceedings of the Third European Conference on Software Maintenance and Reengineering, Amsterdam (The Netherlands). IEEE Computer Society, Los Alamitos, California.

/10/ Jones, C. (1994). Assessment and Control of Software Risks. NY: McGraw-Hill.

/11/ Jones, C. (1997). Software Quality: Analysis and Guidelines for Success. International Thomson Computer Press.

/12/ Piattini, M.G., Ruiz, F., Polo, M., Villalba, J., Bastanchury, T. and Martínez, M.A. (1998). Mantenimiento del software: conceptos, métodos, herramientas y outsourcing. Ed. RAMA. Madrid, Spain.

/13/ Pigoski, T. M. (1997). Practical Software Maintenance. Best Practices for Managing Your Investment. John Wiley & Sons, USA.

/14/ Polo, M., Piattini, M.G., Ruiz, F. and Calero, C. (1999). *MANTEMA: a Complete Rigorous Methodology for Supporting Maintenance based on The ISO/IEC 12207 Standard.* Proc. of the 3rd European Conf. on Softw. Maint. and Reeng. Amsterdam (The Netherlands).

/15/ Polo, M., Piattini, M., Ruiz, F. and Calero, C. (1999). *Using the ISO/IEC 12207 Tailoring Process for Defining a Maintenance Process.* Proceedings of the First IEEE Conference on Standardisation and Innovation in Information Technology (SIIT '99). Aachen (Germany).

/16/ Polo, M., Piattini, M., Ruiz, F and Calero, C. (1999). Roles in the Maintenance Process. *Software Engineering Notes*, 24(4), 84-86.

/17/ Pressman, R.S. (1993). Software Engineering. A practioner's approach. McGraw-Hill.

/18/ Rao, H.R., Nam, K. and Chaudhury, A. (1996). Information Systems Outsourcing. *Communications of the ACM*, 39(7), 27-28.