HISTORICAL PERSPECTIVE ON THE STATE OF SOFTWARE PROCESS IMPROVEMENT

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1. SUMMARY

CMMI and ISO/IEC 15504 (SPICE), the international standard for the assessment and improvement of software processes, provides a framework for the improvement of the organization of software development, whose application became a prerequisite for a software organization to be considered as a reliable business partner already in the 1990's. They are related in this sense to the ISO 9001 standard, they are however significantly more useable originally in the case of the software, but currently in the case of arbitrary processes as well.

The paper presents an update of the change of our expectations regarding software processes and their improvement from a historical perspective following the Software Process Improvement Hype Cycle [1] introduced earlier by the author as an extension of the Gartner Hype Cycle idea.

2. THE SOFTWARE PROCESS IMPROVEMENT HYPE CYCLE

The popular concept of Hype Cycle was coined in 1995 at the Gartner information technology research and advisory company based in the U.S. Referring to the complete analysis of the subject to [2], the phases of this hype cycle, originally applied to emerging technologies are:

(A) "Technology Trigger"

(B) "Peak of Inflated Expectations"

(C) "Trough of Disillusionment"

(D) "Slope of Enlightenment"

(E) "Plateau of Productivity"

The software process improvement movement started with the CMM being a significant innovation. The hype cycle was triggered at the end of the 1980's and went through phases, which do not purely follow the one promoted by Gartner. The reason of the difference is the support and acceptance of the model by the U.S. Department of Defense, which helped the CMM avoiding the full trough of disillusionment by supporting continuous innovation in the form of the Capability Maturity Model Integration (CMMI) for example. CMMI is both the result and the further catalyst of the spreading of process maturity models to other disciplines than software development. This plateau of spreading to other disciplines and models is followed by the trough of doubts and new triggers like agile software development with a new hype cycle starting with new expectations. Feelings are still high more than 2 years after the first version of this paper, however besides the light of reconciliation and a new plateau of industrial adoption, further triggers are emerging.

The altered hype cycle of software process improvement consists of the following phases:

(A) Awareness of process capability weaknesses triggered by the software crisis and CMM.

(B) SPI and ISO 9000 expectations.

(C) Bridging the trough of disillusionment.

(D) Enlightenment leading to further recognition of the importance of business goals.

(E) Plateau of spreading to other disciplines and models.

(F) Trough of doubts and new triggers.

(G) Plateau of reconciliation and industrial adoption.

The particularity of this software process improvement hype cycle is exactly the bridging of the trough of disillusionment by the supported continuous innovation of the CMM, which led to version 1.0 of the CMMI in the year 2000 followed by new high expectations, a plateau of spreading to other disciplines, another trough of doubts, and the new plateau of reconciliation and industrial adoption.

3. FIRST PHASE: AWARENESS OF PROCESS CAPABILITY WEAKNESSES TRIGGERED BY THE SOFTWARE CRISIS AND CMM

One of the most cited proofs of the software crisis is the Standish Group Chaos Report regularly published since 1994. It has recently been discovered, that there are fundamental problems with the Chaos Reports which only question however their current validity. “The figures indicate large problems with software engineering projects and have had an enormous impact on application software development. They suggest that the many efforts and best practices put forward to improve how companies develop software are hardly successful. Scientific articles and media reports widely cite these numbers. Many authors use the figures to show, that software development project management is in a crisis.” “Standish’s definitions suffer from four major problems that undermine their figures’ validity.” [3]

The process improvement movement, intended to overcome the software crisis, was initiated by the SW-CMM developed under the leadership of Watts Humphrey at the Software Engineering Institute (SEI) [4]. Its fundamental recognition was that the quality of the process determines the quality of the product. This slogan became more and more accepted in industrial production in general and in the software industry in particular [5].

The supported continuous innovation of the CMM professionally bridging the trough of disillusionment of the generic innovation hype cycle, naturally following the peak of SPI expectations was discussed in the earlier paper [1].

4. SECOND PHASE: SPI AND ISO 9000 EXPECTATIONS

During the 1990’s several other initiatives emerged to support software developers accepting the fundamental recognition, that the quality of the process determines the quality of the product.

The most popular of these is the ISO 9000 series of standards first published in 1987 followed by the ISO 9000-3 Guidelines to the Development, Supply, and Maintenance of Software in 1990. ISO 9001:1987 focused on quality control via retroactive checking and corrective actions, ISO 9001:1994 emphasised quality assurance via preventive actions, while ISO 9001:2000 (as well as ISO 9001:2008) makes expectations of continuous process improvement and tracking customer satisfaction explicit. It is incorporating more TQM elements and converging to CMM [6]. This convergence is particularly apparent in the ISO 9004:2000 Guidelines for performance improvements where a CMM-like staged model is presented.

In addition to the ISO 9000-3 guidelines, there exist other types of international software quality standards whose relationship to the ISO 9000 series is enlightening. It was already described in the introduction, that the evaluation of the quality of a software product is one of the basic issues in information technology. A system of product quality criteria was summarized in the ISO/IEC 9126 standard, which is evolving today into the ISO/IEC 25000 series. The first level of the criterion hierarchy contains the following six elements: functionality, reliability, usability, maintainability, portability and efficiency. The business decisions that are supported by this standard are as follows:

- Does the software requirements specification adequately reflect the user requirements?
- Does the developed software satisfy the user requirements?

[5] highlight however fundamental business decisions, which are not supported by systems of product quality criteria and which justify the existence of the ISO 9000 series of standards as well as that of software process assessment and improvement approaches, which go beyond ISO 9000. These decision problems are:

- The customer's decision problem: Is the supplier able to sustain the reliability of its production?
- The supplier's decision problem: How can we improve the reliability of the production?

ISO 9000 certification is intended to support the customer's decision by focusing on the process rather than on the product. Nevertheless, certification is a yes/no decision which provides little support for the supplier's decision problem. It is precisely software process assessment and the corresponding improvement action plan which serve the fulfillment of the supplier's need.

5. THIRD PHASE: BRIDGING THE TROUGH OF DISILLUSIONMENT

One of the major criticisms of ISO 9000:1994 was that its introduction became a burden with the overwhelming "ISO bureaucracy", which was only meant to control the production and was not ready to adapt to the permanent change of processes, technology and customer demands. This problem led to heavy disillusionment in ISO 9000 during the 1990's which is keeping up today as well despite the new 2000 versions, which are theoretically much more flexible. The blame for the continuing criticism rests with the consultants and auditors as well, who are rarely open to new paperless approaches otherwise permitted by the standard, which can even be combined with model based process improvement like CMMI and the emerging ISO/IEC 15504 international standard.

One of the experiences successfully combining model based process improvement with the achievement of ISO 9000 certification is described in [7]. The main lessons derived from this experiment are the following:

- The approach of considering the improvement of the maturity level as the principal objective and the achievement of ISO 9001 certification as a side-effect is valid from the efficiency point of view.
- Even if ISO 9001 certification is not the principal objective of process improvement, it is worth capitalizing on its high recognition by allocating appropriate resources to its achievement.
- According to international experiences, there is usually a significant decline of attention towards the quality system after the ISO 9001 certificate is granted. The approach of considering certification as a side-effect of overall process improvement helps avoiding this trap.

Disillusionment regarding the CMM can be perfectly detected in the literature. [8] write: "Still, we detect more than a little discouragement about the pace of process improvement. About a quarter of our respondents say that "nothing much has changed" since the appraisal. Almost half say there "has been a lot of disillusionment over the lack of improvement." Over 40 percent say that process improvement has been overcome by events and crises and that other things have taken priority. Almost three-quarters tell us that process "improvement has often suffered due to time and resource limitations"; over three-quarters say that process improvement has taken longer than they expected; over two-thirds say that it has cost more than they expected."

Measurable and well published research results, together with considerable work invested into the development of the also well publicized Capability Maturity Model Integration in the year 2000, contributed to bridging the trough of disillusionment of the CMM hype cycle.

There was another earlier mentioned SPI initiative Bootstrap which played a pioneering role in introducing SPI in Hungary [9]. The activity of the Bootstrap Institute ended however in 2003. Bootstrap and actually the CMM itself were on the other hand precursors of the international standardization initiative called Software Process Improvement and Capability dEtermination (SPICE), which went through a long and turbulent trial phase during the 1990's. SPICE survived the trough of disillusionment due to a complete rework including generalization to all processes not restricted any more to those related to software. The finally published standard is ISO/IEC 15504 whose new parts are still appearing nowadays. According to the decision of ISO in May 2009, 15504 will be replaced with the 31001 series of standards.

6. FOURTH PHASE: ENLIGHTENMENT LEADING TO FURTHER RECOGNITION OF THE IMPORTANCE OF BUSINESS GOALS

ISO bureaucracy was already mentioned as a burden preventing the achievement of business goals including flexible adaptation to the permanent change of processes, technology and customer demands. After signs of disillusionment, other SPI approaches were also rediscovered in the context of their actual potential contribution to business success. And this is actually one of the gateways to level 4 in the reworked and published ISO/IEC 15504 standard as well.

This issue is systematically discussed among others in the chapter on "The Software Process in the Context of Business Goals and Performance" of the book [10] still quoted by business consulting experts [11], as well as the paper [12], which analyse the ways software process improvement can provide leverage to a firm from the financial, operating, production, marketing, and human behavioural perspectives.

A further issue, which becomes highly relevant with the rising globalization of business operations, is the consideration of the differences in

cultural value systems when introducing new management processes. This issue is discussed in the context of SPI in [13] and in [14].

7. FIFTH PHASE: PLATEAU OF SPREADING TO OTHER DISCIPLINES AND MODELS

As already discussed, the continuous innovation of the CMM resulted in the publication of the CMMI in the year 2000.

The most recent model integrated into the CMMI Framework is [15] which "draws on concepts and practices from CMMI and other service-focused standards and models, including

- Information Technology Infrastructure Library (ITIL)
- ISO/IEC 20000: Information Technology–Service Management
- Control Objects for Information and related Technology (CobiT)
- Information Technology Services Capability Maturity Model (ITSCMM)"

As far as ISO/IEC 15504 is concerned, it already serves any discipline since its actual publication.

It is important to mention multifaceted synergies discovered between the ISO/IEC 15408 (Common Criteria) IT Security Evaluation standard, software product quality evaluation standards and process assessment models [16].

8. SIXTH PHASE: TROUGH OF DOUBTS AND NEW TRIGGERS

Doubts in the effectiveness of approaches, which were summarily characterized as "heavyweight", culminated in the Agile Manifesto.

The Agile Manifesto highlights the imminent sources of disillusionment by pointing out the higher value it attributes to

- "individuals and interactions over processes and tools,
- working software over comprehensive documentation,
- customer collaboration over contract negotiation,
- responding to change over following a plan."

And there is in important additional sentence, which opens the way to the following phase of the hype cycle: "That is, while there is value in the items on the right, we value the items on the left more."

In fact, agile methods have roots dating far back from the manifesto. Two of the most prominent representatives of the direct roots are Barry Boehm with the spiral model for software development [17], and Tom Gilb who was the first to argue for very similar principles in his evolutionary method for software engineering management already in the 1970's, and who published the recognized book [18] before the wide appearance of the CMM.

A clear effect of the agile movement is that it triggered a new hype cycle where it may itself approach the trough of disillusionment, which has even received a rotund name: "death of agile", which may on the other hand be no more than the result of malpractice in many cases.

9. SEVENTH PHASE: PLATEAU OF RECONCILIATION AND INDUSTRIAL ADOPTION

One of the most imminent signs of reconciliation between the "heavyweight" and agile is the CMMI itself, whose version 1.3 [19] published in 2010 states that: "Informative material was improved, including revising the engineering practices to reflect industry best practice and adding guidance for organizations that use Agile methods."

As far as reconciliation with the ISO/IEC 15504 community is concerned, doors have always been open as detailed in [1].

Integrating all approaches with the aim to benefit the software, systems and services industry, the EuroSPI^2 partnership launched the SPI Manfesto [20] world-wide in 2009.

10. LIST OF REFERENCES

[1] Miklós Biró (2009): *The Software Process Improvement Hype Cycle*. Invited contribution to the Monograph: Experiences and Advances in Software Quality (Guest editors: D.Dalcher, L. Fernández-Sanz) CEPIS UPGRADE Vol. X (5) pp. 14-20. http://www.mtakpa.hu/kpa/download/1290381.pdf (accessed: 15/01/2012) http://www.cepis.org/files/cepisupgrade/issue%20V-2009-fullissue.pdf (accessed: 15/01/2012)

[2] Fenn, J.; Raskino, M. *Mastering the Hype Cycle*. Harvard Business Press (2008).

[3] J. Laurenz Eveleens and Chris Verhoef: *The Rise and Fall of the Chaos Report Figures*. IEEE Software (January/February 2010)

[4] Humphrey, W.S., Sweet, W.L.: *A Method for Assessing the Software Engineering Capability of Contractors*, Software Engineering Institute, CMU, Technical Report CMU/SEI-87-TR-23, 1987.

[5] Biró,M.; Sz.Turchányi,P. *Software Process Assessment and Improvement from a Decision Making Perspective*. ERCIM News (European Research Consortium for Informatics and Mathematics) No.23 (1995) pp.11-12. http://www.ercim.org/publication/Ercim_News/enw23/sq-sztaki.html (accessed: 15/01/2012)

[6] Biró,M; Feuer,É.: *Convergence of the Software and Systems Engineering Capability Maturity Models (CMM, CMMI) and ISO 9000:2000*. In: Proceedings of the X. Quality Week International Conference (ed.by A.Róth, I.Jancsovics). (Hungarian Quality Society, 2001) pp.136-141. (in Hungarian)

[7] Biró,M.; Ivanyos,J.; Messnarz,R. *Pioneering Process Improvement Experiment in Hungary*. Software Process: Improvement and Practice (John Wiley & Sons, Ltd.) Volume 5, Issue 4, 2000. Pages: 213-229. http://www3.interscience.wiley.com/cgi-bin/abstract/76503384/START (accessed: 15/01/2012)

[8] Dennis R. Goldenson; James D. Herbsleb. *After the Appraisal: A Systematic Survey of Process Improvement, its Benefits, and Factors that Influence Success*. Technical Report CMU/SEI-95-TR-009 ESC-TR-95-009 (August 1995).

[9] Biró,M., Feuer,É., Haase,V., Koch,G.R., Kugler,H.J., Messnarz,R., Remzsô,T.: *BOOTSTRAP and ISCN a current look at the European Software Quality Network*. In: The Challenge of Networking: Connecting Equipment, Humans, Institutions (ed. by D. Sima, G. Haring). (R.Oldenbourg, Wien, München, 1993) pp.97-106.

[10] Biró,M.; Tully,C. *The Software Process in the Context of Business Goals and Performance*. Chapter in the book entitled Better Software Practice for Business Benefit (ed. by R. Messnarz, C. Tully). (IEEE Computer Society Press, Washington, Brussels, Tokyo, 1999) (ISBN 0-7695-0049-8). http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0769500498.html (accessed: 15/01/2012)

[11] http://www.pmqgsolutions.com/Quotations.html (accessed: 15/01/2012).

[12] Biró,M.; Messnarz,R. *Key Success Factors for Business Based Improvement*. Software Quality Professional (ASQ~American Society for Quality) Vol.2, Issue 2 (March 2000) pp.20-31. http://www.asq.org/pub/sqp/past/vol2_issue2/biro.html (accessed: 15/01/2012)

[13] Biró,M; Messnarz,R; Davison,A.G. *The Impact of National Cultural Factors on the Effectiveness of Process Improvement Methods: The Third Dimension*. Software Quality Professional (ASQ~American Society for Quality) Vol.4, Issue 4 (September 2002) pp.34-41. http://www.asq.org/pub/sqp/past/vol4_issue4/biro.html (accessed: 15/01/2012)

[14] Biró, Miklós; Fehér, Péter (2005): *Forces Affecting Offshore Software Development*. In: I. Richardson et al (Eds.), Lecture Notes in Computer Science, Volume 3792/2005, Springer-Verlag, pp.187–201. (ISBN 3-540-30286-7). http://dx.doi.org/10.1007/11586012_18 (accessed: 15/01/2012)

[15] *CMMI® for Services, Version 1.2 CMMI-SVC, V1.2* CMU/SEI-2009-TR-001 ESC TR 2009 001

[16] Biró,M; Molnár, B. *Synergies Between the Common Criteria and Process Improvement*. Springer Lecture Notes in Computer Science 4764**:** *pp. 31-45.* (2007) http://dx.doi.org/10.1007/978-3-540-75381-0_4 (accessed: 15/01/2012)

[17] Boehm B. *A Spiral Model of Software Development and Enhancement*, IEEE Computer 21(5):61-72, May 1988

[18] Gilb, T. *Principles of Software Engineering Management*. Addison-Wesley, 1988.

[19] *CMMI® for Development, Version 1.3*. http://www.sei.cmu.edu/reports/10tr033.pdf (accessed: 15/01/2012)

[20] *SPI Manifesto Version A.1.2.2010* http://www.eurospi.net/images/documents/spi_manifesto.pdf (accessed: 15/01/2012)