Software Process Engineering Activities in Québec

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A**bstract**

This paper is divided in two parts. The first part will present the Applied Software Engineering Centre, its history, its mission, and the services offered. The second part will present a brief profile of organizations that have undertaken to improve software processes utilizing mainly the Capability Maturity Model developed by the Carnegie Mellon University Software Engineering Institute. This paper is an update of a presentation given on the occasion of a workshop held at GMD, a German software research centre. (Laporte 1993, 1995).

Key Words: Software Engineering, Applied Software Engineering Centre, Capability Maturity Model, Software Engineering Institute, Trillium, Management of Changes.

1 The Applied Software Engineering Centre.

The Applied Software Engineering Centre (ASEC) was created as a result of an agreement between the Computer Research Institute of Montréal (CRIM) and six Canadian corporations committed active in the development and maintenance of software for critical applications: Bombardier-Canadair, CAE Electronics, Keops Informatique, Loral Canada, Oerlikon Aerospace and Spar Aerospace.

An action had been undertaken in 1988 in the form of a feasibility study financed by 13 companies and the federal and Québec governments, with the participation of the Collège militaire de Saint Jean,

which confirmed the role and importance of software engineering in improving the productivity and competitiveness of Canada's industry.

Encouraged by these results, the study's sponsors decided in 1990 to draw up a business plan aimed at creating a software engineering centre, the mission of which would be to assume a leadership role the technological level and to assist industry, where such an expertise is required, to improve their competencies in software engineering. In 1991, the Applied Software Engineering Centre became a division of CRIM.

ASEC was created to respond to an urgent need expressed by the industry in Canada, which is facing a challenge the outcome of which will be decisive. Although information technologies have become an overriding factor of productivity and innovation in all sectors of activity and although demand for more and more complex software has increased in a spectacular way, the lags in terms of software development as well as the lack of qualified personnel are seriously hampering our industry's progression. In this matter, cost overruns, schedule slips, lack of product friability and system failure due to software bugs are innumerable. Even worse, in certain critical applications, these problems can have serious repercussions on public security or result in significant financial or social losses.

The mission entrusted to the Applied Software Engineering Centre is to provide access to and training in the best software engineering managerial and technical solutions. Its target clients comprise companies and agencies that rely on information technology to improve the productivity and quality of their services and products. ASEC offers four main categories of services: services related to software engineering process such as software process assessment, auditing of suppliers' competencies and advising, training, awareness to new technologies by means of appropriate activities, as well as implementation of and relevant support to specific interest groups. ASEC is also part of a network of similar centres subsidized by the federal government.

ASEC signed in December 1995 a co-operation and research agreement with the Software Engineering Institute (SEI) of Carnegie Mellon University. In accordance with this first SEI's international agreement, ASEC is not only able to utilize the SEI's assessment methods to assess the maturity of the software process engineering, but also transfer to industry in a more efficiently way methods and technics permitting to improve software development and maintenance practices.

Until now, the "Capability Maturity Model" (CMM) has only existed in English, which limited considerably its usage for the French-speaking community. Fortified by its strategic agreement with the SEI, ASEC jointly with organizations from France (CEGELEC, Dassault Électronique, the French

Department of Defence, Snecma Elecma and Thomson-CSF) and other from Quebec (Bombardier and Hydro-Québec) as well as the federal and Quebec governments (respectively Industry Canada and ministère de l'Industrie, du Commerce, de la Science et de la Technologie) the translation into French of the Capability Maturity Model developed by the SEI. ASEC also participates in the creation of software Web site in French. This Web site will comprise not only French translations but also information conceived and circulated in French through all French-speaking communities.

2 First Experiments with the Maturity Model

A first exposure to the software process assessment methodology developed by the Software Engineering Institute (SEI) was done in Montréal in the summer of 1989. Two members of the technical staff of the SEI conducted a one-day workshop at École Polytechnique, Montreal. The workshop was attended by 50 persons. The participants came mainly from defence, aerospace and finance organizations, of both the private and public sectors. During the workshop, the participants answered the SEI questionnaire, that was used to conduct formal **assessments [1]. The questionnaires were compiled, and the results were that 93%** of the participants to this workshop worked for organizations at the initial maturity level (level 1) and the remaining 7% were at the repeatable level (level 2) of the maturity scale. Although the assessment of organizations according to the SEI's approach would have been far more stringent, these results remain nevertheless indicative of the situation prevailing at that time.

As a comparison, the United States conducted similar workshops and gathered **data from 113 projects [2]. The assessment workshop results as of January 15,** 1989, indicate that the majority (86%) of the participants reported projects at the initial level (level 1). Fourteen per cent (14%) of the participants reported projects at the repeatable level (level 2) and one per cent (1%) reported projects at the defined level (level 3). Moreover, in 1993, the SEI presented the results of 150 U.S. organizations which proceeded to formal assessments (Zubrow 1993). The participating organizations were not randomly selected. Therefore, they do not necessarily constitute a valid sampling of U.S. organizations. None of the participating firms were performing at level 4 or 5. Seven per cent (7%) of the organizations were at level 3; nineteen per cent (19%) were at level 2 and seventy-four per cent (74%), at level 1. Data published in 1995 by the SEI indicate that 73% of the 379 assessed organizations stood at level 1, 16% were at level 2, 10% were at level 3, 0.6% were at level 4, and 0.3% at level 5.

Following the tutorial held at École Polytechnique, some organizations decided to conduct software process assessments. The following section will present capability maturity models as well as the organizations that have performed software capability assessments.

3 Software Capability Models

The Capability Maturity Model (CMM) (Paulk 1993) is a model of the key practices to be implemented in any organization desirous to develop or increment software aiming at a high quality and a significant productivity. Based on concepts of total quality and continuous improvement, the CMM was developed by the Software Engineering Institute (SEI) and was the object of a wide consensus on the part of the software community. It quickly became a standard de facto, first in the United-States then worldwide, to assess the maturity of an organization's software. It can be used as is, as a manual of good practices , but also as a reference for audits or assessments within an organization specialized in software development and maintenance. Table 1 presents the main features for each of the five levels of maturity. To pretend to a level of maturity, an organization must have implemented all key sectors of the level it pretends to as well as those of the lower levels.

Using this model as a base, the SEI rightly developed a certain number of assessment methods for the organizations which develop or maintain software. One of them called CBA IPI (Capability Maturity Model - Based Appraisal for lnternal Process lmprovement) is not aimed at auditing a software supplier but at enabling him to examine internally his own practices in view of deriving an improvement plan to be applied to its own software organization.

Since 1982 (Coallier 1995), Bell Canada has also been developing a Software Capability Maturity Model to assess the processes of its telecom systems suppliers in view of reducing risks. Trillium is now part of the management program of Bell Canada's suppliers. Trillium insists on the self-improvement of software manufacturing processes as an approach allowing to improve the quality and reliability of telecommunication systems and reduce their operation and maintenance costs. This is critical when considering that Bell Canada's telecommunication network depends on more than fifty million code lines.

Level	Characteristics	Key Process Areas
5 Optimizing	Continuous process capability improvement	Process change management Technology change management Defect prevention
4 Managed	Quantitative measurement of process and qualitative management of product	Software quality management Quantitative process management
3 Defined	Software processes defined and institutionalized	Peer reviews Intergroup coordination Software product engineering Integrated software management Training program Organization process definition Organization process focus
2 Repeatable	Management controls in place; stable planning and product baselines; still dependent on individuals for new products	Software configuration management Software quality assurance Software subcontract management Software project tracking & oversight Software project planning Requirements management
1 Initial		

Table 1. Software Capability Maturity Model

Trillium was developed by Bell Canada, Nortel and Bell Northern Research. Although strongly inspired by the CMM Model, several requirements were drawn from the ISO, Bellcore, IEEE standards as well as from the criteria related to the Malcom Baldrige National Quality Award. A major difference between the CMM and Trillium is that the latter contains key sectors the capability of which varies on a five-level scale (road map) contrarily to CMM where each key sector lies at one capability level only. The Trillium model also comprises practices that are not covered in the CMM. A France-Quebec project deals with the translation of Trillium and adding practices for use in the management software sector. This model called Camelia was tested both in Quebec and in France, in 1995. It should be published very soon.

4 Some Process Experiences in Québec

The data published here have been supplied by the organizations themselves and not by ASEC, since the latter has to respect the confidentiality of the steps taken by the organizations. Moreover, we will only be discussing the organizations that have undertaken the improvement of their processes utilizing either the CMM, a model, or an assessment method associated to a software capability maturity model such as Trillium.

In 1990, CAE Electronics, in collaboration with Bombardier-Canadair, decided to go ahead in performing a Software Process Assessment using the SEI's assessment method. This division of CAE Electronics is responsible for the maintenance of the software of the Canadian Armed Force's CF-18 fleet. (aircraft est invariable). For this assessment, it was decided that the assessment team would be composed of representatives from the customer's organization as well as representatives from the assessed organization. The on-site assessment was performed in February of 1991 and the action plan was published in September. The costs of process assessment and improvement activities (Lambert 1992) are summarized below (Table 2). This division has also performed, in collaboration with ASEC staff, in the summer of 1994, an assessment using the new method developed by the SEI. This method is called CBA/IPI (Capability Maturity Model - Based Appraisal: Internal Process Improvement). We know that this site was assessed at maturity level 2, hence mastering all objectives of the 6 key sectors of the CMM. The assessment has also showed that several objectives of level 3 were reached.

Assessment training and consulting cost:		Cdn $40,000
Labour:		
	Training	160 hours
	On-site assessment	240 hours
	Action plan elaboration	500 hours
	Action plan implementation	2,500 hours

Table 2: Assessment and Improvement Costs

In 1991, Loral Canada, formerly known as Paramax Systems Canada, decided to perform an SEI assessment. Loral Canada is an organization mainly responsible for the development of the Canadian

patrol frigate's computer system. The 2 million source lines of code software were developed by a large team of over 200 engineers, geographically dispersed in Canada and in the United States. Since 1991 Loral has been improving its processes using the SEl's CMM, TQM (Total Quality Management) and ISO 9000 principles.

In 1993, four organizations performed SEI assessments. The first organization is the province of Québec's electricity supplier: Hydro-Québec. Its automatization department conducted an in-house assessment using the SEI questionnaire (Humphrey 1987). This department, staffed with 17 people at that time, is mainly responsible for the development and maintenance of real-time embedded software that controls the Quebec's electrical network.

The second organization that conducted an assessment in 1993 is Oerlikon Aerospace. This organization is responsible for the production of an air-defence anti-tank system. The software engineering department, staffed with over 20 people, is responsible for the maintenance of the weapon's software; the command control and communication system's software; simulation software and instrumentation software. These four software domains add up to 530,000 source lines of code. The on-site assessment was done in collaboration with the customer, in the spring of 1993. The action plan was completed in December 1993 and the process improvement activities were initiated in January 1994. The action plan aims at implementing within Oerlikon Aerospace level 2 and 3 practices in compliance with the SEI's model. The organization is planning a re-assessment by fall of 1996.

The third organization that performed an assessment is the Montréal Trust. Montreal Trust has been, since then, acquired by the Scotia Bank. Montreal Trust used to offer a range of financial and trust services. It administered assets of $64 billion. The on-site assessment was done in spring of 1993 and the recommendations were presented to management in fall of 1993. Montréal Trust was assessed as a strong level 2 and was expected to reach level 3 by the end of 1994.

CAE Electronics is the fourth organization that performed an assessment in 1993. CAE Electronics mainly develops and manufactures a wide range of military and civilian simulators. In September, the Energy Control System Department, staffed with 90 software engineers, performed an assessment of its processes in collaboration with a customer. CAE uses the ISO 9000 standard as an objective and the CMM as a guide to implement practices compliant to the ISO standard.

The management responsible for the Network Technologies (DTR) of Hydro-Quebec's research institute (IREQ) has undertaken to improve its processes in 1994. This initiative follows the basics of several development models, particularly the CMM. At IREQ's, the improvement is done by establishing methodological guides, such as definition of the requirements, the development plan and the typical mandate, related to software engineering and system engineering fields. By the end of 1996, the DTR should ensure a repeatable development process and be able to supply process descriptions and/or documentary standards for each step of development, as well as umbrella activities in planning and project-tracking, configuration management and quality-assurance support. It is also foreseen to perform an assessment of the processes in 1996 and a follow-through assessment in 1998. The DTR's objective is having a defined process, i.e. a level 3 one according to the CMM, by 1999.

In 1994, the IST Group started a process improvement initiative using the S:PRIME assessment method (this method is described further in this text). This initiative began by a training session in 1994, followed by a series of assessments in 1995 in Toronto, Quebec and Montreal. An action plan was approved in May 1995. The initiative permitted to identify the best practices, to complete their descriptions and transfer them in other sectors. Each sector could customize the practice to its own requirements. One of the objectives aims at obtaining the ISO certification in 1996.

In 1994, the company Ericsson undertook an improvement program. The ISO certifications had been obtained in 1993. The initiative followed a reflection on the challenges to be faced by companies world-wide. Following this reflection, it was decided that the software capabilities were among the company's major objectives. In May 1995, an assessment was realized in Montreal by a team of experts belonging to the mother company. It is interesting to underscore here that Ericsson conducted over twenty assessments on its various sites. The assessment method used was very similar to CBA/IPI. Elements were added to it, from the assessment method called "European Quality Award" in order to add practices that were not covered by the method CBA/IPI. The company foresees to conduct a second CBA/IPI assessment in 1997 using the S:PRIME method to assess the progress made between two major assessments.

5 Process Related Activities

Montréal is the host of a SPIN (Software Process Improvement Network). Essentially, a SPIN is an interest group composed of software professionals from industry, government, academia, professional organizations, and consulting agencies. The SPIN provides a forum for the free and open exchange of

information on software process improvement. The SEI provides some support to the SPIN [5]. In fact, the SPIN in Montréal is part of an international network of interest groups called "SPIN for Software Process Improvement Network". The 1996 directory listed 42 U.S. and 29 international SPIN organizations. The Montréal SPIN was founded in 1993. Its mission is to facilitate the understanding, the adoption and the deployment of proven or innovation solutions for software process improvement. Each year, the SPIN organizes events such as tutorials, workshops and round tables. The SPIN is affiliated to the Applied Software Engineering Centre; the meetings are generally held at ASEC facilities. In addition, the SPIN benefits from the administrative services offered by ASEC (e.g. mailing, reservation, accounting). The co-operation between the Montreal-SPIN, ASEC and the SEI will give rise to an international symposium on software process improvement to be held in Montreal in October 1996. This symposium will aim at gathering managers, professionals and contributors intervening in the continuous implementation and improvement of system and software processes. It represents a unique opportunity to perfect participants' knowledge and enrich their vision by sharing their experience and concerns on subjects such as investing, stakes, risks, profits and international trends re process improvement.

ASEC also hosts an interest group that focuses on software engineering standards. More specifically, this group is very active in the ISO-SPICE project (lnternational Standards Organization Software Process lmprovement and Capability Determination [6]. In collaboration with the interest group, ASEC participated to the first field trials of this forthcoming ISO standard, in 1995. More than 35 international organizations participated in these field trials, of which one took place in Quebec. Hydro-Québec's Automatisation Department, i.e. 35 people, participated to the field trials. An action plan was developed following the assessment: it integrates both the concepts of the SPICE model and those of the SE-CMM model (Systems Engineering CMM). The second SPICE field of trials will begin in May 1996 and will last 12 months. Again, the GINIGL and ASEC will play a major role in the co-ordination of the field of trials in Canada, Central America and South America.

A committee on Software Process was spawned from the IEEE Computer Society Technical Committee on Software Engineering (TCSE). The mandate of this committee is to help structure and improve communication within the process community. The committee is chaired by professor Nazim Madhavji of McGill University. This committee publishes a Newsletter as part of the TCSE Newsletter (IEEE) [7].

Since most of Québec's software is developed in small or medium business, it was felt that these organizations could not afford the resources of performing an assessment of the type of CBA/IPI and still be able to set aside resources needed to address the findings of the assessment. ASEC, in collaboration with industrial partners, developed a risk evaluation method based essentially on the CMM key process areas. The method, called S:PRIME (Software: Process Risk ldentification Mapping and Evaluation), puts the CMM in contact with the risks software companies or projects face. The taxonomy of these risks constitute the results of the work performed by the SEI these past years. The result of an assessment of S:PRIME type consists in an identification of the risks the organization or the project are faced with, as well as in an identification of the CMM practices that should be improved or introduced in the organization or project in order to prevent these risks. (Poulin 1996). ASEC has conducted seven S:PRIME assessments in 1994 and eleven assessments in 1995. Other assessments are planned in 1996, of which two in Chile and one in France. The method typically takes 100 staff-hours to perform the assessment of an organization. Once an organization has been trained, it can perform by itself follow-up S:PRIME assessments in order to track action plan progression or identify other areas of priority. In this aspect, ASEC is presently involved in the preparation of a training that will permit, within a few months, to transfer this technology to the Canadian industry more efficiently.

The Personal Software Process (PSP) is a framework for doing disciplined software engineering. The PSP was developed under the direction of Watts Humphrey (HUMPHREY 1994) of the SEI. The PSP consists in activities similar to several key sectors of the CMM. Essentially, PSP shows professionals how to use measurements and statistical methods to plan and control their work. It also helps them to make accurate plans, to estimate the accuracy of these plans, and to track their performance. They learn to define, evaluate and improve a software process that is tailored to their own evolving personal needs. This helps them to evaluate and progressively improve their own performance.

Table 3 lists organizations known by the author, that are actively involved in software process engineering activities. So far, most assessments were performed by large organizations, using the SEl's approach. ASEC performed at least five assessments since April 1994 and expects to conduct another five in 1996-97. Since in Québec the number of small and medium organizations outnumbers the number of large organizations, we expect a growing use of S:PRIME method. Finally, it is expected that SPICE will become and ISO standard in 1998. It is possible that organizations choose to wait two or three years before deciding whether to adopt this type of assessment or stay with the SEI’s approach. It is also possible that the SEI decides to map its maturity model to the SPICE framework. It

is worth mentioning that the SEI is collaborating to the development of a System Engineering Capability Maturity Model (CMM). This CMM is using a framework nearly identical to the SPICE framework for the mapping of process areas and maturity levels (Bate 1995).

Organization	Sector	Year	Activity
CAE Electronics and Bombardier-Canadair	Defence	1991	SEI - SPA (1)
Loral Canada	Defence	1991	SEI - SPA
Hydro-Québec	Utility	1993	Internal assessment using SEI - CMM
Oerlikon Aerospace	Defence	1993	SEI - SPA
Scotia Bank (Montréal-Trust)	Finance	1993	SEI - SPA
CAE Electronics	Energy Management	1993	SEI - SPA
Hydro-Québec- IREQ	Utility - Research	1994	Internal assessment using CMM
Ericsson	Telecommuni-cations	1994	SEI - CBA / IPI (3)
CAE Electronics and Bombardier-Canadair	Defence	1994	SEI - CBA / IPI (4)
Canadian Marconi	Defence	1994	SEI - CBA / IPI
M3i	Network Management	1994	S:PRIME
Hydro-Québec	Utility Automatisms	1995	SPICE
IST Group	Information Systems	1995	S:PRIME
CRIM	Research & Development	1995	S:PRIME

Table 3: Software Process Activities in Québec

Note:
1. SEI - SPA: Software Engineering Institute Software Process Assessment with third party.
2. Internal assessment using SEI - CMM conducted without participation of third party.
3. SEI - CBA/IPI: SEI - CMM based-assessment: Internal Process Improvement with third party together with additional practices.
4. SEI - CBA/IPI: SEI - CMM based-assessment: Internal Process Improvement with third party.

7 The Software Capacity Maturity Model and the ISO 9000 Standard

Given the lack of space, we will not compare here these two approaches. However, should the reader wish to compare them, we suggest he reads the technical report produced by the Software Engineering Institute (Paulk 1994a) or an article in the IEEE Software magazine (Paulk 1995). It can still be indicated here that there a close correlation between the two approaches. Each approach presents features that the other one does not have. In the next version of the CMM, the SEI intends to bring practices that will enable a better coverage of the ISO standard. The ISO 9001 standard must also be revised thoroughly in 1996.

8 Lessons Learned

These assessments enable us to learn certain lessons likely to be used by other organisations or companies in the future.

Appropriate expectations must be set prior to embarking on a process improvement journey. The trap consisting in communicating to management the idea that the initiative will be easy, fast and inexpensive has to be avoided at all costs. As a first step, a top management member realises the benefit that attaining a maturity level can represent for his organisation's competitiveness. As second step, a project manager or an external consultant states, in order to upset the top management, that this objective is easily attainable. As a third step, top management gives managers the mandate to attain this objective in a very short lapse of time. During the assessment, the managers face countless a string of findings. Findings that had been known by developers for a long time, but remained ignored due to the mode of management that consists in dealing continuously with the problems created, in a clumsy way at times, by managers. Top management, that had maybe already announced its objective to its

peers from other organisations, realises suddenly that this objective will take a lot more time and resources than what had been estimated. At that time, three reactions are possible. Top management may accept the findings and confirm that it will continue to support the objectives announced. It may announce discreetly that it will be lowering its objectives. Finally, it can deny everything and renounce to implement an action plan to correct the deficiencies highlighted by the assessment. This decision could have a destructive effect on developers, since they know for a fact that the deficiencies they had been deploring for a long time are now known by everybody and will remain ignored for a long time. The lesson to be remembered is to prepare a first action plan -- some sort of a brief appraisal of the situation status -- preferably by someone who is not involved in the sector targeted and to assess the time and resources necessary to assessing, writing and implementing the action plan. One has to remember top management does not like bad surprises. Moreover, it is better not to proceed to an assessment if it is not intended to deal with the findings. As a matter of fact, once the problems are identified and publicised within the organisation, if the management decides not to act, it then sends a very bad message to practitioners.

A second lesson for CMM level 1 organisations consists in realising that the assessment findings target the deficiencies of project management processes. It is necessary to create an environment where the management is ready to invest in the implementation of processes rather than blame its managers; in other words “where the management is ready to fix the process, not the people”. This is one of the reasons why it is necessary to also keep informed senior management representatives so that they can show understanding and full commitment when these findings are publicised within the organisation.

Beside senior management buy-in, it is essential that middle management and even some first line managers become champions of the process improvement program. The developers must receive very clear signals announcing that the changes advertised would be implemented and that they themselves will have to adopt new practices.

The Software Capability Maturity Model suggests the formation of a Software Engineering Process Group (SEPG) for any organization heading toward level 3 (Fowler). Even for a level 1 organization, it would be better that a small number of persons become active in process activities a couple of months before the on-site assessment. The SEPG should take this time to familiarize itself with the Capability Maturity Model and associated process improvement methods and tools. Ideally, there should be one full-time person on the SEPG while the other members could be assigned on a part-time

basis. Beside their technical competencies, the members of the SEPG should be selected based on their enthusiasm for improvement and the respect they have within the organization.

The assessment team should be composed of members of the organization plus one or two persons that do not belong to either the organization or the projects assessed. This would ensure the objectivity and credibility of the findings.

With regards to the development of the action plan, the organization should capitalize on the momentum gained during the assessment period. The organization does not have to wait for a completed action plan to start process improvement activities. Some improvement activities can begin soon after the completion of the on-site assessment. The implementation of certain improvements is an important motivation factor for all members of the organization.

During the assessment, it is recommended to collect both quantitative and qualitative data (i.e. indicators), which will be used later to measure the progression realized. One could obtain data on non-respected budgets and schedules, or measure the degree of satisfaction of the customers regarding product quality level. Since senior management will have made investments, it is very appropriate to be able to demonstrate that these investments have been profitable.

Once the processes defined, it is essential to train all users. Otherwise, all related documents will end up getting dusty on shelves. It is illusory to think that developers will study, by themselves, new processes in addition to their workload. A training session also serves as a message that the organization is going ahead and will require that its developers use these practices. During the training session, it is necessary to indicate that, however everybody's good will, errors are bound to happen while using new practices. This will help reducing developers' level of anxiety in their using these new practices. It would be a good thing that a resource-person be available to help developers when the latter face obstacles while implementing new practices.

The author also wishes to make the reader aware of the importance of the human dimension in a process improvement program. The people responsible for these changes are often extremely talented software engineering practitioners, however not too well equipped in change management tools. The reason for this is simple. During their training, they focused on the t technical dimension and not on the human aspect. However, the major difficulty in the whole improvement program is precisely the human dimension. Also while preparing the technical part of the action plan, the change management

elements have to be planned (Laporte 1994). This implies, among other things, a knowledge of (1) the organization's history with regards to any similar efforts, successful or not, made formerly; (2) the company's culture; (3) the motivation factors; (4) the degree of emergency perceived and communicated by (a) the management, (b) the organization's vision, and (c) the management's real support. The author is convinced that the success or the failure of an improvement program has more to do with managing the human aspect than managing the technical aspect. We could now draw up the profile of the ideal software process improver with a major in social work and a minor in software engineering. It is highly recommended that the people responsible for these programs be given an appropriate training. The author recommends a course given by the SEI, the title of which is "Managing Technological Change". For lack of such a course, the author recommends to read two books that may facilitate change management: the first one (Block 1981) gives advices to anybody acting as internal consultant; the second one (Bridges 1991) gives the steps to be followed for writing a change management plan.

9 Conclusion

The Software Engineering Institute's Capability Maturity Model has been used successfully by some organizations in Québec to conduct assessment and to put in place process improvement programs. As more organizations perform similar activities, we should be in position to verify if these activities will have an impact on software productivity and on organizations' profitability. Finally, let's remember that any improvement process includes a human dimension which, at times, has a bigger impact than the technological dimension, should it be neglected during the improvement phase.

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For more information, please get in touch with the following electronic addresses:

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