

Rapid Assessment to solicit Process Improvement in SMEs

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In recent years, Software Process Improvement (SPI) has achieved a good level of penetration in medium-large enterprises. Several well-known methodologies exist and are applied as standard tools in the organisational processes devoted to continuous improvement. Unfortunately, this is not the case for many small and micro enterprises that often are simply unaware of the existence of such methodologies.

The need for making such enterprises aware of SPI concepts as well as the potential benefits of their application was one of the driving motivations for the TOPS project, funded by the European Community as the ESPINODE for Central Italy within the ESSI programme.

In order to overcome the typical inertia showed by enterprises toward usual dissemination initiatives, we adopted *rapid-assessment* meetings to allow enterprises to “taste” SPI. Such activity was part of the goals of TOPS toward the regional industry. Rapid assessments, based on the tailoring of SPICE model, have been offered as a free service to enterprises that joined TOPS.

This paper describes rapid assessment as a powerful way for both diffusing software best practices and proposing actual improvement paths to enterprises. Data collected through the assessments are presented together with some findings about software process maturity in Central Italy.

Introduction

Several authors [1, 2] have pointed out that small enterprises find it difficult to adopt the most acknowledged Software Process Assessment and/or Improvement methodologies, such as CMM, SPICE, BOOTSTRAP, etc., since they are felt cumbersome, overdimensioned and too expensive. In fact, it is hard for a small organisation to relate the scope of consolidated software assessment and improvement techniques to its business objectives.

This is no surprise if one considers how software process is carried out in small enterprises: the software team is usually very small, made of few individuals, with little or no differentiation of roles. In this context the deployment of procedures appears to have an immediate impact only in terms of overhead and bureaucracy. But if one considers that Information Technology will be one of the key factors driving progress in the 21st century – and that small enterprises will continue to be the majority of software organisations – it becomes more and more important to devise evaluation criteria and procedures for addressing their needs.

The key factor for approaching software process improvement in small enterprises is to understand that their software process has little structure and that they need to identify only a few aspects on which to focus. Furthermore, given the pressure under which software professionals and programmers tend to work, to be successful, a methodology must show measurable benefits in a short time. A reasonable approach is to take a subset of concepts and methods from the above mentioned methodologies and to adapt them to the specific needs of a given organisation.

However, it is not an easy matter to convince small enterprises to plan on a process improvement experiment. One must provide evidence of the bad and the good things of current operation. The objective of the experiment should be to insulate some specific aspect which can be improved and such that the foreseen benefits can be measurable in the short run. However, this requires that the current software process is analysed and assessed and again we are faced with the need to resort to an assessment procedure as “easy” as possible.

This paper describes a *rapid software assessment* technique which has been defined and successfully applied by *TOPS* (*TOPS* stands for *Toward Organised Processes in SMEs*) within the context of the *ESPINODE* initiative [3] funded by the European Commission within the *ESPRIT-ESSI* programme.

The *ESPINODE* network links a set of 18 projects (17 in Europe plus one in Israel). All nodes aim at diffusing Software Best Practices (SBP) and Software Process Improvement (SPI) concepts and methodologies, and supporting enterprises already involved in *Process Improvement Experiments* (PIEs) funded by the *ESPRIT-ESSI* programme. *TOPS* is the *ESPINODE* for Central Italy [4]. *TOPS* is run by *CESVIT*, the *Agency for High Technology in Tuscany*, whose mission is to promote technological innovation in order to improve the competitiveness of the regional industry.

Project Background

The definition of a rapid assessment technique has been motivated by objectives of *TOPS* within the *ESPINODE* initiative. Like the other *ESPINODES*, the target audience of *TOPS* is made by regional industry. The regional industry is made by the local enterprises that are interested in improving their software process. Activities targeted

to the regional industry are primarily concerned in to promoting awareness event regarding the benefits of SPI, in many cases using results of PIEs as examples.

The problem with the local industry is that small enterprises are reluctant to perform SPI. Usually they do not have neither the resources nor the culture to embark in software process improvement: we cannot ask a small organisation to change the way they produce software, unless we are able to show that there will be an immediate return on the investment. On the other hand, at least in Italy, you rarely find in SMEs a professional dedicated to software process and software quality. Even those firms that understand the potential benefits of improving their software processes have little interest in performing a long term plan. For the same reason, there is no chance to perform a process assessment unless this can be carried out in a rapid manner.

Since the beginning of the project, we have found that the best way to solicit execution of SPI experiments was to establish direct contacts with the enterprises and to perform a rapid assessment of their software process in order to identify and plan specific actions. To this end awareness and training events have been used as a way to establish the very first contact with the enterprises and to present the opportunity of a rapid software process assessment as a free service. The subsequent assessment programme had the following specific goals:

- to stimulate interest in software process assessment and improvement;
- to contribute to the definition of specific improvement plans;
- to collect data and statistics about software process maturity.

In the search for a methodology to use for the rapid assessments, we had to cope with three other requirements:

- to be compliant with the *Regional Industry Survey* promoted by the ESPINODE network;
- to devise tools, questionnaires and a procedure allowing the performing of the assessment in half a day;
- to stay within project budget.

In search for a good compromise between accurate results and low costs, we decided to develop our own methodology. Existent tools, such as, for instance, *Bootcheck* [5], or *Process Advisor* [6], need a full day or more to perform an assessment, while we want to stay in half a day and have time for explaining and discussing SBP and SPI concepts with the enterprise people.

The Rapid Assessment Methodology

The use of questionnaires as a practical base for assessment is very common. The already cited *Bootcheck* and *Process Advisor*, for instance, are questionnaire based assessment tools. The TOPS rapid assessment is made with the aid of a questionnaire too. However, in our opinion, the questionnaire is just a schema to carry out the assessment meeting: the skill of the professionals that actually drive the assessment is the most important thing in the success of the meeting.

In the development of the questionnaire we followed the model defined by the SPICE project. SPICE [7] is a well known model and is the base for definition of the ISO/IEC 15504 foreseen standard for software process assessment methodologies. The standard is still in development, last result of the standardisation process are currently published

as ISO/IEC TR 15504:1998 [8]. We decide to use SPICE and not ISO 15504 for the following reasons:

- SPICE documentation is publicly available, ISO documents are not; we use the questionnaire to diffuse SPI and SBPs, then publicly available documentation is an important issue;
- the ISO standard is non yet definitive, it is a TR and updates are expected until the final standard will be released (technically it is a TR type 2, i.e. a document subject to review for the proposal of a standard – note that TR are not standard but just ISO documents and that not all ISO TR became a standard);
- differences between SPICE and ISO 15504 mostly concern details and terminology without changing the basic SPICE concepts;
- after SPI and SBPs diffusion, the goal of our assessment is to find improvement paths; because capability certification is not the goal, there is no need of a reference standard.

We also decided to refer the first SPICE model, that identify 35 processes, because, for our purposes, we feel it more accurate than the second SPICE model (29 processes). Yet, with a limited effort, it will be possible to map the questionnaire results in the other models, among which the SBP Questionnaire [9] developed within the ESPRIT-ESSI programme. In this perspective, results of our assessment can be directly used in the survey promoted by the European Commission.

Being “rapid”, the methodology is necessarily approximate. Due to time constraints we sacrifice the scope and the accuracy of the assessment, since the assessment meeting has to last only half a day, including time for discussion. In particular, a very general assessment is made on the 35 processes and some more accurate questions are made about just three processes belonging to two of the five SPICE process categories. Moreover, accuracy of the assessment is limited to the answers given by the enterprises; in other words, we do not look for sources of evidence or probe for process management indicators.

The Questionnaire

The methodology is based on a three part questionnaire. All parts are to be compiled by TOPS professionals with a substantial experience in software process assessment, quality management and software engineering related activities. However, data relevant to Part 1 (QP1) are collected by phone, while Part 2 and 3 (QP2, and QP3 respectively) are compiled within a direct audit meeting. The Questionnaire is public and available on the TOPS Web site [10].

The aim of this QP1 is to collect general information concerning the enterprise, including enterprise characteristics such as company type, dimensions, turnover, and so on. It also aims at identify enterprise goals for the near future, awareness about SPI methodologies and benefits, as well as knowledge of European initiatives to support enterprises in their SPI experiments. Answers are predefined (excluding of course those that refer to enterprise data) and the enterprise has to pick the most applicable one.

QP2 is organised in three sections respectively aimed at: *i.* collecting some general data as regards the software development unit, such as dimensions, type of life-cycle, type of software products, and so on; *ii.* assessing the organisational and technological level of the software development unit; *iii.* assessing software process awareness in the enterprise.

The goal of QP2.ii is to evaluate how much the enterprise is well organised and technologically mature and thus some questions regard issues that are considered Software Best Practices (SBP). In the analysis of the assessment results, we do not use data from QP2.ii to define the software process maturity; instead we use them to give an evaluation of the improvement capability of the enterprise. A well defined organisation is a strong advantage in the enactment of a software process improvement action. From another point of view, technology is often a factor of change: for instance when the introduction of a development methodology pushes forward the formalisation of the development process.

QP2.iii aims to evaluate how much the enterprise is aware of the many components of the software process. With respect to the 35 key processes identified by the SPICE model, enterprise has to declare the status of each process, where a process can be:

- *known*, if the enterprise is able to describe the process in terms of goals and activities and recognise it as a component of its business processes;
- *performed*, if the enterprise actually performs, either in a formal or informal way, the process as one of its usual processes, so that, for instance, there are resources allocated to the process tasks and there is evidence of the process performance;
- *defined*, if there exists procedures that define how the process has to be performed, for instance addressing planning and documentation of the process;
- *critical*, if the process is perceived as critical, where the meaning of critical is the most large one: critical because of costs, because it is not well applied, because it is really an important process for the enterprise business perspective, and so on.

Note that if a process is not known, it cannot be declared performed, nor defined or critical. To limit the number of critical processes, enterprise can select a maximum of 2 critical process for each category and a total maximum of 8 critical processes.

QP3 finally is the true software process assessment that is made with respect to three specific processes of the SPICE model: *ENG.2 develop software requirements*, *ENG.5 integrate and test software*, and *CUS.4 perform joint audits and reviews*.

We restricted the assessment to these processes mainly for time constraints: we want to have time for discussion rather than to submit the enterprise to a long succession of questions that need quick answers. We also want to avoid the risk of “difficult” topics, as for instance configuration management, that may need explanation diverting the focus of the meeting. Moreover, the chosen processes, because they directly impact product quality and customer satisfaction, are often naturally seen as the ones in which improvement is more important and then they are the most suitable for small improvement projects. In this sense, we privileged the use of the assessment meeting as a means to pick out improvement opportunities and suggest a consequent experiment. Results of QP2.iii demonstrated that the choice was appropriate since enterprises perceive *ENG.2* and *ENG.5* as the most critical processes.

As shown in the example reported in Fig. BCC.1, for each specific process there are five questions, each one corresponds to a maturity level and summarises the best practices of that level – i.e. the generic practices of the SPICE model. Answers to many of the questions of QP2 and QP3 are of yes/no kind. To answer *yes*, there must be an appropriate documentation proving that processes actually follow the best practice presupposed by the question. To the yes/no answer a percentage value is added. In the *yes* case, the percentage represents how much the activity is performed as stated; in the *no* case, percentage represents how much the practice is not stated but de facto applied, for instance by customer request or personal initiative. While *yes 100%* is the best

situation and *no* 0% the worst, *yes* 0% (a practice stated but completely disregarded) and *no* 100% (a praxis established but not formalised) are still possible answers. We use the percentage value to have a measure of the distance between the actual situation and the ideal one. The measure can be interpreted in terms of needs of internal diffusion (*yes* with low percentages) or needs of procedure formalisation (*no* with high percentages).

Integrate and test software (ENG.5)		
The purpose of this process is to integrate the software unit and assure that the software satisfy the requirements. This process is accomplished through developing aggregates of software units and testing them as an aggregate, and then testing the resulting integrated software. The ENG.5 process is defined in terms of the following activities:		
ENG.5.1	determine regression test strategy,	
ENG.5.2	build aggregates of software units,	
ENG.5.3	develop tests for aggregates, test software aggregates,	
ENG.5.4	develop tests for software,	
ENG.5.5	test integrated software.	
a.	Do software integration and tests produce specific plan and reports?	yes/no ___%
b.	Are software integration and tests defined and planned before the beginning of the coding activities?	yes/no ___%
c.	Is there a standard procedure for planning and executing software integration and tests and reporting their results?	yes/no ___%
d.	Is there a standard procedure to measure and control test effectiveness with respect to predefined goals?	yes/no ___%
e.	Is there a standard procedure for the study of past test results aimed to prevent future software defects?	yes/no ___%

Fig. BCC.1: An excerpt of the TOPS questionnaire, questions about ENG.5

Final results of the assessment, a part of the maturity results in the three assessed processes, are expressed in terms of *actual maturity level* and *potential maturity level*. Actual maturity level is defined as in the SPICE model and requires full application of stated practices. Potential maturity, instead, captures the situations in which maturity level is not reached because of lack in procedure application or because it exists as a praxis that demonstrates the awareness of the best practice. Organisational and technological level are also calculated as an output of the QP2.ii results and expressed as a score in the range 0-5. They are computed for the purposes of evaluating the enterprise improvement capability and by no means they are related to the software process maturity level.

Performing a Rapid Assessment

We think that process assessment based on a self-compiled questionnaire may lead to wrong results. When the questionnaire regards process quality, i.e. the quality of the way in which people are used to work, the self-compilation often results in a lack of realism reflecting a “good” or “bad” vision closely related to the feeling of the compiler. For instance, a workshop on SPI and SBP, while can be the way to perform many assessments at one time, it is not a solution to improve accuracy. The event, instead of being a guide to questionnaire compilation, works as an amplifier of feelings, resulting in “very bad” or “very good” visions. Furthermore, with self-compilation we lose the opportunity to establish a true contact with the enterprise.

Then, we decided that TOPS skilled professionals should compile the questionnaire by interviewing the enterprises, explaining the questions and discussing the answers. In

spite of its higher cost, this technique is more accurate. Moreover it is less tedious and more useful for the enterprise, which has the opportunity to meet expert people without any direct cost.

We use awareness and training events organised within TOPS as a mean to contact regional industries potentially interested in the target enterprise role. Even if event participation is for free, investing some person/time to participate is an indicator that the enterprise is potentially interested in a future SPI experiment.

Then we contact by phone the enterprise for QP1 compilation. QP1 is an occasion to talk about SPI and SBP and serves also to enterprise selection for the assessment meeting. TOPS funds are limited and then we want to accurately aim our effort towards enterprises. We do not want to bother enterprises with initiatives they are not interested in: the assessment has to be an effective opportunity for their business.

Data from our Survey

During the project, from April 1998 to May 2000, TOPS collected 95 QP1 to be used for the Regional Industry Survey and 36 rapid assessments based on QP2 and QP3. Here we present some general considerations about the results of our survey. A previous analysis of a partial set of assessment was in [11]. Full aggregate data and analysis are available as project technical reports on the TOPS Web site.

The Regional Industry Survey

The large majority of enterprises are very small both in terms of employed people and turnover. This reflects the typical situation of central Italy enterprises and, in fact, TOPS has SMEs as a specific target audience. The geographical distribution of the collected questionnaires reflects the localisation of CESVIT (in Florence) and Innova (partner of TOPS in Rome), with the majority of the interviewed enterprises located in Tuscany, Latium and Liguria.

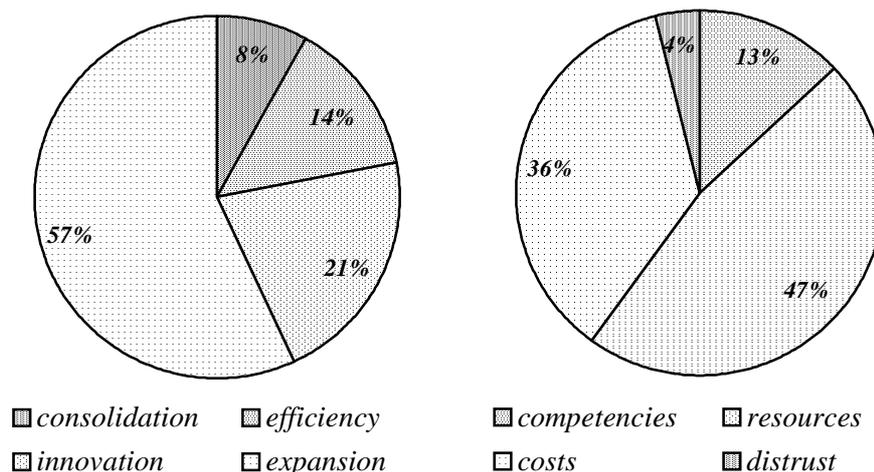


Fig. BCC.2: Enterprise goals and SPI barriers

It is remarkable that the large majority of the interviewed enterprises has expansion (57%) or innovation (21%) as their goals for the near future. On the other part, very

few of them want to make their processes more efficient (14%) or consolidate their market position (8%). This depicts a situation in which SPI can rely on very few resources: all enterprise efforts are directed to new targets and not towards consolidation and improvement of the already reached ones. As a natural consequence major barriers to SPI are costs and resources (83%); noticeably very few enterprises do not invest in SPI because of distrust in its benefits (4%). When and where some SPI initiative is performed (50%), the most pursued goal is efficiency (50%).

In conclusion, enterprises have lot of business opportunities and logically want to exploit them as much as possible. Quality is put in background and SPI is principally viewed as a way to be more profitable. These consideration are even more sharp if we consider very small enterprises (under 50 people): expansion is the main goal for the 62% and only 43% perform SPI. Fig. BCC.2 shows data about enterprise goals for the near future and general barriers to investments in SPI activities.

Software Process Awareness

QP2 and QP3 were submitted to a subset of the enterprises that received QP1. This subset has the same general characteristics of the bigger one. From QP2.i we had some more information about the assessed development units:

- 40% of them rely on internal or local customers, a situation that presuppose an elevate grade of confidence often based on personal relations;
- 56% of enterprises does not have at all a quality system and another 23% had only approached its definition.

QP2.ii assesses organisational and technological level. Generally enterprises obtain better evaluations in organisational than in technological aspects (average organisational level is 2.59 where average technological level is 1.75). Going to the details, poor technology evaluations mainly depend by the scarce adoption of tools for project management, version and configuration control, test automation and software measurement. In many cases, regarding pure product technology, enterprises are strongly committed in innovation, for instance about RAD and CASE tools (72%). So we have to read the result not as poor technology at all, but as poor technology in support of process and quality control.

QP.iii aims to evaluate how much the enterprise is aware of the many activities of the software process. During the assessment meeting we ask the enterprise to briefly describe how they perform each one of the 35 SPICE processes and, on the basis of their answers we classify the key-process as *known*, *performed* or *defined*. On the average, enterprises declare that, out of 35 SPICE, processes 32 are known, 25 performed and 14 defined. However, despite these apparently good results, we had the feeling that many enterprises were reasoning about their process for the first time.

Using these data it is possible to have a first approximation of the maturity level. Setting *performed* as correspondent to level 1 and *defined* as correspondent to level 3, we can calculate an average maturity level of 1.4. In fact, as we will show later, this is an optimistic result.

More interesting are data about processes that enterprises perceive as critical. The most critical processes are ENG.2 and ENG.5: two of the three processes we selected as the ones subjected to the “detailed” part of our assessment (QP3). Some oddities reveal the naive approach of many enterprises. For instance, *PRO.6 Manage risks* is another very critical process that also results to be one of the less known, and it is perceived more critical than, for instance, *PRO.4 Manage requirement* and *PRO.5*

Manage quality. As a possible interpretation, many of the assessed enterprises suffer risks because do not manage requirements nor quality. As a consequence, they feel critical the process that they are compelled to perform. They instead forget the processes that they should perform and that are the actually critical ones.

We consider this part of the assessment very important because it often results in discussions about goals and responsibilities of the various processes. With respect to the “awareness” goal of the initiative, this part of the assessment is a good mean to show to enterprises the many facets of the software process and to highlight the difference between a naive and a structured approach to software development.

Result from the Rapid Assessments

Figures BCC.3 and BCC.4 show the results of the rapid assessments. Data are presented as the average on the number of enterprises of the maturity levels calculated as defined in the SPICE model.

Results about actual maturity are very poor. The very large majority (84%) of enterprises scores a 0 level: they have no documentation evidence that activities are performed. Average value is 0.3 and the maximum scored level is 3.

Potential maturity scores, while not exciting, are better, with an average value of 1.8 and a maximum score of 3.7. This reflects a usual situation: there is a general knowledge of SBP but, instead as being received as enterprise standards, they are applied by demand, for instance in the most critical projects.

To tune our assessment tool, 6 of the 36 enterprises we assessed were selected between enterprises that had a certified quality system and already had some rigorous SPI experience, for instance in an ESSI-PIE or in a SPIRE experiment [12]. Some of them already received a formal assessment using CMM or Bootstrap or participating in the SPICE trials. In these cases our assessment showed an average error of ± 0.18 in terms of potential maturity level.

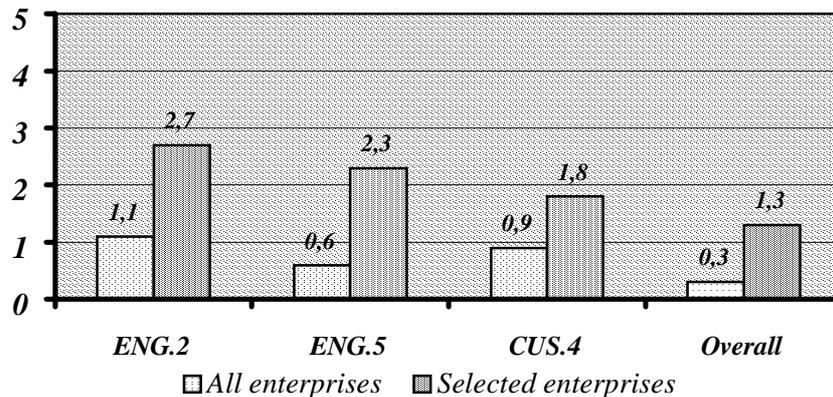


Fig. BCC.3: average actual maturity levels

Because the maturity scores of the selected enterprises are far better than the average, we use these results to stimulate the regional industry: while the average is low there are some excellent performers that demonstrate that SPI is a valuable investment.

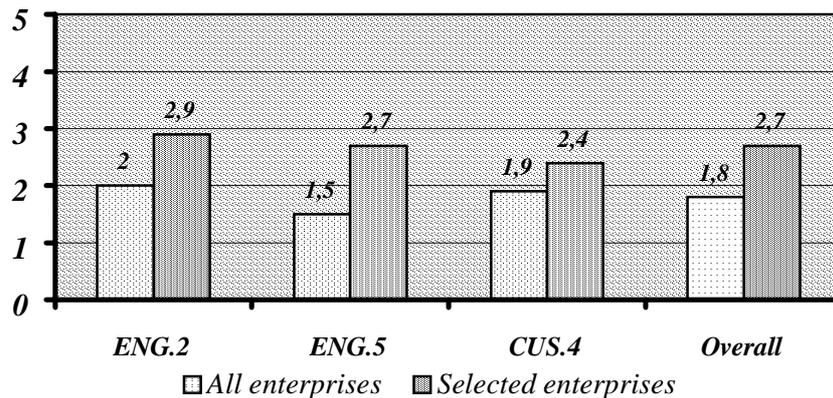


Fig. BCC.4: average potential maturity levels

Conclusions

Having performed a sufficient number of rapid assessment, we can draw the following conclusions. These conclusion refer to the situation in Central Italy.

- Small enterprises (whose customers usually belong to the same regional area) feel not to have a strong need for process quality. However, since they are committed to grow, there is a potential for more organised processes.
- The survey shows enterprises that have grown as their main goal, but score low maturity levels and display very scarce intention about SPI investments. It is still a sector in which enterprises want to be subsidised for improving their organisation. Maturity level is low, however it is possible to argue that SBP are in general known, though not applied. In many cases documentation of procedures and internal training are viable paths to achieve higher maturity levels.
- Technologies to support process control are not applied.

The rapid assessment procedure, offered through awareness and training events, allowed us to show that in very many cases, identifiable benefits could be achieved via focused SPI projects.

The rapid assessment initiative is a clear success: 8 of the 36 target enterprises we assessed asked specific advising services to enact improvement activities identified during the assessment meeting. Six of them accepted our services, in some cases partially funded by local initiatives to promote innovation. In one case our advice service lead to a proposal for a Best Practice project funded by EC. In conclusion, for a significative number of target enterprises, our rapid assessment was the starting event of an improvement process. We regard to this as an important achievement.

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