

PRISMS: an Approach to Software Process Improvement for Small to Medium Enterprises

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Abstract

The paper describes an ongoing project to define a suitable process model for software process improvement in small to medium organizations. This is being carried out as a collaborative project between Leeds Metropolitan University and four small to medium companies who are currently implementing SPI programs. Key features of the PRISMS process are: explicitly relating improvement goals to business goals, which are used to choose and prioritize key process areas for improvement; the use of a simplified and tailorable assessment method based on CMM [1]; the definition and use of metrics from the outset; and mechanisms to encourage maximum transparency in the process and participation by all stakeholders.

1. Introduction

As software systems become ever larger and more complex there is an increasing need for a well-understood and managed software development process, to ensure quality of the product, reduce costs and maximize productivity. This is true in the small to medium enterprises (SMEs) that represent a significant sector of the software industry, as well as in large companies. Over the last ten years a consensus has emerged that this is best achieved through an iterative process of evaluation and improvement of the software process. The Capability Maturity Model (CMM) [1] developed by the Software Engineering Institute, together with other models and standards such as SPICE [2] and BOOTSTRAP [3] provide frameworks and tools for software process improvement (SPI). Such models typically define the levels of process maturity through identification and assessment of various key attributes. Published studies from the US [4] and Europe [5] report substantial business benefits.

There are potentially large gains to be made within the industry by wider application of SPI, but as yet the use of models such as CMM within smaller organizations has been limited. There is general agreement that they cannot be applied unmodified to small organizations [6]. Some research has been carried out in order to determine what modifications must be made to the model to make it effective in these development environments. Johnson and

Brodman [6] suggest that tailoring is needed in specific areas, including documentation, management, review, resources and training. Laryd *et al.* [7] propose a “Dynamic CMM” model, concentrating mainly on roles and responsibilities of individuals within the organization. In contrast, Horvat *et al.* [8] conclude that “major improvements can be achieved by improving the technical issue of the process instead of the organizational issue”, and propose a model which integrates CMM with the ISO 9001 and ISO 9000-3 models. Richardson [9] proposes a generic model based on self assessment and use of a process/practice matrix, which helps to determine the importance of each practice within the software process, and hence set priorities for improvement. Paulk [10] also concludes that “the issues associated with interpreting the software CMM for the small ... organization are different in degree but not ... in kind.” Paulk also emphasizes the need to tie the SPI programme to the organization’s business goals. However, there is no explicit mechanism for this in CMM. Kautz [11] reports measurable business benefits even for very small enterprises using a flexible, tailored improvement approach.

Encouraging though these results are, many questions remain to be answered. Typically, SMEs operate within tight financial constraints. They require low-risk strategies which relatively quickly show results for any investment of resources. Which generic model provides the most reliable way to achieve these results? Can risk assessment and minimization be factored into the SPI model? How can SPI be tailored to the organization’s business goals? How can software measurement be used effectively within the SPI programme? How can the effectiveness of the SPI programme be assessed, so that managers can see the return on their investment? The PRISMS (PProcess Improvement for Small to Medium Software enterprises) was set up in order to address some of these outstanding areas.

2. The PRISMS project

PRISMS is an action research project, with a team of three researchers working alongside managers and developers in participating companies advising and assisting with the planning and implementation of software process improvement programmes, over a three year period.

Table 1: Participating companies

	Type of company	Business area	Total number of employees	Number of software developers
Company A	Independent	Financial packages	72	47
Company B	Part of group	Telecommunications	35	11
Company C	Independent	Administrative systems	21	11
Company D	Independent	Design and hosting of E-commerce sites	28	6

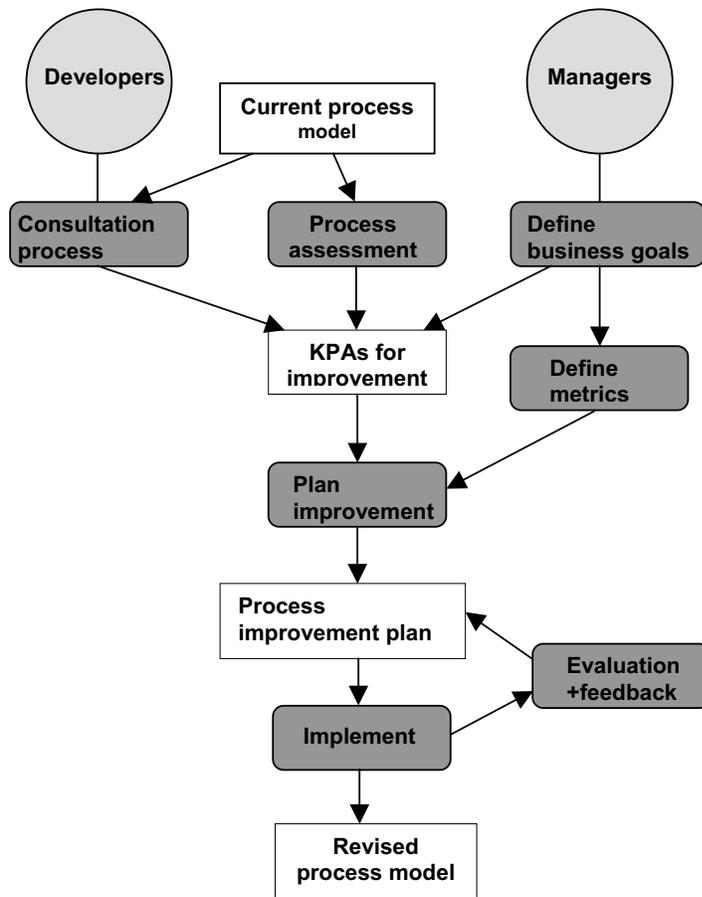


Figure 1: The PRISMS process

As well as this active involvement we are currently using observation and informal discussion as methods of data collection about the projects; at later stages as projects mature we will use more formal data collection techniques, including questionnaires and structured interviews.

Four companies are currently participating in the project, four in the UK and one in Europe. As can be seen from table 1 they cover a wide range of sizes and business areas. Three are independent software houses, and one continues to function independently as a software producer within a larger telecommunications group. Working alongside the managers and developers in these companies for the past nine months, we have begun to evolve an essentially pragmatic and (business) goal oriented SPI process model for SMEs.

3. The process model

The PRISMS process model is summarized in figure 1. The key features of the process are:

- The existing process, however informally defined, is examined, and, if resources permit an explicit model is created. (This often leads to heated discussion as different interpretations of the existing process specification are uncovered!)
- Early in the PRISMS programme the business goals are defined by management. These goals drive much of the subsequent activity, especially the selection and prioritization of key process areas for improvement, and the selection of measurements.
- A consultation exercise is carried out, involving all members of development teams. This is a useful exercise which plays to the strengths of small, flexible teams found in smaller organizations. A brainstorming session, and/or questionnaire-based survey helps the developers team to take ownership of the SPI programme, and to be involved in the programme from the earliest stage.
- A tailored version of the CMM assessment (see section 4) is carried out by members of the research team, primarily to help identify key process areas (KPA) for improvement. This also indicates the CMM level of the software process, which is often of less immediate usefulness to SMEs, but still useful as a baseline from which to measure future progress. This is in agreement with the observation of Paulk that “maturity levels should be measures of improvement not goals for improvement” [10].
- Using these inputs the KPAs for improvement are identified and prioritized. The main criteria here should be the extent to which the KPAs are likely to contribute to the identified business goals. One company has found a weighted selection approach of the type described by Martin [12] to be useful. The process/practice matrix approach described by Richardson [9] could also be used.

- Measurements are defined as an integral part of the SPI planning process. This activity is described in section 5.
- The SPI plan is periodically reviewed, and mechanisms are put in place to collect feedback from stakeholders.

The research team are involved mainly in the assessment and measurement definition activities. We also review plans, and assist in putting in place data collection procedures to assist both company staff and researchers. The following sections describe some of these activities in more detail.

4. Assessment method

Our approach to process assessment consists of an *awareness and business case workshop* which focuses on process improvement, cost-effectiveness, and providing a road-map for process improvement, followed by a series of *assessment interviews* where we meet different groups individually and collectively. assessment is based on a modified and customizable version of the CMM assessment questionnaire. We place emphasis on meeting at least one top level manager as well as technical managers and members of the development teams. This two way process enhances communication and understanding. In particular, it clarifies the issue of people involved in the process improvement actions. We also stress the importance of having a process improvement champion who takes responsibility for overseeing the implementation of improvement actions. Until now the assessment has been carried out by researchers involved in the project, but we have recently developed a web-based version to be used for self-assessment.

5. Measurement

Measurement is an essential part of the PRISMS approach, and managers in the collaborating companies are keen to have more precise ways of tracking key resource and quality indicators. Following the example of many authors, for example Briand *et al.* [13], we use the Goal Question Metric paradigm, with the selection of attributes to measure based on the business goals defined for the SPI programme.

The most popular measurements are metrics for project tracking and monitoring, and those related to defect detection. In our experience the most important aspects of measurement for SPI programmes in smaller organizations is that they are simple to gather and interpret, and that they are actually used in planning and decision making. Simple automation can help reduce the overhead associated with data collection and processing, but as one manager explained to us, he is unwilling to devote resources to automate the process until it has proved its usefulness.

It is also essential to put in place some baseline for measuring the effectiveness of the SPI programme, in

order to ensure that adequate payback is being achieved and maintained. For this we use the simple payoff model of Krasner [4].

6. Results

We are still at an early stage of this project, so conclusions are necessarily tentative, and based on informal observation and discussion.

All of the technical managers were very supportive of the idea of an SPI programme, and enthusiastic champions were found in all the companies. Business managers tended to be somewhat more sceptical, and will require evidence of payback before becoming fully convinced of the usefulness of this approach.

There was general acceptance and enthusiasm for a more quantitative approach, especially to project tracking and management. Measurement programmes, if kept as simple as possible and with clear relevance to business goals are welcomed as a useful aid to management and planning.

Where there is some reluctance on the part of developers to support the SPI programmes this has mainly been due to a perception that it increases the burden of documentation, and stops them "getting on with the job". For this reason new documentation requirements should be kept to a minimum, kept as simple as possible, and phased in gradually. The purpose of the documentation should be made clear.

Company A is now well into the implementation phase of their SPI programme, and already report improvements in project tracking and maintenance of schedules. However more analysis will be needed to determine if this is in fact a direct result of the improvements initiated as part of the PRISMS programme.

It is important that improvements are applied in key process areas that will provide visible payback within a fairly short period. Certainly there should be measurable benefits visible with about a year from the outset, or else confidence and support for the SPI programme will be eroded.

In all companies baseline measurements are being put in place that will allow us to measure the return on investment, and this will be the principal means by which we will evaluate the effectiveness of our approach.

7. Conclusions

A process model for SPI has been devised, specifically tailored for small to medium software enterprises. It emphasizes the importance of business goals for the selection of key process areas for assessment, senior management and developer involvement, and the use of quantitative measurements. The approach is currently being applied in four companies, with support from the research team. Two companies are currently at the stage of defining KPAs for improvement, one is planning the SPI programme, and one has gone some way into implementation of the planned improvements. Although

the project is still at an early stage the results so far are encouraging, especially in gaining the support of business and technical managers for an SPI programme. Early measurements in one company indicate progress, but this remains to be confirmed by more detailed analysis. Ongoing work is concentrating on quantitative evaluation of SPI programmes, and in developing the assessment method.

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