

Process Improvement in Four Small Software Companies

Aileen P Cater-Steel

University of Southern Queensland

Toowoomba, Australia

Email: caterst@usq.edu.au

Abstract

For many small software companies, full-scale software process improvement (SPI) initiatives are often out of reach due to prohibitive costs and lack of SPI knowledge. However, to compete in the global market, software developers must improve their productivity, time to market and customer satisfaction.

As part of an Australian National Industry Improvement Program, Software Engineering Australia (Qld) sponsored a process improvement program in which 26 of its member companies participated. A RAPID assessment method, based on SPiCE (ISO 15504), was developed and applied by researchers from the Software Quality Institute. As well as detailing the RAPID assessment method, this paper presents findings from the process improvement program as experienced by four small software companies. For each company, the initial assessment findings are presented followed by the outcome of the recommendations, as determined by follow-up meetings.

The discussion which follows compares the capability of the four companies and links the findings from this case study to existing literature related to software process improvement success and failure.

1. Introduction

The Australian software industry makes a significant contribution to the Australian economy by creating jobs, and increasing productivity, capability and competitiveness [3]. At the end of June 1999, there were almost 15,000 businesses in the computer services industry: these businesses generating \$10.5 billion in the 1998-99 financial year. Non-bundled customised software accounted for \$3.4 billion of the income, software maintenance services \$740 million, the sale and licensing of packaged software \$340 million [1]. The software industry is also one of the fastest growing industries in Australia, growing at a rate of 15 per cent

per annum [3].

The Australian computer services industry is dominated by small and very small businesses – 98 percent employ fewer than 20 staff and 88 percent employ less than five persons [1]. A similar situation exists in the USA; 65 percent of data processing companies have less than five employees [7], and the current software industry is largely made up of very small teams, many of which comprise less than 10 people for software development [2]. This presents a challenge in terms of devising improvement initiatives which are feasible for these very small organisations.

In recognition of the need for the Australian Computer Services industry to achieve global competitiveness [9, 11], the Australian Federal Government supported the formation of Software Engineering Australia Ltd. (SEA), a not-for-profit association, funded under grants and in-kind contributions from the Australian Federal Government, State governments, universities and the private sector. Its aim is to coordinate national expertise and resources to deliver internationally competitive software engineering environment skills throughout Australia [16]. Each SEA resource centre offers a range of facilities, including information services, education and training, technical problem solving and process improvement activities [15].

Software process improvement (SPI) is recognised as having the potential to improve competitiveness by increasing productivity; reducing costs, defect and rework; and improving time to market and customer satisfaction [5]. A Process Improvement Program was sponsored by SEA (Qld) and conducted by the Software Quality Institute. From September 1999 to December 2000, a total of 26 organisations participated in the program. Based on the Software Process Improvement and Capability dEtermination (SPiCE) standard ISO-15504, an assessment method was developed and applied to enable one-day assessments of software organisations to be performed [14]. This paper describes how the RAPID method was used to assess the capability of software development companies and then reports on the

actions taken by four of the companies in response to the recommendations made by the assessment team.

2. Methodology

In January 1999, a survey was conducted in Queensland to determine the extent to which software developers were using best practice techniques. The survey provided a list of respondents who indicated interest in participating in SEA activities. SQI personnel used this list as the basis to invite organisations to participate in the process improvement program. A total of 26 companies accepted the invitation. This program was funded by SEA (Qld) for SEA members and was conducted at no cost to participants. Researchers at SQI developed a procedure to enable Rapid Assessments for Process Improvement for software Development (RAPID) [17]. The RAPID method is based on the ISO/IEC 15504 (SPiCE) standard and is designed to enable assessments to be performed in one day [14, 18].

Assessment Instrument

The ISO 15504 standard sketches out a roadmap for the implementation of best practice in software engineering by defining 40 processes, divided into five categories: customer-supplier (10); engineering (9); support (8); management (4); and organisation (9). The process capability of each defined process evaluates to what extent the process achieves its defined purpose and objectives [20 p.57]. Capability is measured in levels from incomplete (level 0) to optimising (level 5) as shown in table 1. These capability levels represent milestones along the road to software process improvement.

Table 1. Capability Levels

Level	ISO 15504 SPiCE Capability Levels	Software Process Improvement in Regional Europe (SPIRE) Level Descriptions
0	Incomplete	Chaos reigns
1	Performed	Do your own thing
2	Managed	Teams rule
3	Established	The organisation learns
4	Predictable	Management by number
5	Optimising	Optimising

As the RAPID assessments were restricted to one day each, eight key processes were selected, as listed in table 2.

Table 2. RAPID Processes and Process Categories.

Process	Process Category	ISO-15504 ID
Requirements Gathering	Customer-Supplier	Cus.3
Software development	Engineering	Eng.1
Project Management	Management	Man.2
Configuration Management	Support	Sup.2
Quality Assurance	Support	Sup.3
Problem Resolution	Support	Sup.8
Risk Management	Management	Man.4
Process Establishment	Organisation	Org.2.1

Although ISO-15504 provides rating levels from 0 (incomplete) to 5 (optimising), only questions relating to levels 1 (performed), level 2 (managed) and level 3 (established) were included for the RAPID assessments. The RAPID method collects evidence only by interview, but participants may illustrate issues under discussion by reference to documents. Two trained SPiCE assessors undertook each evaluation, one in the role of team leader and the other as support assessor. A set of procedures and templates was prepared including a demographic questionnaire, assessment plan, assessment instrument, assessment report, feedback form, follow-up meeting and final report.

Assessment Procedure

Firstly, the assessment team leader contacted the sponsor of the organisation, and sent the demographic questionnaire to the sponsor for completion. Using the demographic information, a plan was compiled jointly by the team leader and the support assessor, and agreed to by the sponsor. The team leader and support assessor conducted on-site interviews with key people involved in managing the software development effort of the organisation. For each of the eight processes examined, the assessors followed the script of the assessment instrument to determine the extent to which the process attributes have been achieved using a four point scale: not achieved; partially achieved; largely achieved; and fully achieved. The capability level (0, 1, 2 or 3) for each process was then determined, based on the organisation's achievement of the process attributes.

A draft report was prepared by the assessment team leader and support assessor and forwarded to the sponsor at the organisation to confirm that the assessment team had accurately recorded the information discussed. Any changes suggested by the sponsor were discussed and then the assessment report was submitted to the organisation sponsor, SEA (Qld) and SQI. A feedback form was sent with the assessment report to the sponsor to

solicit comments regarding the conduct and value of the assessment. Six months after the assessment, a half-day follow-up meeting was planned and conducted, and the final report prepared for the organisation sponsor, SEA (Qld) and SQL.

3. Process Improvement Program Findings

To date, 26 assessments and most of the follow-up meetings have been conducted. Many organisations requested the follow-up meeting be postponed as all their resources were absorbed implementing changes for the Australian Goods and Services Tax (GST).

In the following section, the findings from the assessments and follow-ups of four organisations are reported. To preserve confidentiality and to protect the identity of the companies, they are referred to as Company A, B, C and D.

Company A: Background and Initial Assessment

Company A employed about 10 staff. The RAPID assessment revealed that Company A had a remarkably mature process for a small business. The principal business of the organisation focussed around a well-defined process, based upon the company's methodology and Quality Manual. There was excellent control of initial project requirements, and changes over the course of a project were well handled, though on an individual project basis. Company A effectively addressed financial risks, through undertaking work on a "time and materials" basis. Project management was limited in scope but effective. Most projects were small, and the level of management was appropriate to that size.

As a result of relatively rapid growth in recent years, Company A faced problems in ensuring consistent application of its defined process across the life cycle. Many of its approaches to project management, while appropriate to its current environment, were limited in their use in less well-controlled environments. There was a need for a thorough review of the quality management system, to ensure that it retained its usefulness in a changing business environment. Company A also needed to take more advantage of its strengths by developing effective measures for monitoring performance in terms of both productivity and product quality.

The initial assessment identified the following key strengths:

- The methodology was at the core of Company A's operations, and provided a strong, disciplined and coherent approach to definition of requirements;
- The quality management system was well documented and reasonably comprehensive;
- Company A placed substantial emphasis on developing a partnership with its clients and began each

development with a good and well documented understanding of the requirements for the project; and

- Through their ability to base their business on "time and materials" contracts, Company A had good control of financial risk.

However, some key risks and improvement opportunities were also identified:

- There was some evidence that application of the methodology and control of the development environment might not be uniform across the product life cycle;
- Recent changes in the environment had not yet been reflected in the standards and procedures that constitute Company A's process assets;
- There was no real process in place to support ongoing refinement of the substantial process assets held by Company A; and
- Few measures were in place to support enhancement and improvement of the defined process.

Company A: Actions Resulting from Assessment

The follow-up assessment was held 9 months after the initial assessment. Company A had taken substantial actions since the performance of the RAPID Assessment.

The company's methodology had been through a major review process and subsequently updated. In particular, modelling had been extended to include Object Oriented (OO) and Unified Modelling Language (UML) concepts. All templates were updated to reflect changes. To ensure all staff became familiar with the changes, a workshop was developed and delivered. In total, about 250 hours of staff time were involved in this action item.

Procedures for the use of a configuration management (CM) tool were updated and dispersed through mentoring. A staff member had been given the duties of code librarian. These duties are performed as required; it is not a full-time role. About 150 hours of staff time were involved in developing the procedures; ongoing time will be spent setting up for new projects as they occur.

An Enterprise-wide change request system had been designed and was in the process of being developed with implementation planned for December 2000. It was estimated approximately 230 hours had been expended on design, development and testing. Also, a software package had been introduced to help track and manage bugs and issues.

One staff member attended a Risk Management training course at SEA (Qld) and then developed a Risk Assessment and Management procedure. This project had a major impact on the Quality Management System and necessitated changes to procedures including testing, contract review and planning, and requirements control. It was estimated that 150 hours of staff time were involved in this project.

A process for developing new procedures had been defined and a template had been developed and included in the Quality Manual to be used for all new procedures. This task involved about 20 hours work.

Impact on capability at Company A

The changes implemented by Company A impacted on the capability of four of the target processes. The following processes have shown an improvement in their capability ratings: Software Development; Configuration Management; Risk Management; and Process Establishment.

The participants regretted that no staff members could be freed to attend the Practical Software Measurement course. Consequently, no new measurement activities are being undertaken. Also, many of the changes were too new to have impacted at the time of the follow-up meeting. However, it was stated that the CM tool and error-tracking software had made it easier to manage multiple developer projects, and that testing had been enhanced in terms of efficiency and quality.

Company A: Overall conclusions

Company A considered that the RAPID assessment provided valuable motivation to review and improve the software development process. The assessment provided the impetus to make available resources to address the action items from the assessment report. Staff at Company A also considered the assessment results provide evidence of their software process capability and therefore provide competitive advantage in formal tenders. Finally, the strengths highlighted in the assessment report improved the morale of the team by providing positive feedback about the value of process improvement. Company A was convinced the improvement actions resulting from the assessment will return great value in the future by ensuring it is better placed to bid for large projects.

Company B: Background and Initial Assessment

Company B also employed about 10 staff and concentrated its development on a single product. The product had a high reputation, and the company had developed good relationships with all of its client groups. The company followed a reasonable planning process to establish the scope of major releases of the product, though activities to achieve the plans were tracked only informally. Sound configuration management practices to ensure the integrity of the product were in place. A stable environment helped to control the risks associated with processes that do not demonstrate adequate capability.

Product development was weakened by the lack of any structured approach to system testing. In addition, the process for tracking customer-reported problems was informal and not controlled effectively. Tracking of activities was limited, and no records of the effort, costs or duration of tasks were kept, so that estimating for new releases lacked credibility. No effective processes existed for quality assurance or risk management, and while some assets to support process performance existed, there was no mechanism to identify or develop additional assets.

The following key strengths were identified at Company B:

- The company had considerable market strength and a mature product that appeared to be relatively stable;
- The company maintained a strong relationship with all relevant customer groups;
- A sound approach to identification of functional requirements for major releases of the product was followed;
- The company had competent and professional staff who applied sound basic principles to software development;
- Most activities required for development of the software were identified and performance was tracked informally; and
- Sound configuration management infrastructure ensured the integrity of the product in most situations.

The following key risks and opportunities for improvement were noticed:

- There was no mechanism to provide feedback to customers regarding requests or problems reported;
- Testing of developed software was limited and poorly documented. While there was a strategy for beta testing, this was not well controlled;
- Although informal tracking of development activities was in place, this was not adequate for full monitoring of responsibilities and status, and did not evaluate performance against planned schedules;
- There was a weakness in the application of configuration management to newly created code modules and documents; and
- There was no effective system for quality assurance or risk identification and management.

Company B: Actions Resulting from Assessment

Nine months after the initial assessment, a follow-up meeting was held. Since the RAPID Assessment was performed, GST had a major impact on Company B. To cope with the huge increase in product sales and subsequent training and support, the total number of staff had increased by 70 percent. The chief programmer had resigned (and had not yet been replaced) and a full-time tester had been appointed.

As a result of the assessment, Company B had commenced a SPI project to document and formalise the software development processes. To address recognised risks regarding testing, a tester had been appointed, test plans were formulated and test logs and incidents recorded.

Furthermore, Company B's Workflow Management system had been extended to integrate client registration, automated problem tracking, help desk and despatches. This system was being integrated with the development systems. This project and others were being tracked with Microsoft Outlook at the task level.

Impact on capability at Company B

As Company B has just commenced its SPI project, the capability of the target processes was not re-evaluated.

Due to pressing work commitments, the development manager was unable to attend the Practical Software Measurement course. However, he was actively pursuing this area by browsing the IEEE Computer and Software journal articles on metrics. Details relating to size of released product were being collected. Also, tasks associated with six projects were being tracked in Outlook.

Company B: Overall Conclusions

Company B considered the RAPID Assessment to be of great benefit. Prior to the assessment, the company had recognised the need to undertake a SPI program, but did not know where to start. The proposals for action in the assessment report provided the impetus to develop a SPI program by enabling the company to focus on a set of tasks. As well as providing a practical approach, the involvement of the 3rd party assessors provided a measure of accountability: staff were motivated to get the SPI program underway prior to the follow-up assessment.

Company B's SPI program was not as advanced as was hoped, however, the improvements in the testing procedures have resulted in Company B being more confident now in releasing products than ever before. Also, there was more confidence to expand the development effort. The SPI program had already shown value by reducing the disruption resulting from staff turnover.

As far as the costs incurred by Company B, the SPI project had consumed about 125 hours to develop and review. A further 30 hours had been spent researching integration of Project Management and Workflow Management (Help Desk, Client Registration etc.).

The chief programmer had spent about 2 months working on the Workflow Management system with administration and support staff feeding in their requirements (36 hours). The Development Manager was

also involved for about 5 hours in project management activities.

To address the area of System Testing, the Development Manager attended the SEA (Qld) 1-day course and found it of great benefit. Subsequently, he developed the position description for the tester (4 hours) and documented test plans (3 days). The tester was appointed and had been in the position for 7 weeks, with about five weeks spent in testing activities.

To extract a complete system design, Visio 2000 was purchased and about 8 hours had been spent producing documentation module by module.

In conclusion, Company B found the assessment provided value in motivating improvement actions. Due to phenomenal sales and support activity (due to GST introduction) and the loss of key staff, Company B was not very advanced with the improvement actions taken since the assessment. However, Company B was convinced the actions taken have already resulted in improvements in the product and processes. As well as expressing appreciation in regards the assessment, the Development Manager felt that SEA (Qld) was providing excellent support for companies such as Company B. As well as attending the testing course, the Development Manager participated in an OO development course run by SEA (Qld). He commented that the two SEA (Qld) courses and other seminars have been of great value.

Company C: Background and Initial Assessment

Company C, employing about 60 staff, was a much larger organization than Company A and B. Software development in Company C was generally performed so as to achieve the purpose of the processes employed. There was however considerable inconsistency across the organization in process implementation. This problem was accentuated by the distributed nature of Company C's organization, with development activities spread across several locations in different regions. This problem had been addressed by emphasising the professionalism and competency of staff, and there had been significant investment in staff development. The values of competency and professionalism were strongly institutionalised throughout Company C.

Most of the problems faced by Company C derived from the distributed nature of the organization. With project tasks being performed in multiple locations, project management was more difficult, particularly for monitoring and recording progress. Configuration management posed particular problems, while difficulties were found in quality assurance and problem resolution. The development of a consistent approach to process performance across the organization would help to address many of the issues.

The following key strengths were identified at Company C:

- All key processes were performed at the basic level;
- The company managed a highly distributed development process well;
- The competency of company personnel was a critical strength of Company C;
- Staff development was highly valued and was provided with ample resources; and
- The values of competency and professionalism were strongly institutionalised throughout Company C. This institutionalisation was informal but thorough.

The following key risks and opportunities for improvement were noted:

- Configuration management was vulnerable due to the distributed nature of system development;
- The distributed nature of the company led to specific problems in project management, quality assurance and problem resolution;
- There was no common approach to documentation throughout the company;
- Staff development did not extend to project management;
- There was no formal procedure for risk management; and
- Processes in use were not defined or documented so that performance varied from project to project.

Company C: Actions Resulting from Assessment

Eleven months after the initial assessment, a follow-up meeting was held. Company C had taken the following actions since the performance of the RAPID Assessment.

An internet-based document control system had been set up but was not well supported within the company. The level of Internet access varied considerably between the different company locations, and this had been a major factor hindering implementation.

A more formal system for approval of projects had been established, involving approval by the relevant Business Unit, with overall coordination and monitoring through a new control unit. The initial design of the process had been revised, with concerns that the level of formality may have been too great.

A Workflow Management System was being developed to support the control of tasks for individual project tasks. While the system has been designed and development had commenced, it had not yet been implemented at the time of the follow-up meeting.

Difficulties had been encountered in the development and deployment of an effective problem management system. The distribution of functions across the different sites of the company was partly responsible for these difficulties; problems were often reported in terms that

were not easily understood in the element responsible for addressing them.

The establishment of a control unit had resulted in clarification of responsibilities for risk management within Company C. Risk management was still seen mainly as the responsibility of top-level management, and the process for managing risk remained informal.

No action had yet been taken in respect of the development of a company-wide system for configuration management, or towards the development of a set of common assets across all elements of the company.

Impact on capability at Company C

The additional control steps introduced through the establishment of the control unit and the revised project approval process have helped to address some of the identified weaknesses in the Project Management process. In the original assessment, the Performance Management attribute was rated as only partially achieved; this was recognised as largely achieved in the follow-up meeting. Because so little had been done to address the noted problems in work product management, however, none of the overall capability level ratings from the original assessment had changed.

No measurement program was in place, though some of the systems under development may help to provide useful measures once implemented.

Company C: Overall conclusions

As was noted in the original assessment report, the development of a common approach to systems development across the widely-distributed sites of the company remained the principal focus of attempts to improve overall effectiveness. Because each site was an independent cost-centre within the enterprise as a whole, there tended to be an inward focus by management, with each centre taking actions in their own interest, rather than in the interest of the company. Until more progress is made towards the more effective integration of the whole enterprise, simple process improvement efforts will tend to have limited success. Nonetheless, useful progress had been made towards addressing some of the identified risk areas, and further actions were planned.

Company D: Background and Initial Assessment

Company D was the smallest of the four companies with only 6 staff. The assessment found that Company D had a generally informal process for development of software that was supported by excellent tool selection, leading to high confidence in the integrity of the delivered software. The company placed significant

importance on the service and support of its customer base. Considerable effort had been invested in the development of user requirements for the core product.

The informality in the development processes was seen as constituting significant risks for the company in an environment of system and market growth. There was a need to adopt a more formal and structured approach to both technical and management issues. It was recommended that more attention should be paid to aspects of software development, in particular testing, and also to the establishment of a coherent strategy for project management.

The following were the key strengths identified in the original assessment:

- The approach to gathering requirements and managing ongoing communications with customers was flexible and responsive. It should result in products responsive to change in the customers' environment, providing that the development process can deliver its outputs in a timely and effective manner;
- The availability of timely and accurate information on proposed changes to the system, through the on-line Customer Service Request (CSR) database, established a sound platform for effective control of system maintenance;
- The current approach to configuration management delivered a high degree of confidence in the overall integrity of the product, due primarily to the excellent tool support provided; and
- The identification of an overall methodology for software development, albeit at a high level, provided a sound architecture for ongoing process improvement.

The original assessment identified the following key risks and improvement opportunities:

- The lack of capability in project management, covering not only the lack of scheduling of required activities, but also the absence of effective scope management, represented a potential major problem in controlling the development, particularly if any major enhancements in product function were planned;
- The lack of an identified Quality Assurance strategy could have immediate impacts on Company D's business objectives, either through decreased customer confidence or in maintaining quality attributes in delivered performance of the product. The level of re-work was substantial, and was causing problems in scheduling of outstanding work;
- There was no structured approach to risk identification and management;
- The level of documentation of the system could be improved. In particular, the specification of key "business rules" was not well integrated with the rest of the system, and there was no complete set of test cases for integration and pre-release testing;

- Although the development environment provides good support for product integrity, there were numerous intermediate products that were not placed under control, and a change to this policy would further strengthen this area;

- The methodology provided conceptual support for the development process only. It could be strengthened and completed with relevant policies, procedures and standards, using templates defined within the scope of the configuration environment;

- The spreadsheets developed for tracking CSRs could be modified to incorporate and capture relevant measures for monitoring progress and performance.

Company D: Actions Resulting from Assessment

Seven months after the initial assessment, a follow-up meeting was held. Company D had taken the following actions since the performance of the RAPID Assessment.

Since the assessment, the company had relocated to new offices, and the staffing profile had changed slightly, with additional domain expertise and fewer part-time staff. There had been no increase in the number of technical staff. The company had been reorganised, with the aim of reducing the managerial load on the Senior Manager, though this had happened too recently for any impact to be noticed. There had been noticeable growth in business opportunities, with a major contract being negotiated.

The development process had been formalised. Project plans, containing a detailed statement of scope for the work to be performed, were now produced for all work except corrective maintenance, which was still monitored using the CSR system. A specification of requirements, based upon IEEE Std 830, had been introduced. This was a recent initiative, and evidence of improved monitoring of project status was not available, but the basic capability had now been established.

The CSR system had been improved and was now used as a key driver for all work in the company. Formal projects were linked to existing CSRs, and corrective maintenance was managed using the CSR system.

The company had enrolled in the "Quality in Small Organizations" workshop held by SEA (Qld), and was considering whether to seek registration of their Quality System after completion of the program. This work was being used to drive the development and implementation of quality assurance practices in general.

Some specific new procedures had been introduced, especially in relation to the control of report generation routines, where a major problem with consistency and integrity had been found. The range of application of the Configuration Management system had been expanded, partly in response to this problem.

Impact on capability at Company D

An informal re-evaluation of capability was carried out for the Project Management, Quality Assurance, Risk Management and Process Establishment processes. On the basis of this re-evaluation, the actions taken by the company have impacted on process capability.

Individual projects were now defined and the scope of work was clearly documented. The project plan supported better decisions on feasibility, which was reinforced by more effective contract reviews. Timesheets were used to capture information on project status, but there was limited analysis of the data. Overall, the achievement of the Process Performance attribute was now rated as largely achieved.

The objectives for Quality Assurance have been defined; the company had a documented and well-disseminated Quality Policy. A variety of quality records were now identified and retained. Responsibilities for quality assurance and control were defined and seemed to be well understood. Further experience with the new system documentation should result in more effective verification and validation of achievement of system requirements. Overall, the achievement of the Process Performance attribute was rated as largely achieved.

Risks were now routinely identified for all projects, and mitigation strategies were defined. However, there was very limited identification of risk metrics, and data which was being collected were not analysed on a routine basis. Overall, although capability for this process was being developed, it was rated as only partly achieved.

There had been significant activity in the development of new and revised procedures for software development and project management. However, the process for establishing these additional process assets remained largely ad-hoc and uncontrolled. It was not possible to find any real evidence of better capability for this process, only more use of the existing informal arrangements. The ratings remained unchanged from the previous assessment.

Awareness of the importance of measurement as a source of objective information on status was high. A number of relevant data items were collected on a routine basis, and some of the key systems in the company, including the CSR system, have been modified to improve data collection. A timesheet system had been introduced for recording effort, with reasonable work breakdown codes in use.

Although there was much more data being collected, there was very limited analysis of the data, and the impact of the added data on actual project performance was minimal. As analysis of the data was introduced and the basis for a repository of historical data was

established, the impact of more widespread data collection will become evident.

Company D: Overall conclusions

The company saw the assessment as valid and accurate. The suggested priorities for action were seen as reasonable.

Company D had taken significant actions over the past six months which have resulted in measurable improvements in process capability. The actions have followed proposals identified as a result of the assessment of process capability. The company was in a significantly stronger position to benefit from a more formal approach to quality management and measurement. The critical problem identified in the follow-up meeting was a lack of resources for the development of necessary infrastructure to support more effective software development.

Summary of SPI Program Outcomes

Table 3 shows a comparison of the capability ratings determined during the RAPID assessments for the four companies. Where the capability was reassessed at the follow-up meeting, this is denoted by an arrow, for example 2→3 means that the capability level was assessed at level two (managed) during the RAPID assessment and level 3 (established) at the follow-up meeting. Across all companies, requirements gathering exhibited greatest maturity; on the other hand, all four companies initially had an incomplete process for risk management. Process establishment was also neglected in all companies except for Company A where it was performed.

Table 3. Capability Levels by Process from RAPID Assessment and Follow-up Meeting

Process	Company			
	A	B	C	D
Requirements Gathering	3	1	2	1
Software development	2→3	1	2	1
Project Management	2	0	1	0→1
Configuration Management	1→2	1	2	1
Quality Assurance	2	0	1	0→1
Problem Resolution	1	0	1	1
Risk Management	0→1	0	0	0
Process Establishment	1→2	0	0	0
Levels: 0 incomplete, 1 performed, 2 managed, 3 established				

Despite attempts to capture quantitative data, the cost benefit analysis remains very subjective. Each company invested time in preparation and involvement in the

RAPID assessment and follow-up meetings. Senior members of the development team worked with the assessment sponsor to review the recommendations and formulate an action plan. The effort of each company in implementing the actions varied, often including releasing staff to attend training courses, to evaluate software development tools, and to purchase and implement tools. As evident from the follow-up meetings, the main benefits included improved configuration management, project management and testing. All companies improved the standard of their documentation, a move which has already returned dividends for one company which lost a key developer. A further important benefit in one company was the competitive advantage provided by the capability ratings.

It may have been considered ambitious to include process establishment in the assessment of such small companies. Only one of the four companies had a process for creating and enhancing process assets, but because this process was included in the assessment it raised awareness and provided the impetus to institutionalise the new processes which were spawned by the process improvement process.

On-going mentoring was not provided for the four companies described in this paper. Through a complementary program, 'SEA Showcase', SQI has provided ongoing mentoring for two of the other process improvement participant companies. To facilitate the necessary technology transfer for SPI, the role of mentor may be critical to the success of SPI programs. The effectiveness of mentors in SPI programs has been documented [13] with the role of mentors promoted to include 'motivating, advising, supporting, encouraging, teaching, listening, solving problems, calming fears, and assisting in artefact collection' [13 p.6]. An analysis of 37 high maturity organisations revealed that half of these successful organisations have a 'formal mentoring program to impart skills and knowledge' [12 p.8]. Further research will evaluate the relative success of SPI adoption within the mentored Showcase companies compared to the other process improvement program participants.

4. SPI Enablers and Inhibitors

What are the critical success factors for SPI? This question has prompted surveys, analyses and industry case studies. Consequently, various factors have been suggested as enablers and inhibitors of successful SPI programs.

After analysing responses to participants in 56 software process assessments in the USA and Canada, six success factors and three key barriers to SPI initiatives were identified [8]. In relating these findings to this case, further insights can be gained.

The primary success factor identified was that managers actively monitor the progress of the process improvement [8]. In the SEA program, the sponsor agreed that the outcome of the RAPID assessment would be evaluated by a follow-up meeting. This commitment by the sponsor (a senior executive in the company) ensured progress was monitored so that, as far as possible, all agreed recommendations were implemented prior to the follow-up meeting.

The second key success factor noted was explicit assignment of responsibility for SPI [8]. Once again, the sponsor took on this responsibility by providing commitment to the program, and by participating in the planning, assessment and follow-up stages of the program.

The third success factor mentioned is that the people involved are respected [8]. This was achieved in the SEA program as all the RAPID assessors had completed the SPiCE certification training and were experienced assessors. Also, their credibility was enhanced by the reputation of SQI. SQI provides a focus in Queensland for expertise in software quality and serves as a catalyst for innovations in software quality techniques. It is engaged in a program of action research with the local software industry and provides consulting and professional support to industry on setting up and managing software quality systems and on using national and international software standards [19].

The fourth success factor was also achieved with involvement of company technical staff in the assessments [8]. It is clear from the follow-up meetings that commercial pressures limited the fifth success factor: staff and resources availability. The final factor, that the process goals were clearly stated and understood depends on how clearly the sponsor in each company communicated the recommendations and action plan to the development team.

The key barrier identified, organisational politics [8], may have been defused in this case because the SPiCE assessors, as external change agents with authority from the sponsor, were seen as removed from the internal company politics and outside the scope of 'turf wars'.

These success factors were confirmed in a later study involving the analysis of 138 responses from organisations which implemented the Software Engineering Institute's Capability Maturity Model [6]. In this study the most important factors for successful SPI are firstly, focus by management and developers on the SPI effort, secondly commitment of management and availability of resources, and thirdly internal politics which may promote or hinder the SPI project.

Whilst agreeing on the importance of management commitment and understanding, an industry-based study [4] rated the late impact of the SPI program on projects as the second most important issue. It is suggested [4] that

action plans from an assessment should cover a 3-5 month timeframe as management tends to lose patience and practitioners lose momentum when planning for longer time periods. This issue was addressed in the four cases reported here as the focus was on action items achievable in the 6-month time frame leading up to the follow-up meeting. Warnings were also issued [4] against attempting to cover too wide a scope in the action plan. As the RAPID assessment only covered 8 processes, the scope was defined to a manageable extent.

The third factor raised [4] involved the lack of software management skills. An important factor in the overall success of the process improvement program was the availability of appropriate training courses and seminars conducted by SEA (Qld). Participants expressed appreciation that quality training at reasonable cost on topical issues was available in Brisbane.

5. Conclusions

In the late 1980s, two thirds of all SPI programs faltered or failed after the initial assessment due to flawed strategy, lack of commitment, lack of follow-through, not measuring improvements, and lack of crisp SPI objectives tied to business objectives [10]. It would appear that the RAPID method as sponsored by SEA (Qld) has succeeded in avoiding such problems.

However it may be that the factors which determine success or failure of SPI initiatives may vary depending on the size of the company. Large organisations often have the technical knowledge but need a strong champion to push SPI. Small companies are able to more easily garner enthusiasm but often lack the SPI knowledge.

All four organisations considered the findings from the RAPID assessment to be valid and accurate. In all cases, the suggested priorities for action were seen as reasonable although lack of resources limited the extent of implementation. Also, some changes were too recently implemented to assess their impact on processes and products.

As well as detailing the capability of four small software development companies, these case studies provide an interesting insight into the enablers and inhibitors of software process improvement.

REFERENCES

- [1] Australian Bureau of Statistics 2000, Computer Services Industry Australia 1998-1999, 8669.0, Commonwealth of Australia.
- [2] Batista, J. & Dias de Figueiredo, A. 2000, 'SPI in a Very Small Team: a Case with CMM', *Software Process: Improvement and Practice*, vol. 5, pp. 243-50.
- [3] Business Software Alliance 1998, The Contribution of the Packaged Software Industry to the Australian Economy.
- [4] Debou, C. & Kuntzmann-Combelles, A. 2000, 'Linking Software Process Improvement to Business Strategies: Experiences from Industry', *Software Process: Improvement and Practice*, vol. 5.
- [5] El Emam, K. & Briand, L. 1997, Costs and Benefits of Software Process Improvement, ISERN-97-12, Fraunhofer Institute for Experimental Software Engineering.
- [6] El Emam, K., Goldenson, D., McCurley, J. & Herbsleb, J. 1998, Success or Failure? Modeling the Likelihood of Software Process Improvement, ISERN-98-15, ISERN, Int Software Engineering Research Network.
- [7] Fayad, M.E., Laitinen, M. & Ward, R.P. 2000, 'Software Engineering in the Small', *Communications of the ACM*, vol. 43, 3, pp. 115-8.
- [8] Goldenson, D.R. & Herbsleb, J.D. 1995, After the Appraisal: A Systematic Survey of Process Improvement, its Benefits, and Factors that Influence Success, CMU/SEI-95-TR-009.
- [9] Goldsworthy, A. 1997, The Global Information Economy: The Way Ahead, DIST, Commonwealth of Australia, Canberra.
- [10] Krasner, H. 1997, Accumulating the Body of Evidence for the Payoff of Software Process Improvement, <http://www.utexas.edu/coe/sqi/archive/krasner/spi.pdf>, [accessed 14 Mar 2001].
- [11] McKerlie Consulting 1996, Needs Analysis for Enhancement for Software Development Capability within Australian Industry, DIST.
- [12] Paulk, M.C., Goldenson, D. & White, D.M. 2000, The 1999 Survey of High Maturity Organizations, CMU/SEI-2000-SR-002, Carnegie Mellon Software Engineering Institute.
- [13] Reeb, J. & Henderson, R. 1997, 'Experiences in establishing mentor relationships for software process improvement efforts', *Crosstalk: The Journal of Defense Software Engineering*.
- [14] Rout, T., Tuffley, A., Cahill, B. & Hodgen, B. 2000, 'The Rapid Assessment of Software Process Capability', *SPICE 2000*, pp. 47-55.
- [15] SEA 1999, Overview of SEA, <http://www.sea.net.au>, [accessed 11 April 2001].
- [16] SEAQ 1997, Software Engineering Network Business Plan - Technical Support Centres Program.
- [17] SQI 1999, Method for the Rapid Assessment of Process Capability, Griffith University, Brisbane.
- [18] SQI 1999, Process Model for the RAPID Assessment of Process Capability, Griffith University, Brisbane.
- [19] SQI, Software Quality Institute General Information <http://www.sqi.cit.gu.edu.au/>, [accessed 10 April 2001].
- [20] SPIRE 1998, *The SPIRE Handbook: Better, Faster, Cheaper Software Development in Small Organisations*, CSE, DCU, Dublin.