A Practical Application of the IDEAL℠ Model
(An Industrial Perspective)

Valentine Casey and Ita Richardson
Department of Computer Science and Information Systems,
University ofLimerick,
Limerick, Ireland

Abstract:

The focus of this research is to outline the experience of a small-to-medium-sized European-based software development organization, utilizing the IDEAL℠ model while implementing a tailored Capability Maturity Model (CMM) software process improvement (SPI) program. The goal of the approach undertaken was to achieve process improvement rather than a specific CMM℠ maturity level. In doing this, the IDEAL℠ model was extensively researched and employed. The benefits and limitations of the use of the IDEAL℠ model are presented as experienced.

Research was carried out on a number of software process improvement paradigms prior to the final selection of the CMM℠. The approach employed as far as possible remained true to the spirit of the CMM. A key element of this strategy was to see the requirements of the organization as paramount and immediate. It was deemed important for the organization to achieve specific Key Process Areas regardless of their position in the CMM. The approach provided the organization with the flexibility to invest in the achievement of specific maturity levels at some future date and thereby capitalize on their current process improvement work.

KEY WORDS: IDEAL℠ Model; capability maturity model; CMM; small-to-medium-sized enterprises; SME; process improvement; process assessment; effective process change

1. INTRODUCTION

Software process improvement (SPI) is a complex and expensive exercise that should not be entered into lightly or without due preparation. The correct implementation of any improvement initiative is an important undertaking. Prior to implementing an improvement plan, an organization must give serious consideration to the approach to be employed. This is particularly important for the small to medium sized enterprises (SME), where the company needs to have fast return on investment (Richardson 2002). No company, regardless of whether they are large or small, is willing to undertake any project without being assured that the resources expended will in fact give maximum value for money. The research project presented here demonstrates an implementation of the IDEAL℠ (Paulk *et al*. 1997) model in a small to medium sized enterprise, ensuring that the organization's business requirements are top priority.

2. RESEARCH PROJECT

The methodology employed for this research was the action research paradigm. Action research entails the analysis of direct intervention of the researcher (Gill and Johnson 1997). The traditionalaction research five-phase cyclical process–basedapproach as defined by Susman and Evered (1978)and Baskerville (Baskerville 1997) was utilized for this research project. Using this approach allowedone of the authors perform the role of assessorin the process-improvement program detailed in this paper. It also provided both authors with theobjectivity and structure to effectively perform their work.The action research five-phase cyclical-based approach is coincidentally similar in structure, buttotally unrelated to the IDEAL℠ model. Initially, theclient-system infrastructure is established and theremaining steps are defined as follows (Baskerville 1999):

The action research five-phase cyclical-based approach is coincidentally similar in structure, but totally unrelated to the IDEAL℠ model. Initially, the client-system infrastructure is established and the remaining steps are defined as follows (Baskerville 1999):

1. Diagnosing
2. Action planning
3. Action taking
4. Evaluation
5. Specify learning

The client-system infrastructure is the collaborative agreement reached between the client (organization) with whom the research is being carried out and the researchers. This agreement defines the boundaries of the research area. The initial diagnosing phase is where the underlying causes and reasons for change are collaboratively defined. In the 'action planning phase', the activities required to bring about that change are collaboratively planned. This is followed by the 'action taking phase' where those activities are carried out. A collaborative evaluation is carried out and the effectiveness of the actions employed are researched. This is followed by the specifying learning phase, where the lessons learned from the activities as a whole are directed to the client. The client may utilize this information to amend the organizational norms to reflect this knowledge. It is also utilized by the researchers as part of the research program, where it is used to evaluate and validate the research carried out. The action research five-phase cyclical based approach was selected prior to the selection of the IDEAL℠ process improvement model. However, given the similarity between the two approaches, this proved a very effective research methodology to employ.

2.1. Research Questions

The SPI program was carried out within a subsidiary of a software company employing 120 people. It focused on two teams with a total staff of 20, each running an independent process. It had its own Project Manager who reported directly to senior management and was financed as an independent profit center. This subsidiary, given its independent mode of operation, meets the criteria necessary to be considered a small to medium sized enterprise.

The questions researched in this project included:

- Can standard models work within SMEs?
- Do process improvement models make a meaningful contribution, or do they add unnecessary levels of bureaucracy?
- Does the IDEAL℠ model work?
- How does the research undertaken in this project compare with the findings on the IDEAL℠ model presented by Bill Curtis at ICSE 2000 (Curtis 2000a)?

3. THE ORGANIZATION AND SELECTION OF THE CMM

The organization, Software Future Technologies (pseudonym) is based in the Republic of Ireland and while having an Irish management team, is part of a multinational company whose parent is in the United States. The parent organization established a mainframe software application development and maintenance company in Ireland during the last decade. While mainframe application development and maintenance continued to be a significant part of the organization's business, by 1999 the technological focus of the Irish operation had evolved to include the development and maintenance of applications on a number of diverse platforms, including client server, web-based and CASE tool technologies. Software Future Technologies developed and expanded its market share in Europe and the United States, and while this research was being carried out, employed 120 staff.

When Software Future Technologies was established, a defined process had been documented for mainframe software application development and maintenance. The documented process was stored on the company's intranet. This proved very successful. Despite the introduction of projects for other platforms, no new defined processes were developed.

3.1. The Selection of the CMM^{v}

Having reviewed customer and prospective customer quality expectations, it was determined by the Marketing department that there was no demand for the organization to achieve any specific external certified quality standard, or the achievement of any specific maturity level. This allowed the assessor to review and evaluate ISO 9001 (International Organization for Standardization 1994), ISO/IEC 15 504 (SPICE) (ISO/IEC 1998a, 1998b) and CMM^{v} (Paulk *et al*. 1997), prior to the selection of the CMM^{v} as the basis for the process improvement initiative. The goal of this review was to determine the most suitable and flexible model for the organization to implement. Each model was extensively compared and their strengths and weaknesses explored.

On the basis of the organization's goals, an extensive comparison was made between the CMM^{v} and ISO 9001. This included the examination of a correlation between ISO 9001 and the CMM^{v} (Paulk 1994), and differences between them (O'Tinney 1997), (Jalote 2000). The final decision to choose the CMM^{v} was reached because ISO 9001 had specific limitations from the organization's perspective. The major limitation was that the ISO 9001 standard provided only a minimum quality baseline for software organizations (Paulk 1994). ISO 9001 placed an emphasis on meeting minimum requirements rather than promoting continued process improvement.

ISO/IEC 15 504 (SPICE) was also considered. This standard was in beta test at the time the initiative was undertaken. It did offer advantages; these included the separation of process and capability into two dimensions and the consistency of results between ISO/IEC 15 504 and CMM^{v} (Varkoi and M¨akinen 1998). The problem identified with this option was that there was only an academic knowledge of the model within the organization and the cost of further training and outside support would be high.

On the other hand, the CMM^{v} offered a comprehensive approach to process improvement. There was also the advantage of the opportunity to leverage any formal CMM^{v} assessment that might take place in the medium to long term, utilizing ISO/IEC 15 504 to generate an internationally standardized rating. The compatibility between ISO/IEC 15 504 and the CMM^{v} was seen as a further advantage offered for utilizing the CMM^{v}. A commitment to continued process improvement was a key element in the initiative undertaken. It was also determined that given the location of a number of the organization's customers in the United States, a US centric improvement paradigm with acceptance in Europe would be the perfect model to apply.

The process improvement initiative had to be performed under a number of constraints and within a defined scope to achieve goals and objectives. The constraints included the availability of only a limited budget to support the effort. There was only local senior management support for the initiative and only one person was available to carry out the assessment and be the day-to-day driving force behind it. The scope of the project being undertaken was also restricted to only one part of the organization. As a result, the goals and objectives of increased efficiency, customer satisfaction, market share and effective process improvement would all be impacted. At this stage, the scope, constraints, objectives and goals had only been verbally discussed and their full implications on the process improvement effort were not clearly analyzed.

It was understood that there was need for clear guidance on the implementation of the process improvement initiative. That guidance appeared to be provided by the IDEAL^{SM} model (Dunaway 1996). The initial selection of the IDEAL^{SM} model as the life cycle approach to the process improvement initiative went hand in hand with the selection of the CMM^{v} (McFeeley 1996).

4. USING THE IDEAL^{SM} MODEL

Having accepted the IDEAL^{SM} model (Figure 1.) as the life cycle paradigm for the initiative at a preliminary stage, its suitability was reviewed in detail. It was determined that in general it provided comprehensive guidelines and direction with which to manage the change process. It was noted that it particularly addressed initial areas of concern in the key stages of the improvement project. Management in Software Future Technologies agreed that it should be utilized in the development of the initiative's mission statement, the initial project plan and as a framework for reference as the initiative developed. It was also agreed that it provided a good basis for continued improvement during future iterations of the process-improvement cycle.

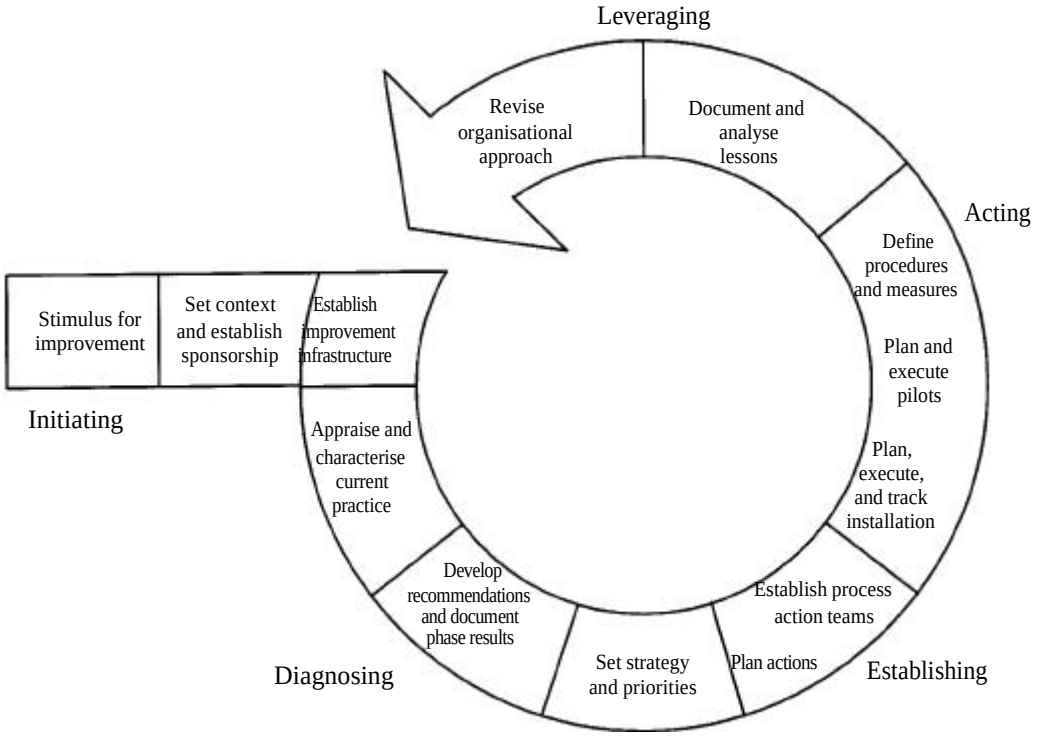

Figure 1. The IDEAL℠ Model (Paulk *et al*. 1997)

However, it was recognized that the IDEAL℠ model had limitations and would have to be tailored for use within the organization. The reason for this tailoring was that any approach taken by a small to medium sized software development organization undertaking effective process improvement should include the following characteristics (Richardson 2002):

- Give maximum value for money.
- Propose improvements that have a maximum effect in as short a time as possible.
- Provide fast return on investment.

While these characteristics are important to any organization undertaking such an endeavor, they are critical to any small-to-medium-sized enterprise as they have limited financial resources and require timely and effective results from any process improvement efforts undertaken. This dictates an approach that minimizes delay and maximizes quantifiable returns.

The Acting phase was identified from the detailed review of the IDEAL℠ as the area where tailoring was required. The organization did not have the time nor the resources to get involved in such a protracted exercise. Once the initiative was underway, prompt positive results were essential to maintaining management and staff support. If the pilot test solution and refining solution stages as outlined in the Acting phase had been implemented, it would have had a negative impact on the process improvement effort. The approach that would be taken was that Key Process Areas (KPA) to be implemented would be simply tailored to the needs of the organization and based on achieving the goals and objectives defined in the CMM.

Using a software process improvement model like the CMM℣, which outlines and addresses the achievement of the goals of a mature software organization, ensures that a cyclical best guess approach is not required. Tailoring of the IDEAL℠ model to meet the needs of the organization implementing process improvement is strongly recommended (McFeeley 1996).

4.1. The Initiating Phase

Utilizing the IDEAL℠ model as the basis for the process improvement initiative, the assessor and a senior manager held their first meeting. The first

items to be addressed were the stimulus for change and the business reasons for change. These had to be defined and articulated. The importance of this step cannot be understated. Without a clear understanding of why an improvement initiative is undertaken, it will in most circumstances be doomed to failure, given the level of commitment required by all concerned for its successful conclusion.

The stimulus for change and the business reasons identified included increased profitability, better levels of service to existing customers and the development of new business. This initiative also offered the opportunity for the development of a CMM[v] based development process, which would tie in with any future quality initiatives that might be undertaken by the parent organization. To address each business reason, clear objectives were defined and agreed upon.

One of the business reasons identified was Software Future Technologies requirement for the development of new business. The objectives to achieve this were outlined as follows:

- Leverage the organizations commitment to quality as a marketing asset.
- Utilize the organizations reputation within the industry to attract new customers.
- Meet potential customer requirements so that prior to awarding contracts an effective commitment to quality and process improvement is evident within the organization.

Having determined the stimulus for change, it was now time to set the SPI initiative in the context of Software Futures Technology's business strategy. It was determined that the initiative would assist with future development and expansion of business with new and existing customers by increasing customer satisfaction and enhancing the organization's reputation. It would allow the development of a repeatable, effective and efficient production process, which would underscore that expansion. It would help to ensure that product delivery was on time and within budget. It would also allow management more visibility into the process at all stages of development, which was recognized as being essential for the successful maintenance and development of quality software.

Once business reasons and how they fitted into the company's overall business strategy were established, management sponsorship was sought. The level of commitment required through managerial support and the availability of resources were outlined. The constraints that would have to be imposed on the effort were also formally defined and fully discussed. This was very important, as management now clearly understood the full implications of these constraints and how they would impact on the level of achievable goals and objectives. This provided an excellent first step, which greatly assisted with the building of management sponsorship. A clear understanding of why the initiative was being undertaken, what goals it was going to achieve and how they fitted into the overall business strategy of the organization was invaluable in presenting and winning the required level of approval and commitment from senior management. As a result, a local senior manager was appointed as sponsor and a long-term commitment to the initiative was made.

Sponsorship being established, it was essential to develop a mechanism to manage the implementation of the initiative. The need for the establishment of a Management Steering Group (MSG) was addressed and its role and responsibilities were defined. They included the strategic and tactical direction of the initiative. This necessitated the establishment of clear goals for the initiative to achieve, setting direction, priorities and monitoring the effort.

A Software Engineering Process Group (SEPG[SM]) was established, and the members consisted of the assessor and the local outsourcing center Project Manager. The role of the SEPG[SM] was to maintain the motivation and the enthusiasm for process improvement within the organization.

To complete chartering the infrastructure for the SPI initiative, the need for the establishment of a Technical Working Group (TWG) was identified. The role and responsibility of the TWG was defined and included dealing with the specific elements of process improvement as the initiative progressed. This included the documenting and assessing of current processes as well as making a meaningful contribution in implementing process improvement.

It was decided after discussions with the sponsor that a mission statement would not be formulated. It was also agreed that the assessor would develop a project plan for the initiative in consultation with the MSG and the SEPG[SM].

The project plan formally recognized the current and desired states for process improvement in the company. It set priorities for change and it formally outlined the business reasons for the initiative. It laid out a time frame and highlighted key activities that would have to be carried out to implement the tailored process in keeping with the IDEAL℠ model and the CMM℠.

4.2. The Diagnosing Phase

Before meaningful process improvement can take place, a company must determine its current level of maturity. '*If you don't know where you are, a map won't help*' (Humphrey 1989). To that end, a CMM℠ based process assessment was undertaken. As an initial step, information was provided to the teams whose process was being assessed describing what the CMM℠ was about and what was involved in a CMM℠ assessment. There was no official rollout meeting for the initiative as the sponsor felt it was unnecessary. This was something the assessor disagreed with, as this offered an ideal opportunity to demonstrate visible management support for the effort.

A Project Manager, two team leaders and three software engineers completed the full CMM℠ maturity questionnaire. Given the complexity of the questionnaire, full support was provided to those who required clarification on any of the content of the questionnaires. On completion of all questionnaires, a comprehensive report was compiled detailing the results. This report was analyzed and areas highlighted for further research. A document review was undertaken and some queries were answered while others were raised.

Interviews were held to clarify outstanding issues. Seven people were interviewed, a Project Manager, two team leaders and four software engineers. Four of the people interviewed had completed the questionnaire. The interviews followed a structured approach and while dealing with outstanding issues also endeavored to define the existing process culture. This broadened the assessment to include areas outside the definition of the CMM℠, but which directly impacted on the existing process. On completion of the interviews, a report was compiled

Each CMM℠ Key Process Area was addressed in the light of the questionnaire, document review and interview report. The results were as follows:

basic Requirements Management (KPA at Level 2 of the CMM℠) was in place as was limited Project Planning (KPA at Level 2) and Project Tracking and Oversight (KPA at Level 2). A number of methods of Configuration Management (KPA at Level 2) were employed, but this did not extend to documentation or specifications and was not used on all projects. An extensive Training Program (KPA at Level 3) was in operation and Peer Reviews (KPA at Level 3) were carried out from the establishment of Software Future Technologies in Ireland. While some basic Software Quality Assurance practices were in place, defect prevention had been identified as a major problem area. In the CMM℠, this is a Level 5 KPA. Any process improvement initiative in Software Future Technologies would have to address this problem area

A maturity audit report was prepared and a maturity level determined. The outsourcing process was rated at a CMM℠ maturity Level 1. It was clear that two process cultures existed side by side in the teams reviewed. These cultures, which were due to the background of the teams involved, were a formal disciplined approach to the process and a more ad hoc Rapid Application Development (RAD) approach. The maturity audit report with its specific recommendations was incorporated into the assessment report. The findings were presented to management and the teams to ensure that they were aware of what had been achieved and to prepare them for the next phase.

4.3. The Establishing Phase

Having reviewed the assessment report and analyzed pressing business requirements, the Management Steering Group prioritized the establishment of a defect tracking system as an urgent requirement. The template provided by the CMM℠ Level 5 Defect Prevention KPA provided guidance on what was required. While the researchers were aware that it was contrary to CMM℠ recommendations to implement a Level 5 process in a Level 1 organization, their knowledge of the continuous SPICE model (Zahran 1998) and the business requirement gave them the confidence to proceed in this manner. Indeed, the recent publication of the CMMI℠ (Phillips 2002) would suggest that this is now an acceptable approach. An implementation plan was prepared, which outlined the schedule,

roles, milestones, and metrics, tracking and reporting procedures for the initiative.

The Software Engineering Process Group met and undertook the management of the implementation of the Defect Prevention KPA. This was purely a supportive role. The assessor prepared a non-technical translation of the KPA's key practices for presentation to the TWG. The SEPG℠ also took responsibility for informing management and staff on a regular basis on the status of the initiative.

The next step was the selection of the TWG. It was agreed that the initial group would be made up of four members, the assessor and three software engineers. Membership of the TWG was to be a part time position. This would ensure that the TWG members were not divorced from the rest of the organization.

The initial role of the TWG would be to examine the requirements of the KPA. When they had established a clear understanding of them, they would tailor the KPA to meet the specific requirements of the company. When this was complete, the group would take responsibility for introducing new procedures, roles, documentation, organize training and ensure the availability of essential infrastructure and resources. Feedback on the progress of the initiative would be presented to the rest of the teams on a regular basis through the SEPG℠.

4.4. The Acting Phase

At the first meeting of the TWG, the goals of the initiative were outlined and the need for the establishment of a Defect Prevention Group presented. A presentation was made on the Defect Prevention KPA (CMM℠ Level 5) and the introduction of a Defect Tracking System. Using the Defect Prevention KPA as a guide, a detailed action plan was drawn up. This included the identification of resources, responsibilities, tasks and milestones. Measurements to assess the success of the initiative were discussed and agreed upon; these incorporated the metrics outlined in the implementation plan.

Having a clear understanding of what was required and utilizing the CMM℠ as a template, an effective solution was created. As outlined in Section 4, there was no benefit to be gained through the development of a best-guess solution, cyclical pilot testing and refining. Indeed, it would have had a negative impact on the project. The CMM℠ outlined an effective approach and the knowledge and experience of the TWG confirmed that prior to its implementation. The tailored key practices of the Key Process Area were implemented on a project by project basis over a three month period.

A problem-centered approach was applied in this initiative. If all the activities outlined for the Acting phase had been carried out, the time scale required would have had a serious impact on the success of the program. Curtis (June 2000b) states, '*Most successful improvement programs begin working with projects to make improvements very early*'. This ensures that preliminary positive results are available to management and staff and this encourages support and enthusiasm for continued process improvement. This is particularly important in an SME with limited resources.

4.5. The Leveraging Phase

Having successfully introduced a Defect Tracking System based on the CMM℠ Defect Prevention KPA, the team validated and analyzed what had been done. The criteria for monitoring the performance of the Defect Tracking System was evaluated and reviewed. The level of success achieved in all aspects of the improvement program was assessed. It was determined that the effort had been an overall success, which led to a quantifiable improvement in the operation of the software development process. The MSG, SEPG℠ and TWG had all worked well together and having achieved an initial success it helped to reinforce the value of team effort and support.

While the Sponsor had been committed to the initiative, it became clear that there was a lack of overall senior management support for further process improvement in general. This was hard to understand given the success of the initiative and the minimal cost it incurred. There had been a positive effect on all aspects of the process as a result of the undertaking. The goals of the effort had been closely tied to the overall business strategy and objectives of the organization. Better software was being produced as defects were reduced and tracked back to source, allowing preventive and effective action to be taken to stop reoccurrence. As a result of the reevaluation of management sponsorship, further process improvement was put on hold. To leverage from the exercise undertaken, as much material

and experience gained was documented and stored. This valuable resource is available for utilization in and for future process improvement activities.

5. ANALYSIS AND EVALUATION

5.1. Use of IDEAL SM Model

The use of the IDEAL[SM] model made a substantial contribution to the success of the process improvement initiative outlined in this research. The only full-time person employed on the initiative was the assessor. The Management Steering Group consisted of only two members, as did the Software Engineering Process Group. Membership of both groups was on a part-time basis. The roles that both groups fulfilled provided a substantial contribution to the overall success achieved. When applying the IDEAL[SM] model in a small-to-medium-sized company, the temptation is to ignore roles like the Management Steering Group. Our research demonstrates that this group is vital and that its inclusion has direct benefits.

The Initiating phase addressed the need for a clear understanding of the initiative. Once that had been determined, goals and objectives were defined and put in context with the objectives and business strategy of the organization. The clarity provided by this exercise allowed senior management to make an informed commitment to provide the necessary leadership and resources required for effective process improvement to take place. It also provided senior management with the opportunity to decide at an early stage if the effort would be worthwhile, or if it should be abandoned. The appointment of a committed sponsor ensured that the required resources would be provided and the resistance to change that is encountered in all organizations could be addressed and successfully overcome. The commitment of senior management is key to any successful process improvement initiative and cannot be underestimated.

The Diagnosing phase allowed a baseline of the existing process to be established. It allowed a maturity level to be determined and the strengths and weaknesses of the process were highlighted. This facilitated the development of clear recommendations for current and future improvements. During the Establishing phase, changes were outlined and the need for a Defect Tracking System prioritized. The Defect Prevention KPA was utilized as a template for process improvement based on the business needs of the organization. An implementation plan was prepared and the TWG was established.

In the Acting phase, the TWG's approach and available time scale did not allow or require the development of a best-guess solution. Neither did it require the use of pilot testing and further refinement prior to implementing the improvement strategy. The CMM[v] provided the required solution. The TWG did not divorce itself from the rest of the organization. Membership was a part-time role and change was introduced on a project-by-project basis. On the basis of the Defect Prevention KPA, the TWG determined the requirements of the organization. The implementation of the KPA was tailored to meet those defined requirements. If the pilot test solution and refining solution stages as outlined in the Acting phase had been implemented, it would have had a negative impact on the process improvement effort. The organization did not have the time or the resources to get involved in such an exercise. This fact was identified at an early stage and the implementation of IDEAL[SM] model modified accordingly.

The Leveraging phase provides an excellent opportunity to evaluate what has been achieved and opportunity to learn from work that has been completed. The activities of the initiative, which has been undertaken, are reviewed and analyzed. The achievement of goals and objectives are assessed. Lessons learned are recorded for future reference. The evaluation of continued sponsorship is very important. The IDEAL[SM] model quite rightly stresses the importance of continued sponsorship and support of senior management for effective process improvement to be undertaken in further iterations of the model.

5.1. Response to Research Questions

In summary, the IDEAL[SM] model provided a good framework for process improvements to take place within the SME we researched. That stated, we would stress that the model should be tailored to fit the needs of the organization utilizing it (Karlheinz *et al*. 2000). The need for tailoring is clearly understood and recommended by McFeeley (1996) who states, when referring to the IDEAL[SM]

model '*One Size Does Not Fit All*!' and '*SPI managers must tailor the guide to their particular situation*'.

The layers of management, supervision and support provided by the IDEAL℠ model encouraged effective process change and improvement. To be effective, the model did not require the establishment of a bureaucratic system. It offered a clear path for continuous process improvement to take place. We conclude that the tailored IDEAL℠ model worked.

In his workshop presentation at the ICSE 2000, Curtis (2000a) outlined the problems encountered utilizing the IDEAL℠ model. The problem as he defined it is what he termed '*the action teams separation from development work*'. It takes too long to set priorities, develop and pilot its approach and implement process improvements. When improvements are finally implemented, it is too late, both management and staff have lost faith in the improvement program. This paper concurs with those findings and has been researched independently of his work. We would not suggest that there should be a quick fix approach, but the CMM℠ offers clear guidelines with regard to where and how improvements can be made. The CMM℠ template should be utilized to ensure that timely and effective process improvement takes place.

6. CONCLUSION

The Defect Tracking System introduced as a result of this effort led to a large reduction in the number of defects produced. Defects that arise are logged, corrected, tracked back to source and discussed. Preventive action is taken to ensure that where possible such defects do not arise again, or are identified at an earlier stage in the process. The level of rework has been reduced; milestone and deadlines have been met on a more consistent basis. Both teams are much more aware of quality as each team member spends time working as part of the Defect Tracking Team. These improvements have been achieved with the support and guidance of the IDEAL℠ model. The CMM℠ provided the template, while the tailored IDEAL℠ model provided the framework to implement it.

As demonstrated in our research, the tailored IDEAL℠ model is a useful framework for software companies who wish to implement process improvement. The Initiating, Diagnosing, Establishing and Learning phases are of particular value. If the activities of the Acting phase are adapted to the needs of the organization then required results can be achieved.

ACKNOWLEDGEMENTS

This research has been supported by the Science Foundation Ireland Investigator Programme B4-STEP (Building a Bi-Directional Bridge Between Software Theory and Practice).

REFERENCES

Baskerville RL. 1997. Distinguishing action research from participative case studies. *Journal of Systems and Information Technology* **1**(1): 25–45.

Baskerville RL. 1999. Investigating information systems with action research. *Communications of the Association for Information Systems* **2**(19) 1–31.

Curtis B. 2000a. T11 software process improvement: best practices and lesson learned. Tutorial notes. ICSE 2000, Limerick, Ireland, June 2000a, 4–11.

Curtis B. 2000b. From MCC to CMM℠: technology transfer bright and dim. Proceedings of the 22nd International Conference on Software Engineering, Limerick, Ireland, June 2000b, 521–530.

Dunaway DK. 1996. *CMM℠* Based Appraisal for Internal Process Improvement (CBA-IPI) Team Members Handbook. CUM/SEI-96-HB-005, Carnegie Mellon University, PA, USA.

Gill J, Johnson P. 1997. *Research Methods for Managers*, 2nd edn. Paul Chapman Publishing, London, UK.

Humphrey WS. 1989. *Managing the Software Process*. Addison Wesley, Boston, USA.

International Organization for Standardization. 1994. ISO9000-1 quality management and quality assurance standards, Part 1: Guidelines for selection and use. Geneva, Switzerland.

ISO/IEC. 1998a. *Information technology – Software process assessment – Part 1: Concepts and introductory guide*, ISO/IEC TR 15504-1.

ISO/IEC. 1998b. *Information technology – Process assessment – Part 2: Performing an assessment*, ISO/IEC TR 15504-2.

Jalote P. 2000. *CMM℠ in Practice*. Addison-Wesley, Boston, USA.

Karlheinz K, Hansen HW, Thaysen K. 2000. Applying and adjusting a software process improvement model in practice: the use of the IDEAL℠ Model in small software enterprise. ICSE 2000, Limerick, Ireland, June 2000, 626–633.

McFeeley B. 1996. *IDEAL℠* A Users Guide for Software Process Improvement, Handbook, CMU/SEI-96-HB-001, Carnegie Mellon University, PA, USA.

O'Tinney M. 1997. *Comparing ISO 9000, Malcom Baldrige and the SEI CMM℠* for Software. Prentice Hall, Upper Saddle River, New Jersey, USA.

Paulk MC. 1994. A comparison of ISO 9001 and the capability maturity model for software. Technical Report CMU/SEI-94-TR-12 ESC-TR-94-12, SEI, Carnegie Mellon University, PA, USA.

Paulk MC, Charles Webber V, Curtis Bill Chrissis Mary Beth. 1995. *The Capability Maturity Model, Guidelines for Improving the Software Process*. Addison-Wesley, Boston, USA: (8th Reprint November 1997).

Phillips M. 2002. CMMI℠: improving process for better products, key note address. Profes 2002, Rovaniemi, Finland, December 2002, 9–11.

Richardson I. 2002. SPI models: What characteristics are required for small software development companies? *Software Quality Journal* **10**(2): 101–114.

Susman G, Evered R. 1978. An assessment of the scientific merits of action research. *The Administrative Science Quarterly* **23**(4): 582–603.

Varkoi TK, M¨akinen TK. 1998. Case study of CMM℠ and SPICE comparison in software process assessment, engineering and technology management, 1998. Pioneering new technologies: management issues and challenges in the third millennium. IEMC '98 Proceedings, International Conference, Puerto Rico, USA, October 1998, 11–13, 477–482.

Zahran S. 1998. *Software Process Improvement, Practical Guidelines for Business Success*. Addison-Wesley, Esser, UK.

N.B This is a prepublication version of this paper