

QUALITY MANAGEMENT SYSTEMS IN AUSTRALIAN SOFTWARE HOUSES: SOME PROBLEMS OF SUSTAINING CREATIVITY IN THE SOFTWARE PROCESS

Liisa A. von Hellens

School of Computing and Information Technology, Griffith University
Nathan Campus, Kessels Road, Brisbane, 4111 QLD, AUSTRALIA
L.Hellens@cit.gu.edu.au

ABSTRACT

Software houses are taking steps towards the implementation of quality management systems (QMS) and achieving certification to international quality standards. There is an increasing tendency to require quality certificates from system suppliers before business can be even considered. The QMS is seen as a way of avoiding personnel risk if product and market knowledge remains in the possession of individuals. It is also felt that quality procedures in place will improve the company's image, attract new staff and help to keep the staff turnover low. However, the application of standards to the less structured tasks, eg. pre-sales or research and development tasks, was seen to stifle the creativity needed to complete them successfully.

INTRODUCTION

Background — The National Initiative to Improve Software Quality

As barriers of free trade are gradually disappearing the opportunities for co-operation and world wide trade increase also in the IT industry. The new trade order requires adoption of adequate standards, otherwise the offerings of individual nations will not be trusted and the proper development of the market will not become possible. For some markets, it is essential to have quality certification for software products. An essential step in achieving software quality is the construction of a Quality Management System (QMS). This involves the identification and formalisation of all business processes that can affect delivered quality. The collective efforts of staff can then be recognised by seeking conformance certification of the QMS to international standards by impartial certification companies operating under agreed arrangements. This paper provides an insight into some of the problems related to the quality accreditation process in systems houses. Although the research was carried out in Australia and the results therefore reflect local industry structure, we feel that software industry in other countries is very much the same, with only minor differences in emphasis. Our plan is in the near future to compare our findings with the situation in some European countries.

The Australian software industry is a major growth industry¹ playing a vital role in enabling the manufacturing and service industries to become more efficient, productive and competitive. Despite its vital role several factors are threatening the software industry's ability to survive and flourish in the increasingly competitive international market.² There is a lack of information available for senior management on the internal and external value of quality management systems for software developers and on more general quality issues. There should be more options for software developers to apply quality methods, and infrastructure support for companies wishing to implement quality.

Software Pilot Case Studies

The Software Pilot Case Studies Project which is considered in this paper is part of the Australian Commonwealth Government response to requests from the software industry, to provide an overview of the current status of software quality management systems in medium sized systems houses and to provide a basis for recommendations to improve the benefits of such as system. In this paper we discuss the process of implementation of quality management systems in the systems houses included in the pilot investigation. The

¹ According to the Department of Industry Technology and Regional Development, the software and information industries are forecast to grow by 16 % per annum. Twelve of the top 50 companies were listed as the fastest growing in Australia were software developers. In a recent survey it was also pointed out that exports have grown strongly, but there is significant potential for further growth; see Smilie (1993).

² The discussion paper by professor Geoff Dromey (1990), The Software Quality Research Institute at Griffith University, points out several factors are causing problems in software industry: 1) Outdated management methods, 2) Indifference to quality throughout the industry, 3) lack of coordination in relation to quality, standards, accreditation, marketing, education and training, 4) Lack of international software market information and access.

paper emphasises issues, that from the software developers' point of view, seem to be reinforcing or inhibiting the creativity of the more intangible and less structured activities of the sales cycle and product development. By creativity we mean tasks that are highly unstructured and for which the means to complete them are not well specified. Creativity is also characterised by originality of thought.

The six systems houses included in this study (named here as companies A, B, C, D, E and F) have total staff ranging from 4 to 80 people of which the number of software staff ranges from 3 to 60. The turnover varies from A\$100,000 to A\$ 5 M. The companies are all fairly young, the oldest has been operating in its present form 1973; the others were established in the mid 1980s. Every company currently offers a software package, the applications vary from text retrieval systems and industry-specific financial packages to scientific software for marine navigation. Five companies started as a package supplier, but only two have the majority of sales still coming from the package sale (eg. license fees); others moved to the computing service provision and are currently developing and implementing systems to fit individual customer needs. Development tasks include the definition of the parameters of the software package to make the software fit the users' information systems needs. All companies have started to export their software products, the target markets being Asia, North America and Europe, especially the U.K.

We have to point out that certain factors have had a significant impact on the research and should be considered in mind when evaluating this report. First, the data had to be collected to complete the assignment for the Commonwealth Government. The goal was to present a variety company experiences to illustrate the individual nature of quality management systems. A systematic investigation of specific aspects of the implementation process, eg. of the impact on creativity was secondary at this stage. Secondly, the Australian software industry is new to the researcher whose previous expertise is from the UK and Scandinavia. The vantage point of someone from outside having a fresh view may have helped to pinpoint factors in the QMS implementation that otherwise perhaps would not have not been identified.

Research Methodology

The central problem discussed in this paper concerns the effect the QMS is perceived to have upon the creativity of software development. We define creativity as a process of a "fruitful combining which reveals to us unsuspected kinship between facts, long known but wrongly believed to be strangers to one other" (Couger, et al. (1993)). In software development new ways of structuring the program often leads to more efficient system, not only by combining long known facts but also by incorporating some of the latest features of the operating systems. It is felt that a certain level of freedom in application development facilitates innovative solutions on the one hand, but uncontrolled software process can also lead to unprofitable systems that are difficult to maintain. Our objective is to find out what are the characteristics of creativity that are important to the innovative development process but at the same time allow the control of it to protect corporate knowledge or to assure the solutions are cost effective and easy to maintain providing the software house with a sustainable competitive advantage.

Given the broad objectives of the case studies, our research into creativity at this stage is exploratory, rather than rigorously testing existing hypotheses, trying first to identify general problems of the QMS implementation. Secondly, we aim to identify the features of the QMS implementation that seem to contradict the organisation's objectives of product development in terms of creativity. We suggest that such features *inhibit the success of the QMS implementation as they are likely to cause conflict between the quality controls required for the fulfilment of ISO standards and any existing mechanisms that the company already has to control the quality of its product development and service delivery.* We used the following questions to explore the QMS implementation in the six case companies:

- (i) What is the motivation for QMS implementation in the small software development organisation? In terms of the reason behind the desire to become accredited to ISO quality standards what patterns are evident?
- (ii) How do small software development organisations perceive the link between the quality control and quality assurance activities and the software process? Does a variation emerge in the pattern which helps to explain the success of the QMS implementation?
- (iii) Are there activities in the product or service delivery process that are not covered by the QMS; and if so, should the company-specific quality management system be adjusted to cover them too?
- (iv) How does the QMS relate to total quality management (TQM)?

The data was collected by interviewing a selection of company executives in each company by the author and a research officer from the Department of Industry, Technology and Regional Development. We spent 1 - 2 days in each company, interviewing the management and staff and studying the forms and documents used in the software process. For the interviews we had an agenda with twenty open questions and ten more specific semi-structured questions relating to the points (i) to (iv) above. Our plan was to interview general management, the sales and marketing staff, and the technical staff involved in product development. The managing director was interviewed in all cases and in five companies we also managed to talk to the sales and marketing directors. In two companies we were not able to talk to the technical staff, but in these cases the top executives, whom we did interview, were heavily involved in the product development and that enabled us to consider the company's QMS from the programmer's point of view too. In three organisations we interviewed the quality manager; others had not yet appointed a quality manager. The technical staff interviews provided us with information to evaluate whether the technical people's perceptions of the benefits of company-specific quality manual were in line with those of top management and marketing staff. All interviews were recorded, and we used the transcripts to describe in detail the expressed areas of concerns about the company-specific quality management system. The interview agenda focused on the procedures which facilitate the creation and monitoring of quality covering the following areas:

- Corporate strategy issues — to find out what are the long term and short term objectives of the QMS and the benefits expected through its implementation.
- Implementation of the quality management systems — to find out the differences between expected and perceived benefits, and the reasons for the differences between them. We also wanted to know whether the quality management systems implementation was similar to situations where new technologies have been adopted or process innovations have taken place. This, we felt, would advise how to manage successfully the implementation of the QMS.
- Controls placed to fulfil the requirements for standards — to find out their impact on quality and whether they were totally new procedures, or modified from the existing controls. We asked the staff members to express their opinions about the level of impact of the control procedures on the quality of the product or service delivered to the client (product quality), on the customer satisfaction (customer value), on the cost of producing these satisfactions (development cost), and on the organisation as a whole considering quality as a general philosophy pervading the whole organisation (quality culture).
- The role of the QMS in the software house's product and service delivery process — to find out activities addressed by it, and to find out why others aren't. In three of the companies (A, E, and C) the interviews were completed by running a workshop with the general management, technical and marketing staff to draft the company's value chain (Porter (1985)) to identify the current business processes. The workshop material enabled us to examine if staff members representing different functions (general management vs. sales and marketing vs. technical staff) agreed with the description and the flow of activities. It also enabled us to discuss with the staff about the benefits of including more activities in the QMS.

As stated earlier, our research is exploratory and builds hypotheses rather than rigorously testing them through case study interviews. We formulated working hypotheses for the research questions (a) - (d) which then helped us in analysing the interview material by providing a framework to look for arguments to support or reject them. First, we proposed that the reason to become accredited was the desire to improve the company's image and to cope with emerging market imperatives. We also wanted to know whether export oriented companies differ from those operating solely in the domestic markets. Especially we were interested to find out what exactly are the driving forces for the QMS implementation knowing that the customers in Asia — a popular target for Australian software exporters — do not require formal quality certificates as the potential customers in most European countries do.

Secondly, certain organisational factors may affect the QMS implementation. Previous research has showed that small software houses in most cases have started as one product companies and are technically oriented focusing on product development rather than fulfilling the clients' information systems needs (von Hellens (1991)) Assuming that the companies studied here are also either technically or market oriented depending on how well customer needs and wants are taken into account in their product or service delivery process, we suggested that in a truly market oriented company the staff sees the quality controls, even though they require boring paperwork, as something which actually complements the business rather than stifles its less structured, highly creative activities. Our case companies are all relatively small organisations and thus the technical staff is expected to contribute to customer support and service. Because of this, we assumed that the staff does not regard the implementation of standards as being forced to do something totally different from their everyday business. Instead, we suggest that there are practical problems in converting the existing customer focus and

quality of the service to something the development team (technical staff) can incorporate in their working practices. In addition we wish to find out what the companies are doing to overcome such problems.

Our third proposition states that because some of the R & D and sales cycle activities are intangible in nature and the quality of these activities being highly dependent on the appropriate skills of the individuals involved, there is no single way to complete them. To document these activities to embrace individual variations seems to be a fruitless effort. As a result they are not addressed by the QMS either. We suggest that the main problem is that these activities place more emphasis on the results, ie. a new product or a contract, than on the delivery process. Consequently, the performance indicators that are in use, evaluate the product, not the process. Therefore it is difficult to see the relationship between quality of the process (controlled by the QMS) and quality of the product, which depends on the skills (and creativity) of the staff member involved. In our research we wanted to find out if software houses agreed with this, and if so, do they have any desire or plans to change the situation. Finally, we assumed that the software houses see the QMS as a means to develop the organisation's total quality management (TQM) where the management seeks to remove the cause of faults rather than merely detect them when they have occurred.

QUALITY MANAGEMENT SYSTEM AND MATURITY OF SOFTWARE DEVELOPMENT ORGANISATIONS

Quality Software Process Leads to Quality Software Products ?

Quality refers to the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.³ Quality assurance is all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. Quality control consists of all operational techniques and activities that are used to fulfil requirements for quality. Quality management is the aspect of overall management function that determines and implements the quality policy. Quality system is the organisational structure, responsibilities, procedures, processes, and resources for implementing quality management. The most widely accepted quality management system is the ISO standard 9001 (Edelstein, et al. (1991)). As engineering standards have concentrated on the specification of quality product requirements, the software engineering standards emphasise almost solely the development process. The recent work by international standards committees have focused on developing quality standards for software products.(Standards Australia (1993)) Quality management systems seek conformance to the process oriented standards.

We assume that because software development still possesses craft elements and is very much dependent on an individual's programming skills, the relationship between a 'quality process' and a 'quality product' that fulfil client needs is not clear amongst staff in system houses. Furthermore, standards are seen as stifling the otherwise very creative systems development process and attempts to implement standards may lead to conflicts within software development organisations.

CMM — A Challenging Ladder to Optimised Software Development

The capability maturity model (CMM) by Humphrey (Humphrey (1988)) of the Software Engineering Institute at Carnegie Mellon provide a useful framework to consider the role of a quality management system in the progress towards the higher levels of maturity of software development organisation. The software processes at the first level (Initial Process) are ad hoc type and the organisation operates without formalised procedures. Organisations lack of ability to cope with crises and as a result the software processes capability is unpredictable. In the second level the organisation has established basic management controls. Organisations have learned from their prior experience on similar projects, hence the name — Repeatable Process — for the second level.

Although organisations generally may have learned to manage costs and schedules and the process is repeatable, they face major risks when new challenges arise, such as changes in tools and methods or new types of products. Organisational changes also cause problems, eg. when key persons leave the organisation in the middle of the assignment. To overcome the risks the process has to be defined. The third level of maturity — Defined Process — provides a basis for continuous progress. The process definitions are qualitative descriptions not necessarily involving any exact data of the effectiveness of processes. However, even the qualitative definitions can be used to improve the capability of the development organisation and the product

³ Definitions of quality and quality assurance are from the ISO 8402 [ISO 8402] see eg. Ould (1990), p.98 104; Price Waterhouse (1988), p.98.

quality. In order to do this, more comprehensive measurements on the process are required, more versatile than those measuring the cost and schedule performance. With such measurements in place the process becomes 'managed' (level four).

The highest level of maturity is the Optimised Process where process data is automatically gathered and this data is used to both analyse and modify the process to prevent problems and to improve efficiency. Recent studies has shown that most of the software organisation in the USA and Japan are still at Level 1, only some of the more mature organisations can be said to have reached the Levels 3 and 4 (Humphrey, et al. (1991)).

On one hand the CMM represents ladders towards the ideal, optimised software process, but on the other hand the systems houses in real life are struggling with the chaotic situation, balancing their activities between market imperatives and scarce human resources in terms of computing skills and business skills. More research is required to detect organisational features that support quality practices and to identify ways to relate software quality to competitiveness. Tools that reinforce those ties are expected to provide a platform for software organisations that enables a smooth transition to higher levels of the maturity.

QUALITY MANAGEMENT SYSTEMS — THE TROUBLED PATHWAY TO TOTAL QUALITY MANAGEMENT

Quality Management as A Means to Manage The Software Development Process

A quality management system brings the firm to the level where software processes are repeatable (figure 1). The software process becomes more visible and, as a consequence, the successful completion is not so much dependent on the skills of the individual analysts associated with them. When the processes are explicitly defined, audited and certified by an independent third party examiner, the firm is expected to be on the level three, characterised by defined software processes.

If the performance of the defined processes is constantly measured in a way that allows adjustment when inefficiencies occur, the development cycle becomes more effective and the firm has the potential to move to the Level Four of 'Managed Software Process'. Finally, the audit mechanisms of software quality control combined with other management review mechanisms provide a basis for a firm-specific total quality management system which emphasises client satisfaction and continuous quality improvement. A successfully implemented total quality management system takes the software firm to the highest level of maturity where the software process is optimised.

Software Process versus Sales Cycle

In the systems houses studied in this project the QMS is not always seen as a natural part of the firm-specific total quality management system. Both software development and any quality assurance system relating to it, are regarded as being separate from the sales cycle⁴ and from the control and evaluation mechanisms attached to sales and marketing activities. Moreover, the QMS in its current form, as accredited to be in conformance to AS 3563 (which is the Australian application of the ISO 9001) seems to force the companies to stick to a very formalised set and order of development procedures rather than allow a flexible methodology optimised to fit each assignment. It is felt that this represents the major obstacle of making use of the QMS in the process leading to the total quality management. Indeed, in the company B the staff claimed that the QMS has very little to do with the everyday development activities ("it [the QMS] is divorced from the development methodology" as the chief system analyst put it). Their quality control system could not cope with the different tool set requirements of different projects.

The constant complaint about the current notion of quality control and quality assurance in software product development was that it does not take into account the variety of products and services the system house is offering. Software and systems development is embedded in a myriad of consulting services. One company interviewed attempted deliberately to move from software development towards more profitable services. For them the software provision currently accounts for a third of sales turnover but almost for nil percentage of the profit.

Assuming this is the case in many systems houses currently providing professional services, the focal point of quality management system implementation should move from primary software development activities to the more intangible tasks of product or service delivery. Such activities are less structured and, consequently, to define the resulting product or service is easier than to define the actual process of creating it. However, the quality standard is process oriented and as such gives few guidelines on how to manage the quality of service.

⁴ Sales cycle consists of all activities, eg. tender processing, from initial contact with potential client to the point when the business is agreed and detail contract negotiations with the client commence.

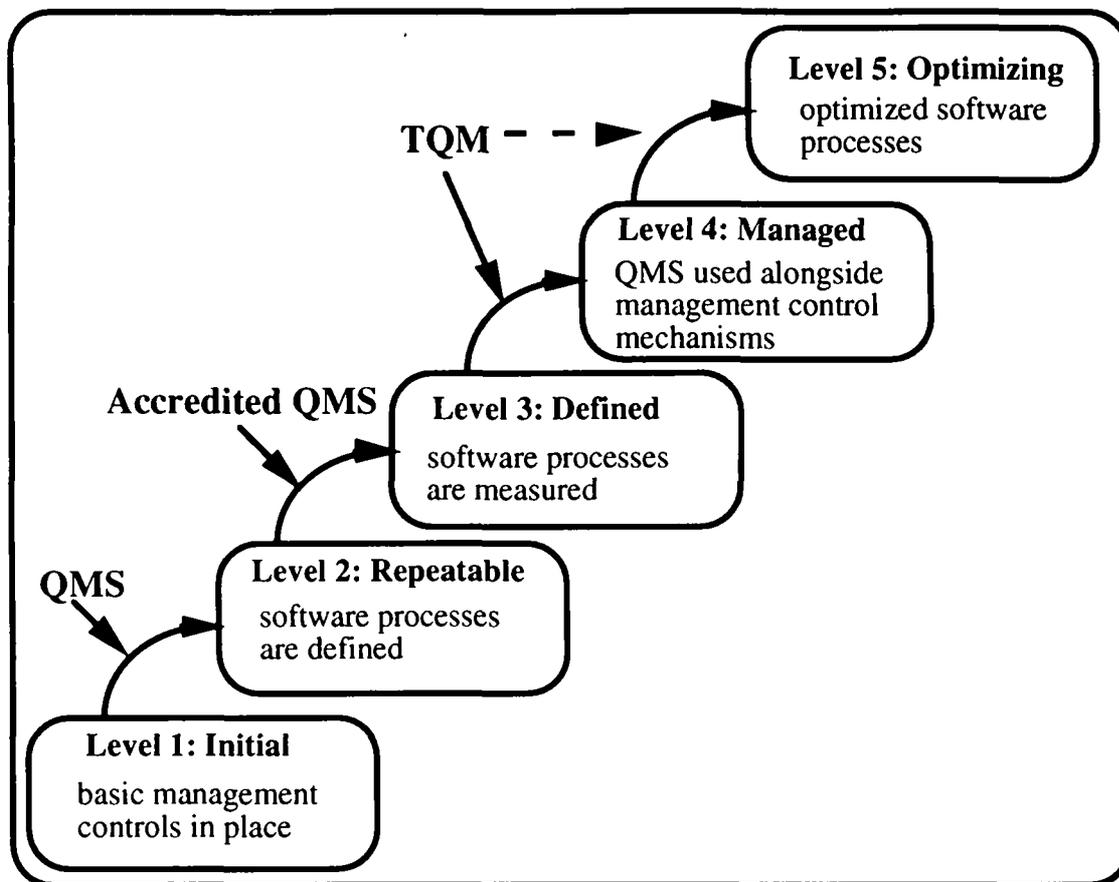


Figure 1: The QMS and maturity of software development organisation.

To overcome the practical problems in converting the very strong existing customer focus and quality of the service to something the development team (technical staff) can incorporate in their working practices, the company E explored new ways of describing the intangible nature of quality to make it more tangible and better appreciated by the staff. As the general manager stated: "We now redefine the content of the quality management process itself and the sort of things which the company wants to capture aiming at success in the market". Their quality manual was defined to provide a more comprehensive understanding of the intangible elements of quality and the business success of the company. In the company E they are also considering ways to re-organise the projects to increase quality appreciation amongst staff. For example, it was noticed that when development staff was dealing with the service tasks they became aware of the direct relationship between customer needs/focus and the process quality and the development teams were brought closer to the customers. The development team was seen to benefit by finding it easier, after being involved in support activities, to define what quality is, and to convert it to something the development team can incorporate in their working practices.

It was observed that the opinions on what exactly are the activities of the product life cycle in systems houses differed significantly amongst staff. In the company B, application development, to construct a well defined system to fit a certain hardware platform and programming environment is seen to be different from a true software project of constructing a system to fulfil the specified information system needs of the client. For an application development project neither the existing software development method could be applied nor the process oriented QMS. The major criticism of the QMS shared by the management of the systems houses in this study, is that the perspective it represents is too narrow, leaving out important business issues, because the objectives of the QMS is to assure that the client's requirements are taken into account during the course of development without considering the cost effectiveness of the project. Similarly, the bidding process is also seen as being separate from the planning of the project. These criticisms are strongly supported by the sales staff which was involved in the negotiations and dealt with the delicate aspects of initiating new businesses.

However, the technical staff involved in the process do not always share these views. In contrast, they felt that a major part of bidding (also called as tender process) was highly structured, could be well defined and could be included in the QMS. Bidding activities were regarded by technical staff as preliminary project planning tasks which support significantly the actual project planning. Technical staff members also pointed out the risks of losing valuable 'corporate information' if a staff member leaves after a successful bid but before project has

started. The company B which stressed this point had lost business due to such instances, after which not enough customer information was left in the company and, subsequently, the competitive advantage they initially possessed, had vanished.

Alongside the definition of the intangible sales cycle activities appropriate measurements need to be developed to provide information of the quality of these activities. They are highly unstructured utilising versatile product knowledge accumulated in the systems house. In order to define and control such a process, various types of qualitative information should be gathered and tools able to make use of qualitative information must be designed. Such tools would help to identify factors that have significant impact on a tender's success. By controlling the factors not only the quality of the processes could be assured but also the success rate of tenders could be raised. In any business organisation a variety of performance indicators to evaluate the sales cycle activities (eg. sales results and customer sales potential) are commonly used. Performance indicators provide a useful basis to define quality measurements for intangible sales cycle activities.

Unexpected Changes of Requirements during Systems Development

A qualitative evaluation of the client's maturity would support project planning, providing information on the likelihood of previously unidentified, major system requirements emerging during the course of the development, which will need to be taken into account in the product or service production to assure the highest possible level of customer satisfaction. Previously unidentified customer requirements may cause unexpected changes during the development, and according to one systems house in this study the bigger the system is the more of them there are.

Unexpected changes to the systems originating from the client are something the software development organisation cannot easily accommodate, except by keeping constantly in touch with the client during the development and having procedures in place to handle new information about the requirements, as was the case with one of the companies interviewed (company C). The procedures involve advice on how to deal with different types of change requests. They vary from "quick fix", to new developments which will result in a "new development project" during the initial systems development life cycle. In both cases the estimated budget and time to complete the initial assignment has changed. The change may have been caused by something external to the client or is simply something the client did not feel as being important for the system structure in the first place, eg. in a financial package a type of invoice, which happens regularly but scarcely, for example once a year, and is processed differently causing major changes in the system structure if taken into account.

Whatever caused the change (from "they did not know" to "they did not tell") it will be dealt with carefully bearing in mind the primary goal behind the product or service design: "Total customer satisfaction, both immediate and ongoing, which will result in a sound and profitable business." According to the company this has been applied successfully ("In our opinion we produce a better product for our client than our competitors"). However, it may turn out to be difficult to document the process in a concise form for a quality management system without losing the existing creativity in restoring the customer focus, that the company C clearly shows, in handling the ever changing customer requests. Company C has recently started to place formalised and documented quality controls on their product/service production process and plans to have the QMS accredited sometime during the next 12 months. From what we have seen so far the time estimate is perhaps too optimistic.

Client Maturity Evaluation

The unexpected changes represent a major risk factor for the project. In order to minimise the impact there should be procedures in place to evaluate during the tender process or contract negotiations how well and comprehensively the client able to present the business processes the supplied system is meant to support. If the customers are mainly organisations that are more mature in the sense that their business processes are well defined, the risk of unexpected changes is minimal and there is no need to define quality controls for handling unexpected changes. Some systems houses do evaluate the client relationship ('intelligence feedback', 'distance to project location') during the tender process.

Company B uses 'a bid approval request'-form to provide information to support the go/no go decision making during the bidding. Potential projects are ranked on the basis of ten variables describing the client relationship and the suppliers experience in handling the type of application as well as competition which affects the success of getting the business. Each variable is rated from 'poor' (= 0 to 1 points) to 'superior' (= 9 to 10 points) and the prospect with a total of 60 points will be recommended as worth pursuing.

The risk evaluation procedure of the company B does expose some situational factors that may inhibit or reinforce the project's success. However, the procedure does not actually say anything about the prospect's

maturity or capability to define the application and system needs. We feel that this is a reflection on the fact that the bidding process is so dominated by the competition that it hides factors that will certainly affect the development. For example, extra implementation costs may occur when new development tasks are needed to add system features which were not previously specified. The staff members admit that there is a more or less total separation between pre-sales activities (tender processing, bidding) and contract negotiations during which the system is specified in detail, and thus many of the documents used in tender processing do not provide accurate information for the project planning. According to the quality manager in the company E they concentrate of getting the business ("we try to convince the Prospect that we are the best") rather than getting the details right ("we worry about it later") in the tender process. The company felt, however, a genuine need to expand the quality management system to the tender processing, in particular if prototypes were used to support the bidding.

Depending on the nature of the business the clients are different, eg. the insurance industry in Australia is for historical reasons well developed. Insurance companies as clients very seldom cause significant changes in systems logic during development (although the systems may possess other risk factors, such as new technology, new software tools), because they have a very definite picture of the business processes and actions that need to be performed to provide services that fulfil their clients' needs. However, not all client groups are as homogeneous as those of the systems house F providing computer-based systems for insurance firms. Other industries are much less developed in this respect.

Client maturity is a kind of a market imperative, appreciated by sales staff in the companies studied, but rarely understood in the sense of the implications for systems development and quality control. If information on such incidents is not gathered to aid the QMS development, there is no way to guarantee that the quality management system is really helping to improve the overall effectiveness because it will merely capture the errors where the enter into the life cycle, but will be unable to advise about a client related risk factor that will badly influence the development process later.

INTERNAL AND EXTERNAL REASONS FOR SEEKING QUALITY ACCREDITATION

Quality Accreditation to Protect Corporate Knowledge

The quality management systems of a software development organisation can be assessed by a first, a second or a third party. In practice the two latter are the most valuable because they provide an independent evaluation of the organisation and are thus more reliable in the potential clients' eyes than an internal assessment by the organisation itself although it may be based on extensive internal reviews, audits, and client satisfaction surveys. A second party assessment is when an organisation and its products are assessed by a purchaser against product or quality system standards selected by the purchaser organisation. Such an assessment may be relatively narrow in scope, covering only the elements relating to the product or services purchased by the assessing second party, but it can provide a sharp focus on that particular area.

The second party assessment may be a valuable step towards third party accreditation, as it was for the company A in this study. They gained second party certification to Australian standard AS 3563 from their major customer Queensland Government in 1990. It became clear that this process eased the way towards the third party certification awarded by Bureau Veritas, an international quality auditor, in June 1993.

Software development organisations may have external or internal pressures for seeking accreditation. An example of the external pressure is the market imperative, such as demands by powerful buyers who require that their suppliers have certain types of standards in place before business can be decided. Product and market knowledge in the sole possession of individual staff members are risks which need to be controlled. This is an example of internal pressures to become certified.

Internal pressures also stem from the need to secure skilled work force in the future. As business is becoming more service oriented the staff required have to possess not only technical skills but also a variety of interpersonal skills. Due to increased competition, obtaining multi-skilled people rather than purely technical specialists is difficult ("No longer can I say that we have the elite of the industry" as the managing director of the company A stated, and continued: "We have start taking people at different levels"). The accreditation of the QMS is seen to attract more people and provide more alternatives in staff selection, because the company will be seen as an advanced and challenging workplace.

Product and market knowledge represents corporate knowledge, expertise accumulated during the pre-sales activities and during the R & D tasks of software production. These less structured tasks are more difficult to define and it was strongly felt in the organisations studied that any formal structure may stifle the essential creativity needed for the successful completion of them. At the same time it was felt that the QMS could benefit both areas and help to avoid some of the problems, such as the too low success rate of tenders and freely evolved innovative product structure which causes problems for those who have to maintain the system.

The dilemma between the R & D and maintenance requirements was illustrated by the managing director of the company D who stated: "We want to keep the internal R & D as informal as possible and the specs [system structure] should be flexible enough. At the same time we do have organisational problems as someone else needs to be able to maintain the system. So far we don't know how to define the QMS for us."

"History of Complaints" Triggers QMS Implementation

Extensive negative feedback from the market often triggers the implementation of a quality management system. Complaints from the customers make suppliers know that they have to improve the quality of their products. Most companies included in this study had a 'history of complaints' which became impossible to handle effectively unless radical actions to improve the systems were taken. For example, in the company A an incident happened in mid 1980s when a large number of a certain release of a text retrieval system were sold before it was discovered that the system could not handle large data volumes. The management still recall the event as a major disaster that must never happen again. The need for further testing and controls became clear and as a result the quality management system implementation and continuous improvement has full support from the top management. For the company A, the visible management support is essential, as the staff resistance is significant especially from the more experienced analyst and programmers. Company A has also the largest number of staff, 80 people, some of them working continuously at the clients' sites, which makes it difficult to impose quality practices and control their adoption.

Other 'histories' were not as closely related to certain releases and to certain types of errors, but to a generally low technical quality of a piece of software. A relatively large number of unsatisfied customers occurred when the product license was bought by staff members establishing a new company. The combination of dealing carefully with the angry clients' complaints and at the same time rewriting parts of the software in order to fix the errors behind the complaints made the management and new staff adopt the theme of "total customer satisfaction" for the software process. In both cases (company A and C) to improve quality became a matter of survival for the company.

A different story was company D whose product is an application of seamless charting for marine navigation and mine mapping. The development team has extensive experience in electronic cartography application use and development. The software product is not a mass market product like a financial package to fit any small or medium sized business, but is highly sensitive to the quality of hardware peripherals attached to it, both of which strongly demand that the software is error free. Due to problems in the relationship with the joint venture partner (which went into receivership) the company D was left alone for several months with the initial concept (given by the joint venture partner) of navigation software. As the business virtually stopped times were rough for the company D.

Because of the circumstances the company D was provided with a more or less welcome break from sales and marketing which allowed the small software development team to thoroughly test the software. After a some six months period they had a flawless piece of software ready to be marketed through a marine equipment retailer. The resulting application is a navigation software system built around the charting system, which is unique in the world and ideal for export. The export markets Indonesia and Canada which company D had chosen do not require formal quality certifications, but to be able to show such a certificate is almost the only way to convince export partners that the software is of high quality. The target is to establish export activity in one new market annually. If the quality management system enables the achievement of this target its implementation becomes justified. However, at the same time the management of the company D is very concerned that the system will stifle the creativity of the research and development activity which is at the core of their products success. The company is currently appointing new high quality computing experts to join the research and development team and one of the main concerns is how to keep their activities separate from the software processes covered by the quality management system.

CONCLUSIONS: NEXT STEP IS TO IMPLEMENT MEASUREMENTS

Balancing between Improved Company Image and Stifled Creativity

It became obvious that the main reason for taking the steps towards the implementation of quality management systems and, subsequently, to become accredited, was to improve the company's image, eg. to be accepted as a quality supplier amongst potential clients and to assure a quality work force in the future. In the long run the quality management system was also seen to be representing an initial step towards total quality management and improved effectiveness of the company. In most cases the basis for the company-specific quality management systems was laid during the time of peaceful software testing or during vigorous debugging in order to keep the customers happy.

However, the implementation of standards possessed a threat as it was seen to stifle the creativity needed for product innovations. This was causing some concerns among management as well as staff resistance. The limited nature of current quality management systems was also highlighted as it was observed that some of the business processes, eg. pre-sales activities and tender processing, all of which are important for the competitiveness in the long run and for commercial success in the short run were not covered.

Measurement Is The Key to Continuous Improvement

The quality management systems should be seen as a step towards total quality management. TQM is about continuous improvement for which three components are needed: management commitment for improvement, motivation for improvement, and measurement for improvement (Alter (1993)). If any of the three components is missing the organisation may not be delivering competitive quality. This study showed that any measurement for improvement is considered very difficult in the systems houses even though the companies do collect a variety of customer and development trouble reports. Partly because of the qualitative nature of the information in such reports and partly because the main objective is to give enough information to the development team to help them fix the system according to the customer's complaints. Although trouble reports are collated and kept in files they cannot easily be used for other purposes, eg. for collecting statistics of the nature of complaints and system modifications, without developing, a way to analyse and classify the complaints. We feel that a content analysis type of study of the trouble report files would provide ideas of an appropriate classification which would suit the company and support the management to control and assure the quality of systems development.

Analysis of Value Activities and Their Relationships

The management understands too well that the money is not just magic, the tasks require a balanced combination of interpersonal skills, technical skills and a quality system. To define the optimal level of quality for each task, multiple perspectives are needed to appreciate the relative nature of quality. Quality procedures in place enable the organisational change, as the Quality Manager of the company A put it: "Quality culture is an evasive thing that will just develop over time, we put signs everywhere".

Two interrelated issues seem to inhibit the rapid expansion of quality improvement programmes. First, the market was not seen to be mature enough as the customers are not willing to pay for the increased quality which is something intangible and not influencing their day to day use of the system being supplied. Secondly, the management's opinions about linkages between the quality management systems and business development vary from no relationship at all to vaguely supportive.

We feel that sales cycle activities should be explored more to discover elements that have major impact on both the success rates of tenders and to provide hints about how customer requirements will be changing during the development process. Generally the management agreed that pre-sales and research and development tasks should be incorporated in the quality management system, but they did not really have any suggestions on how to go about it. The main problem was: how to control the quality of these activities and how to measure the impact of those activities on customer satisfaction and on revenue development. Furthermore, because these activities are less structured and involve hidden knowledge it is very difficult to describe them explicitly and in a way that they could be included in the company's QMS.

To make the QMS support highly unstructured tasks such as sales and pre-sale activities or ongoing research and development, an analysis of the internal competencies of the systems houses should be carried out. The analysis should include a detailed evaluation of the relationship between business development and quality software processes. The value chain analysis⁵ which examines the flow of primary and supporting activities that lead to successful product and service provision would help the managers to direct their effort into areas that improve the competitiveness of the systems house. We feel that the resulting overall picture of the company's activities will smooth the way to total quality management.

ACKNOWLEDGMENT

The author wishes to acknowledge the grateful support of all those executives from the six software houses in Australia participating in this research and thanks the Department of Industry, Technology and Regional Development for initiating this research and supporting it in many ways.

⁵ See Partridge & Perren (1993), which discusses how Porter's (Porter, Competitive Advantage, 1985) Value Chain analysis can be applied to service industries.

REFERENCES

- Alter, Steven (1993), "TQM in the IS Function," Tutorial at the ICIS'14, Orlando, Florida, December 1993.
- Couger, J. Daniel & Higgins, Lexis F. & McIntyre, Scott C (1993), "(Un)Structured Creativity in Information Systems Organisation", **MIS Quarterly**, December 1993, pp. 375-397.
- Douglas, D. P. & Walsh, L. (1993), "TQM in IS: Defining User Requirements", **I/S Analyzer**, May 1993, Vol. 31, No. 5.
- Dromeey, Geoff (1990), "A National Software Industry Initiative", 1990.
- Edestein, V. & Fujii, R. & Guerdat, G. & Sull, P. (1992), "Internationalizing Software Engineering Standards", **Computer**, March 1992, pp. 74-75.
- von Hellens, L. A. (1991), Conditions for the Success in the Design and Implementation of Packaged Software. A Study of Accounting Packages for Small Companies in the United Kingdom, D.Phil thesis, Templeton College, University of Oxford, 1991.
- Humphrey, W. S. (1988), A Method for Assessing The Software Engineering Capability of Contractors, Carnegie Mellon University, Software Engineering Institute, February 1988.
- Humphrey, W. S. & Kitson, D. H. & Gale, J. (1991), "A Comparison of US and Japanese Software Process Maturity", 13th ICSE Austin TX, May 1991, pp. 38-49.
- Ould, Martyn A. (1990), **Strategies for Software Engineering, The Management of Risk and Quality**, John Wiley & Sons, 1990.
- Partridge, Mike & Perren, Lew (1993), "Achieving Competitive Advantage", **Management Accounting**, November 1993, pp. 37-38.
- Porter, Michael (1985), **Competitive Advantage**, Free Press, 1985.
- Price Waterhouse (1988), "Software Quality Standards: The Costs and Benefits. A Review for the Department of Trade and Industry", April 1988.
- Smilie, T. (1993), "The Software Quality Target", **Informatics**, April 1993, pp. 18-22.
- Standards Australia (1993), "Voting Advice on ISO/IEC DIS 12119, Information Technology - Software Packages - Quality Requirements", October 1993.
- Verner, J. & Daneshgar, F. (1992), "Quality of Software Development Process: Australia Needs to Take Notice", **Quality Australia**, Vol. 9 No. 4. pp. 8-10, 1992, pp. 8-10.