

Software Quality: past, present and future – a United Kingdom perspective

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ABSTRACT

The high cost to industry of poor quality software has resulted in greater and greater interest in Software Quality. Within the UK, the production for the Department of Trade and Industry of the TickIT Guide to Software Quality Management System Construction and Certification using EN 29001 and the following TickIT initiative may be seen as a watershed. In the paper a perspective of the past (the pre TickIT years) and present (the post TickIT years) are presented. These are followed by some predictions for the future and identification of those areas which should now receive the greatest attention.

1. INTRODUCTION

The software industry, over the last twenty years, has been subjected to a plethora of new methods, approaches and tools. Each of these have been intended to counter the software crisis and lead to an improvement in the software production process and the products it delivers. However, it is currently recognised that [1]:

"The goal of improving software quality and productivity remains an elusive one. This is so in almost all application areas including business orientated applications. Software development is not yet an engineering practice".

There are many and various reasons for the problems which are associated with the development, production and maintenance of software. Some are related to working practices (or lack of them) within the industry, others are related to

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economic factors, such as time and money while other more fundamental causes may lie with the people in the industry and their psyche. What is absolutely obvious is that there are still major problems in the development of software and it would appear from reports at recent international conferences (eg [2], [3]) that industry has failed to adequately address them. The ongoing problems in the software industry within the U.K. have forced staff, at all levels, to consider the topic of quality. Their level of interest and concern is clearly illustrated by the high level of participation in recent conferences and workshops concerned with software quality, in particular the SQM conferences held in 1993 and 1994.

It is appropriate at this time to stand back and take stock of the situation and make predictions for the future. Hence, in the following sections we attempt to provide a U.K. perspective of the past, present and future with regard to software quality. We first provide a brief historical view of the developments which led to the awakening of the U.K. industry by the Department and Trade and Industry's 1990 TickIT initiative and guide [4]. We then provide a summary of the main areas of concern and interest which have been publicised at conferences and workshops associated with quality which have been held during the last two years within the U.K. [5, 6, 7, 8]. Where appropriate we have also considered matters which have been raised within a European and World context [eg at [9] and [10]]. Finally, we present some predictions for the future and we identify those areas which should receive the greatest attention if we are really going to see further improvements in Software Quality.

2. THE PAST (Pre-TickIT)

It is important that when we consider the subject of software quality that we differentiate between the quality of the delivered products of the software development process and the quality associated with the process itself. As many authors have pointed out (eg [11]) quality is hard to define and almost impossible to measure directly. Thus if the major product is that intangible we call software it is easy to understand why many have decided to consider the quality of the management of the process rather than the product. However, even in this area it is important when measuring quality that we understand the relationship between a quality management system and a quality management standard. As Slater [12] has described, the purpose of a quality management system is to define a procedural framework with active functions to regulate and ensure the quality of products and services. A quality management standard, on the other hand, identifies general quality requirements which need to be addressed by the supplier's quality management system to meet purchaser or national criteria.

2.1 Quality Assurance and UK Industry

During the late 1970s and early 1980s interest in quality assurance increased throughout UK industry. In 1982 the Government's concern for better standards and quality assurance within the UK was revealed in the production of the white paper "Standards, quality and international competitiveness" [13]. The paper, although not stating anything new, helped provide further impetus to increase efficiency. The BS 5750 Standards began to be recognised as was the value of product certification schemes such as the BSI Kitemark and Safety Mark Schemes. In 1987 BS 5750 Parts 1, 2 & 3 were re-issued with additional guidance material to assist with implementation of the International Standard Organisation's ISO 9000 and European Economic Community's EN 29000. At the same time the Department of Trade and Industry (DTI) promoted the National Quality Campaign to generate a growth of interest in quality assurance within British Industry. The number of BSI registered firms during the period 1981 to 1984 showed a slow rise to a figure of 500, whereas, the period from 1984 up to 1990 indicated an ever increasing rise to nearly 7,000. However, a very small percentage of these related to Software Development.

2.2 The DTI and the 1988 Reports

The obvious high costs to industry of poor quality software led the U.K. government's Department of Trade and Industry (DTI) to commission in 1987 investigations from consultants at Price Waterhouse [14] and Logica [15] regarding QA use. These investigations were to determine the true costs of poor quality software, and whether quality procedures and standards could substantially improve matters.

The investigations showed that many billions of pounds were spent annually in the UK on software, by Industry, Government and Commerce. They also revealed that a significant amount of this was being wasted due to poor quality. Extrapolations [16] of the Price Waterhouse figures for traded software have indicated that the total wastage cost for traded, imported and in-house software was at least £2,000 million per year, or £1 million per working hour.

It is also likely that there were significant indirect costs associated with poor quality software, which are difficult to quantify because they relate to individual users. For example: poor software systems may lead to a lack of confidence in a company and result in a loss of business for that company. Thus poor software quality results in substantial costs, monetary and otherwise to both suppliers and users.

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With regard to the use of QA procedures within the UK software industry Price Waterhouse reported:-

"The measurement of software quality is difficult and much work remains to be done to develop satisfactory software quality metrics. A number of studies have attempted to define a set of measures, but the results are so complicated that they are of little general use."

"Few software producers collect quantitative information relating to software quality. Neither do users quantify the costs they incur as a result of poor quality software. However, despite the difficulty in obtaining quantitative measures, it is generally agreed by both suppliers and users that poor quality software is a major problem."

With regard to organisations adopting QA standards for software they stated:-

"ISO 9001 provides an adequate specification of the minimum requirements for a quality system. However, it is at a high level of generality, the terminology is difficult to interpret for software, and the guidance documentation is confusing."

The Logica Report [15] arrived at similar conclusions and their main recommendation was the establishment of a sector based scheme.

2.3 TickIT

To determine the type of scheme that was best suited to the software industry the British Computer Society (BCS) was invited to propose the organisation, procedures and rules for a sector scheme which was compatible with emerging CEC documentation (Commission of the European Communities). The BCS decided to work within the framework that already existed, but to use a fresh approach. The result was the collection of guidance material procured from various sources to form the document called the TickIT guide [4].

It was hoped that the TickIT guide would help reduce misconceptions by interpreting the application of ISO 9001 to the development of software (ISO 9001-3). Also, it was hoped to gain the confidence of the IT sector by strengthening the areas of weakness: Auditor registration and training, guidance and certification body practice.

3. THE PRESENT (1990-1994)

It is clear that over the last four years Software Quality has become one of the U.K.'s computing "hot-topics". This is to a large extent due to a snowballing interest in quality in general and the publicity associated with the TickIT scheme. The particular aspects of the software quality movement which we believe are worthy of note within the U.K. are: standards, certification and assessment, the level of awareness within the industry and the research that is being undertaken, economic and market pressures, information that is coming forward on both successes and failures, the development and use of metrics and methods, and finally aspects associated with people and technology.

3.1 Standards, Certification and Assessment

The TickIT initiative was certainly not an instant success for the DTI. It was launched in 1990 but a survey carried out in late 1991 [17, 18] reported that 67% of the IT companies who responded were unaware of the initiative, that 41% of respondents used no formal Quality Assurance procedures and that only 22% had Quality Assurance procedures which had been externally assessed and certified as being in line with a national or international standard such as ISO 9001/EN29001/BS 5750 Part 1. However, of those that had such an accreditation, almost half had gained it during the previous year. It appeared at that time that the information was reaching only those parts of the industry who were interested in quality but was failing to reach many others. Since 1991 indications are [eg 19] that things are much improved and that there has been an increasing effect. The growing interest in Quality Management Standards, their application and accreditation is also clear from papers presented at conferences during the last two years (eg [20] and [21]).

Accreditation to a recognised Quality Management standard is not the only form of assessment that is taking place. The measurement of an organisation's maturity against the Capability Maturity Model from Carnegie Mellon University's Software Engineering Institute appears to be flourishing (eg [22]) and there is also evidence of use of the Bootstrap assessment approach which has been developed with ESPRIT funding (eg [23]).

3.2 Awareness and Research

The current level of interest in Software Quality and its place within a wide range of areas is clear from the scope of the papers which are found in recent conference proceedings ie [5] - [10]. It is clear that both within industry and research establishments the importance of ensuring and assisting Software

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Quality is recognised. Analysis of recent proceedings indicates that the highest levels of activity are taking place in the areas of:

- The development, use and assessment of standards
- Implementation and use of Quality Management Systems
- Process Improvement
- Metrics
- Tools
- Human Factors in Quality Management
- Testing and Validation
- Financial and Management Aspects
- Quality of Engineering Software
- Approaches to Systems Development
- Education for Quality

3.3 Economic and Market Pressures

The raised level of awareness detailed above both generates and responds to economic and market pressures. It has been rather cynically suggested [24] that it will be external market pressures from customers that will cause Quality Assurance procedures to be adopted by much of the industry rather than an internal desire for improvement. However, it is without doubt that reports which detail real benefits (eg[25]) do much to encourage the adoption of good practices.

3.4 Successes and Failures

Perhaps what is particularly pleasing is that with a highlighted awareness in quality there appears to be a growing openness to discuss and explore both successes and failures. It could be simply that computer systems now have such high profiles that it is more difficult to hide the problems. However, it would appear that there is a greater willingness to share experiences, to the extent that business confidentiality allows, and build up a repository of case histories (eg [2], [26] and [27]).

3.5 Metrics

The topic of Metrics and Quality appears to be much more diverse and in many ways less mature than others. As mentioned earlier it is currently much easier and acceptable to assess the quality of the process than the quality of the product, especially if that product is software!

Proponents of the use of metrics with traditionally designed systems put forward their cases (eg [28] ,[29] while others make proposals for the newer

paradigms such as object orientation (eg [30]). The application of metrics has been a desirable goal for many years and has been greatly assisted by initiatives such as ami (application of metrics in industry) and the production of the MEIKIT training materials [31,32]. It has also been made clear that there are great dangers in using metric data for predictions, if that data no longer accurately reflects the current situation or environments. "Data is not like a fine wine - it does not mature with age. Data is like fresh vegetables - it rots on the shelf" [33].

3.6 Methods

Quality Assurance is inextricably linked with the use of well defined methods and procedures. Current work in this closely linked area extends from the relationship with soft systems [eg 34] through traditional approaches using methods such as SSADM [eg 35] to much newer and more innovative approaches such as methods where object orientation and CASE are totally integrated [36]. It is also clear that much can be gained from the formal methods area [eg 37]. Finally with regard to the development of new methods and approaches it is clear that many of these are being designed with a prime aim of being capable of supporting Quality Assurance procedures [eg 38].

3.7 People vs Technology

In most branches of computing it often appears that the technology (machines, methods and tools etc) is regarded as more important than the people. It is thus pleasing to see, in the field of quality, that the human dimension is being given prominence. For example, in 1994 a conference on quality [10] had as its prime theme concern for people and it addressed both the social and ethical human aspects as well as the technical aspects of software quality. It has been made clear that the technology can greatly assist in the development of quality systems [eg 39] but it must not be forgotten that systems are developed for people, by people, and that the people are actually the most important elements.

4. THE FUTURE (1995 and beyond)

There is no doubt that Software Quality is recognised as a key factor within the industry. Unlike many other "hot-topics" it is not going to fade away. However, we expect that in the future we will see quality being more and more integrated into the production process and no longer being considered as a separate function. Our predictions for the future and the areas which we believe should now receive the greatest attention are as follows:



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4.1 Predictions

- That new technologies and developments, such as the Information Super Highway, will affect enormously the way in which the software industry operates.
- That we will see much more interest in ensuring the quality of the product rather than the process.
- That people will be recognised as the major resource we have and that there must be developments that will aid communication in all respects including those between users and developers.
- Metrics will advance much further than at present.
- That assessment and accreditation will be flexible forms.

4.2 Area that Require Attention

- Professionalism: this needs to be improved throughout the industry
- Information: organisations need clear unbiased information and guidance. There is a clear need for good technology transfer material which relates to software quality.
- Education: the role of quality and its importance should permeate computing courses at all levels.
- Accreditation and its costs: these need to be carefully controlled if accreditation is not to become too costly for small and medium sized companies.

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