

A sustainable TQM programme

M. Hewson

Praxis plc, 20 Manvers Street, Bath BA1 1PX, UK

ABSTRACT

In this paper I look beyond the hype and fog generated by the three little words 'Total Quality Management' and describe a sustainable implementation of TQM that works for software development. It is based on process modelling, process improvement and objective-setting.

Praxis was the first independent software house to gain certification of a quality management system (QMS) to ISO 9001 (BS 5750 : Part 1). Since gaining our registration in 1986 we have continued to develop our quality management system and in 1990 we took the decision to implement a programme of Total Quality Management (TQM) in order to ensure that our services are not simply "fit for client purpose", but satisfy all of our client's needs; the quality that will *delight* our clients.

The focus of our QMS is on providing our project managers with an *effective* framework of formal and systematic processes and standards that assists them in achieving quality for our clients and for Praxis. We soon found that there is not much that is "formal, or systematic or standard" about most of what is promoted under the banner of TQM. Although there are a large number of techniques called TQM and an even larger number of consultants and gurus who claim to help you "do TQM" we could not find any definitions of a TQM process that applied to our business (systems design) or our product (software services).

We therefore set about developing a Praxis TQM process. This paper describes how we:

- define critical success factors, critical processes and critical process owners for a software development organisation;
- set objectives that are focussed upon continuous quality improvement and cascade them throughout an organisation ;
- model software development and associated management processes;
- set standards for process effectiveness and describe how processes effectiveness is measured and improved.

86 Software Quality Management

INTRODUCTION

Start to explore the topic of TQM (Total Quality Management) and you will soon discover two things.

The first is that the proponents of TQM claim that it is the 'Eldorado' of business. Find TQM they say, and you will solve all of your business problems. TQM will delight your customers, increase your revenue, increase your profits, reduce waste, mobilise and motivate your work force and enthuse your managers.

The second is that, like finding Eldorado, finding out exactly what TQM is and how to get to a position where you can enjoy its benefits is very difficult indeed. Most organisations (ninety percent is the often quoted figure) that set out to find a TQM Eldorado, never get there. In fact they never get anywhere: they simply become dispirited, and the notions of quality and improvement are never mentioned again with the result that the organisation withers and dies.

In this paper I describe how Praxis, a software engineering company providing bespoke software, turnkey systems and consultancy, worked out what TQM is and how to practise it.

What is TQM?

It is not that there is no information about TQM: on the contrary, there is so much information about it that a beginner can easily become confused and disorientated.

Clearly no business can turn down the opportunity to gain the benefits claimed for TQM. Where do they go to find out how to practise it?

This was the question we asked in Praxis early in 1990, when we decided to implement a programme of TQM.

Our first thought was that we should ask the experts. There must be TQM gurus — we should read their books and learn.

TQM has many gurus. Each of them (and their disciples) will claim that their way is the true way. Deming's followers will elucidate the "fourteen points" [1] and extol the virtues of statistical process control (SPC). Crosby's followers point to the "quality grid" and the pursuit of the reduction in the price of non-conformance [2]. The adherents of Ishikawa, Taguchi, Juran and the many lesser prophets are similarly ardent about their belief that their guru's way is the true way to the practice of TQM. Whilst very little of the advice of the gurus is bad advice, very little of it is specific and much of the advice is conflicting.

If the gurus do not provide a clear message as to how to practice TQM, perhaps a study of the TQM tools will help to define how to do it.

TQM Tools?

TQM has even more tools and techniques than it has gurus. All the tools seem to have peculiar titles which are generally shortened to meaningless acronyms. So, we have quality function deployment (QFD), quality policy deployment (QPD), process quality management (PQM), SPC, the "seven basic tools" and the "seven new tools". In addition, all the

management and group working tools that have ever been invented seem to have gained new life under the heading TQM. Clearly it is not possible to learn and apply all of these tools. On which of them should you choose to spend your limited training budget? Which are appropriate to what your business does and to the skills of your people. What benefits arise from which tools? There are many claims for each TQM tool but very little quantification of any benefits.

Obviously there are just too many tools to trial them all. If the TQM tools do not point the way to how to do TQM, maybe we should seek advice from consultants.

TQM Consultants?

There are even more TQM consultants than there are TQM tools and techniques. The consultants have a lot of advice for sale. They will tell you that you must have "management commitment", that you need to "empower" your staff, that you need to know your business's "critical success factors", that you need facilitators, that your job is to provide leadership. They will also (unless you are very lucky) demonstrate startling ignorance of your business culture, the products and services you provide, your design process and your production process. Worst of all, practically none of the consultants are practising TQM in their own organisations and they cannot know, therefore, from first hand experience what it is like to operate TQM.

So, if you are not convinced by the consultants, the gurus cannot agree and there are just too many tools, what are you to do?

In the remainder of this paper I describe how Praxis developed a sustainable programme of TQM. We did not find our TQM Eldorado (it doesn't exist), but we did discover four basic principles on which to build a solid law for continually improving our business; that is we discovered the laws of TQM.

THE FIRST LAW — DELIVER QUALITY

The first law of TQM is that: *lasting success for a business is achieved by delivering products and services that are recognised for their quality*. It is important to remember when applying this principle that it is the clients (customers) of products and services who are the judges of what is (or is not) quality.

Everything that is done in a business should be considered against the first principle. Each action proposed by the business should be examined to establish if it is going to increase a client's perception of the quality of the business's products and services.

It is not really possible to apply this 'quality examination' unless there is a clear understanding of what quality is. This means that we must be able to measure quality.

In Praxis we measure quality by characterising our products and services in terms of the *measurable quality attributes* required of them. In this way we avoid quality's becoming equated with luxury (unless the quality

88 Software Quality Management

attributes define a luxurious product), and we are forced to specify quality in terms of things that we can test.

Clearly the quality of a product has very many attributes and many are interdependent. It therefore may be possible to trade off one attribute for another, for example, price for functionality. It is also possible to overlook critical attributes of quality, for example the manner and politeness of the team of people installing a product, or how the project manager discusses proposed changes in a specification.

It is also possible to forget that different functions in a customer's organisation can have different views as to the importance of different quality attributes. For example, in Praxis' world where the product is a bespoke software system, a contracts or purchasing manager is likely to believe that the price is more important than functionality, whereas an end user of the system will rate functionality as most important.

Therefore, we define quality as *meeting specified requirements* and we reach agreement with our clients how we are going to measure these requirements and how we will manage the inevitable changes in them that will arise from changes in the environment and changes in the clients' circumstances.

THE SECOND LAW — QUALITY MUST BE BUILT IN

The second law of TQM is that; *quality can be achieved only by building it in*. Quality cannot be inspected in; quality cannot be achieved by legislation or regulation or dictate.

Quality is built in by using the right tools and methods, the right materials and by following the right process. As we are discussing *total quality*, that means using the right tools and the right materials and the right process for everything that we do.

In Praxis as in many (possibly all) organisations, the deliverables we make to our clients are made up from the contributions of many people: salespeople, programmers, project managers, systems designers, etc.

It is therefore essential that each contribution has quality built into it. We need to optimise our sales process, our programming process and so on, so that each of these contributions co-operate to produce an end product of the quality specified.

We recognise that in order to satisfy our clients, our products must consistently meet their quality attributes. At the same time we recognise that our business uses many processes that are highly variable (unlike the world of manufacturing where processes can be more easily controlled). In the Praxis world our products are always different (no bespoke system, no consultancy assignment is exactly like any other). We therefore use the principle of *quality control* to assure ourselves that each contribution to our client deliverable has the quality attributes specified for it. We do not let contributions pass from person to person (from one contributing process to the next) without applying a quality control to assure ourselves that the contribution meets specified criteria.

In order that we can consistently re-use the best "building quality in" practices that we have established, we define them (in the form of a process standard) and deposit them in our Quality Management System (QMS). We also record any re-usable quality control criteria in the QMS. Quality controls (or product standards) take the form of guidance, templates, forms and check-lists designed to help people not to make the same mistakes that others have made and to pass on to their colleagues a deliverable of specified quality.

By using a quality management system we can retain and re-use the wisdom and practice that has proved successful in the past and hence consistently build in quality.

THE THIRD LAW — YOUR PEOPLE DELIVER THE QUALITY

The third law of TQM is that: *quality is built in by people*. No amount of systemisation, no amount of guidance or quality control can replace the ingenuity and creativity of people.

Any system is only as good as the people who operate it. If a system is too constraining it will prevent rather than encourage built-in quality.

It is necessary for any management system supporting software development (and probably anything else) to be applied in a manner that takes into account a particular client, a particular piece of code, a particular purchase, a particular design. The people who operate the system must be empowered to take the decisions that are necessary to instantiate process and product standards to suit the circumstances in which they are operating.

A quality system will be an effective means of consistently building in quality if its users are trained and empowered to use it as an aid to creativity. A quality system must not be used as a support to be followed blindly and then blamed for its inadequacy.

A useful mechanism for establishing the scope of empowerment is "process ownership". A process owner has the authority and resource to define a process and to change it. The empowerment assigned to any individual can be assessed by the number of processes of which they are owner.

THE FOURTH LAW — IMPROVEMENT, THEN MORE IMPROVEMENT

The fourth law is that: *quality improvement must be continuous*. In order to stay in operation, any organisation and any business must continually improve. If an organisation does not continue to deliver improvements in quality it will wither, either because competing organisations will take its business or because its customers will find an alternative way to achieve their requirements.

It is law 4, the improvement aspect of TQM, that usually takes the limelight. Indeed many people claim that TQM is only the mechanism of improvement coupled with empowerment of people to make the improvements. This is a mistaken view, as without the basis of a quality

90 Software Quality Management

system and a mechanism to measure quality, there is no definition of what should be improved or how improvement should be measured. Hence, before improvement can be attempted, the law of "measurable quality", a defined means of "building quality in", as well as "people empowerment", must be in place.

If TQM is introduced only on the basis of enabling improvement there will be no coherence to the improvement activity. Local improvements will probably have no place in business strategies and will therefore be ignored. Once people see their improvements ignored it becomes more difficult to motivate them, and their work becomes less effective than it was before TQM was attempted.

The improvement process used by Praxis is in five parts:

1. establishing measurable and quality-directed objectives for improvement;
2. establishing which process(es) should be improved in order to meet this objective;
3. empowering process owner(s) to investigate and to act;
4. designing and implementing the improvement;
5. updating the process description so that the improvement is available for all its users.

Establishing Measurable Quality Objectives Quality objectives are derived from two basic sources: they are derived in order to improve the performance of the organisation or they are derived to improve the job satisfaction of a member of staff of the organisation. In other words, they are concerned with improving the quality the organisation delivers to a client or they are concerned with improving the empowerment delivered to a member of the organisation.

Organisational Quality Objectives objectives are those that define the measurable quality attributes that the organisation plans to deliver to its clients. (This includes staff and shareholders as well as fee paying clients).

Objectives should be set by a top down process that starts by defining the top level quality objectives for an organisation, and then proceeds to derive objectives for everyone in the organisation so that each individual's objectives are directly aligned to the objective of the business. (The technique is similar to what in TQM jargon is known as, Process Quality Management (PQM) or, a very similar technique, Quality Policy Deployment (QPD).)

The technique is initiated with a meeting of the organisation's management team (in Praxis this is the company's annual strategy meeting). They work together in a brainstorming mode and establish and agree the business's current Critical Success Factors (CSFs). A CSF is a quality attribute for the business; it defines one of the attributes which the organisation will measure to establish whether it is delivering quality to its clients.

New CSFs can arise for several reasons, for example:

1. an internally generated need to implement a new policy (for example, in reaction to a policy to grow the business or a policy to develop a new product stream);
2. a change to the operating environment of the organisation (for example, a need to react to new legislation);
3. a failure to deliver a specified quality attribute to a client.

Some CSFs can be derived by management's doing its 'normal' job of managing the business, measuring normal business indicators, sales order backlog, revenue and so on. Other CSFs will be identified by carrying out client and staff satisfaction surveys to establish (according to law 1) the clients' perception of where improvements should be made in quality that is being delivered. Quality delivery failures can also be identified by quality assurance auditing activity.

Having decided upon the CSFs, the next step should be to establish which of the organisation's processes make the key contributions to meeting each CSF. For instance, if a CSF is "to increase Praxis' penetration of the safety critical systems market", we could identify that the key business processes contributing to this are, amongst others, a software engineering process including world class skills in the application of formal methods, and a marketing process which demonstrates these skills at relevant conferences and seminars.

Having decided upon the CSF and the contributing key processes, the management team then agree who owns these processes. In the above example they decide upon the owner of the marketing process and the owner of the safety critical software engineering process. Usually the process owner is obvious; but it is not unusual to find unowned processes that are nevertheless important to meeting CSFs.

At this stage the objectives setting process is taken over by the chief executive of the organisation. He works on a one to one basis with each member of the management team to agree on a measurable level of performance for each key process that the management team member owns.

Once the management team's objectives are agreed, each member of the management team can set objectives for their subordinates. They do this by agreeing the contribution each subordinate should make to meeting their manager's CSFs. Each subordinate's objectives are expressed in terms of a measurable quality attribute, the processes that will contribute to meeting it, and any resources or empowerment needed to improve the process.

The objectives-setting process continues to cascade until everyone in the organisation has objectives derived as above.

Personal Quality Objectives "people objectives" are considered to be equally as important as those of the organisation. Personal objectives will arise out of a need to advance an individual's career through improving skills, by satisfying personal ambitions and by defining the indi-

92 Software Quality Management

vidual's personal contribution to the organisation's objectives through the mechanism described above.

In Praxis we couple the company-directed objectives for meeting CSFs with the personal career development objectives. Like the CSF objectives, personal objectives must be measurable and associated with the empowerment necessary to implement them.

Reviewing Objectives objectives; they must be reviewed and modified as experience of working to meet them is gained.

At Praxis, objectives are reviewed and adjusted during the operation of two types of process:

1. as part of the continuing work of the company and the normal management of the business;
2. as part of the staff development process (discussing the progress of personal career ambitions).

Process Improvement

By measuring our performance against quality attributes we can discover whether our processes are delivering the quality we have specified, to our clients.

If we discover that there is a shortfall against the quality we have specified we need to identify a process improvement or we need to agree with our clients that the specification of quality should change.

Shortfalls in quality can arise because a process has been operated incorrectly or because the process itself is inherently inadequate.

If the process is failing because it has been operated inadequately it becomes the process operators' job to correct their application of the process. For instance, such a situation could arise within the context of a Praxis development project's C coding activities. Perhaps the team are making a lot of errors with pointer manipulation. In this case it will be the C coding team's job to set up an action to improve their performance in this area, perhaps by developing some standard pointer manipulation routines or by training to enhance team skills.

If there are failures in the same process throughout an organisation (for example, if quality assurance activity finds that many projects fail to meet the quality attributes set for C code), it becomes the responsibility of the management team member owning the company-wide process, who is tasked with improving the company's process. In this event the process owner establishes a Quality Improvement Team (QIT) drawn from all of the company's practitioners skilled in the use of the failing process. This team then works (using the TQM process improvement tools) to improve the process so that the quality attributes required of it can be achieved.

CONCLUSION

I have described (in brief outline) the four laws of TQM and how they can work to improve the quality that an organisation delivers to its clients. The laws are:

1. Law 1
Lasting success for a business is achieved by delivering products and services that are recognised for their quality.
2. Law 2
Quality can be achieved only by building it in, using the right tools and the right process.
3. Law 3
Quality can only be built in by people who are provided with the means and environment to channel their creativity to building in quality.
4. Law 4
Improvement must be continuous.

If an organisation follows these laws it will be able to set out on its TQM journey.

BUT, these laws are not sufficient on their own, they must be coupled with dogged persistence or, as Dr Deming puts it, with "constancy of purpose" to improve quality as it is perceived by clients.

REFERENCES

- [1] The British Deming Association. Deming's 14 Points For Management. Laverham Press, Salisbury, 1989.
- [2] Crosby, P. Quality Is Free. McGraw-Hill, 1979.