Document Quality – Inspection[1]

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Even within the current drive for quality, documentation quality is often ignored or forgotten. This article cites a number of ways of improving the quality of documentation and, in particular, describes and discusses the inspection method.

INTRODUCTION

Despite many imperative statements, BT's current drive for 'quality' is often seen to be on rather general lines. In many parts of the business, documentation quality is ignored or considered incidentally. Many, if not most, managers 'don't have time' even to check documents for which they are responsible. Yet the company relies on documents for every aspect of its business, both internal and external, and early correction of errors at source is always cheaper than dealing with the results of incorrect documents. How much cheaper is it to check and correct a contract than to renegotiate it after it has been placed with an important clause missing? How much is saved by correcting a specification rather than redesigning a useless product? How much time, frustration and money are saved by getting an internal telephone directory right first time?

The authors wish to exhort the reader to address the issue of documentation quality specifically and earnestly. In the next section, reference is made to four ways in which this can be aided. One of these is 'inspection' and the remainder of the article describes and discusses this and makes recommendations for its use.

IMPROVING DOCUMENTATION

Four methods of improving documentation are briefly proposed. The first three were discussed, to some extent, in the context of specification documents, in reference 1. The fourth is the main topic of this article.

(*a*) Much can be gained from the choice of an author with appropriate writing ability and a suitable background in the subject. The development of authors needs encouragement, insistence on high standards, guidance and, perhaps, training; and all of these require management participation.

(*b*) Managers need to accept responsibility for documents written by their staff. After all, the responsibility is theirs anyway, since the document emanates from their groups, sections, etc.

(*c*) Standards and guidelines for the form and content of documents should be used. (An example of a guideline used in development projects is given in reference 2, which is published in the *Supplement* to the current issue of this *Journal*). Standards and guidelines are applicable to most types of document and should be acquired or developed locally, though it would be preferable to have company-wide standards.

(*d*) All documents should be subjected to inspection.

THE INSPECTON PROCESS

Background

Document inspection entered history as inspection of computer software. In the early 1970s, at IBM, Michael Fagan insisted that there had to be a way of improving the quality of software by using techniques which were well-proven in other fields (see also reference 3). Despite the discouragement of his peers, he persisted in making trials, and his 1976 paper [4], now a classic, not only showed the way, but also announced startlingly good results. Fagan showed that the inspection process revealed 80% of all errors found in the software. This improved the quality of the software, increased reliability, and reduced maintenance costs. These factors were so marked in Fagan's projects that he received an award of $50,000 from his company. Later, Runge [5] reported on the application of inspection in small projects with the involvement of fewer than four people.

Experience also showed that many of the errors which later revealed themselves in the code were due to defects in earlier documents, such as the design or specification documentation. Application of inspection to these documents and, indeed, to all documentation throughout the development life cycle of a project substantially improved the quality of the final product. Further, since it found most errors where they occurred, rather than after they had had an effect on later stages, it reduced development time and cost as well as maintenance costs. The cost of correcting an error early may be 100 times less than correcting it when the system is operational [1 and 3].

The value of inspection can thus be demonstrated dramatically in a development project. However, the process is effective when applied to any documents; for example, objectives, plans, contracts, articles and papers, standards, guidelines, user documentation, maintenance documentation, pseudo-code, program code, and, very importantly, test cases. Indeed, 'it appears that virtually anything that is created by a development process and that can be made visible and readable can be inspected' [6].

To obtain maximum benefit from inspection, the rules of the method must be strictly adhered to. Some companies modify inspection and ignore some of its principles, but statistics show that this decreases effectiveness. Management needs to create and maintain the attitude and environment necessary for inspection in its most effective form.

Also, several proprietary inspection packages are available, usually marketed as a course and a manual. One of these is QSTAR [7], with which some readers will be familiar, but which does not meet the full specification for inspection as described in this article.

Some Benefits of Inspection

Whereas inspection may be the first step towards a total quality management system, and thus have far-reaching benefits in such areas as quality, cost-effectiveness, customer satisfaction and job satisfaction, some of the identifiable benefits are listed below:
• Quality documents are achieved.
• There is an increase in the number of projects completed on time.
• Project end-products are of better quality.
• A quality 'culture' is developed.
• Resources are saved because errors are found and corrected at a time when correction is cheap. On average, inspection adds about 15% to the resource requirement in the preparation

of a document (and this should be planned for), but the total development time of a project can be reduced by 20% to 50%.

• Inspection is an excellent tool for observing deviations from standards. The observations may be used to decide whether the standard or the deviation is 'right'.

• If an organisation has no documented standards, inspections will highlight that some ways of doing things are better than others. A *de facto* standardisation process will be initiated in which the more efficient methods triumph over the less efficient.

• There will be a general proliferation of knowledge about the different products and development activities in the organisation. Studying documents carefully is a much more efficient method of learning than attending seminars or lectures.

• The participants in inspections learn about the strengths and weaknesses of each other. This helps to overcome prejudices and dogmas.

• The frequent, short, formalised meetings teach the participants the differences between disciplined and undisciplined meetings.

Overview of the Process

Inspection is a formal, efficient and economical method of finding defects in documentation. It is performed in predefined steps (see Table 1) and controlled, according to well-defined rules, by a trained 'moderator'. Whereas inspection is a practical technique and needs to be experienced, the following brief overview considers the steps in sequence. Any difficulties in understanding on the first reading may be clarified by reference to the next section, which lists the functions of the participants in the process.

When the document has been completed, the author, who must first be completely satisfied, seeks a moderator to preside over the inspection process. Fagan [6] recommends objectivity (yet familiarity) by choosing a moderator from a different but similar project. In some companies, a list of trained moderators is held in the quality department, with provision being arranged by the quality manager.

The moderator and author select the inspectors and provide them with a copy of the appropriate documentation; that is, the document to be inspected and any relevant background material (standards, higher-level documents and checklists). One inspector will be designated as reader (see below).

At the start of a project or when the inspectors are unfamiliar with the background of the document to be inspected, an overview meeting is held. Here the author (or group of authors) gives an overview of the project, so the inspectors will be able to relate the details or individual documents to the whole. For a single document, the author explains its background and purpose.

A date for the inspection meeting is agreed between the participants, and the moderator arranges a meeting room (preferably without a telephone) and suitable refreshments for the break. Prior to the inspection meeting, the inspectors and the moderator study the document, noting it defects in the margins. Notes should never be on separate sheets, since this diminishes concentration during the inspection meeting. Checklists aid the defect finding by presenting, in the form of questions, typical defects for the current type of document. The reader must additional prepare for interpretation of the text.

Table 1
Participants in the Stages of Inspection

WHAT	WHO				
	Moderator	Author	Inspector(s)	Reader	Secretary
Document is written		R			
Is document ready for inspection?	R				
Planning the inspection	R	P			
Overview meeting	R	P	P	V	P
Inspection of the documentation	R		R	R	V
Inspection meeting	R	P	P	P	P
Collection of statistics	R				
Third hour (not mandatory or official)	V	R	V	V	
Rework (corrective action)		R			
Follow-up (inspection of corrections	R	R			
Signing off document	R				

KEY: R = Responsible   P = Present   V = Voluntary presence

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At the meeting, the moderator starts by welcoming the participants and recording their preparation times. Each section is then read by the reader. Reading the document aloud has been shown to be the optimal speed for inspection. The author or moderator may ask the reader (or the reader may decide) to paraphrase a section, whose interpretation is thus revealed, and misinterpretation is recorded as a defect. At the end of each section, the moderator asks the inspectors, one by one, if they have discovered any defects, and the secretary (usually the author) records the classification and details of all defects. The order of questioning is rotated so that no inspector is consistently first to be asked.

A discussion on possible solutions to a defect may start at any time and, since the only purpose of the inspection meeting is to reveal defects, the moderator, kindly but firmly, should stop this discussion. In order to avoid frustrations, the moderator may decide to add the initials of the inspector to the defect record for reference or defer the discussion until after the inspection meeting, when the author may convene a 'third hour' meeting for the purpose.

When a page is inspected, the moderator asks the secretary to read the recorded defects, so that they may be greed on. After one hour, the moderator may call for a 5-10 minutes break; and the inspection meeting is limited to a maximum of 2 hours.

During the inspection meeting, the moderator collects statistics on the process (such as how long it took each inspector to study the document), and on the defects. On the basis of the latter, the moderator decides if a further meeting is necessary. The author, who is responsible for correcting the document, gives an estimate of when the next draft will be ready.

The author may derive further help from the inspectors, in the form of explanation or proposals for solutions. A discussion, immediately following the inspection meeting, but not a formal part of the process, may therefore be convened by the author. This is referred to as the *third hour*.

When all corrections have been effected, they are reviewed by the moderator and author, although, in some cases, perhaps for technical reasons, a particular inspector may be required to validate certain corrections. Responsibility for signing off the document then rests with the moderator.

The use of statistics, for the benefit both of the particular inspection and the inspection process within the company, is an integral and important part of the process. It will be dealt with in more detail below.

The Participants

Role playing is used to enhance the effectiveness of inspection. The main titles given below comprise one comprehensive means of defining the roles, while other equivalent titles are shown in brackets. It should also be noted that some of the participants' functions differ from company to company.

Author
The functions of the author are
• to write the document;
• to decide, with the co-operation of peers and in-line management, that the document is ready to be submitted for inspection;
• to request inspection;
• to present the document at the overview meeting;
• to participate in the inspection meeting, preferably as secretary;
• to correct the document as a result of the inspection; and
• to present the corrected document to the moderator for signing off.

Moderator
The functions of the moderator (chairman) are
• to decide if the document is ready for inspection;
• to choose the inspectors, in co-operation with the author;
• to arrange and chair the overview meeting;
• to give guidance to the inspectors as to what is expected of them;
• to issue forms to the inspectors for the recording of statistics;
• to choose and instruct the reader;
• to ensure that all participants prepare for the inspection;
• to arrange the inspection meeting;
• to moderate (chair) the inspection meeting according to strict rules;
• to ensure that all defects (errors) are recorded and classified;
• to collect inspection statistics;
• to decide if a further inspection is required;
• to ensure that corrections are carried out by the author; and
• to sign off the document.

Reader
The functions of the reader are
• to read the document aloud at the inspection meeting and interpret its meaning; and

- to be an inspector.

Inspectors

The functions of the inspectors (reviewers) are
- to understand the author's presentation at the overview meeting;
- to prepare for the inspection meeting by studying the document and recording the defects discovered in the margins;
- to report on the defects at the inspection meeting;
- to assist the author, if required, during the third hour or later, to find solutions; and
- to sign off individual corrections, if this is requested by the moderator.

Secretary

The function of the secretary is to record the defects and their locations in the document.

Principles of Inspection

If used well, the inspection process is cost-effective in improving documentation quality. The moderator, who controls the process, must therefore be fully trained.

No document should be inspected until it is as good as the author can make it. The author's management should assist in this and it is the moderator's task to check the document before arranging an inspection. If the defect rate later turns out to be too high, the moderator should postpone the inspection until the author re-submits an improved document.

An aid to the author is a guideline or standard for the document being produced. Either of these would contain a table of contents or checklist of what the document should contain and, preferably, how it should be structured. In most cases, there should also be a 'higher-level' document available. For example, a design is a translation of a specification which, therefore, is the higher-level document at the inspection of a design document. They should be supplemented with a checklist of defects repeatedly found in this type of document. The guideline or standard, higher-level documents and checklist should be used as tools by the inspectors during preparation.

Preparation is important, and unprepared inspectors find only trivial defects. If the moderator encounters an unprepared inspector at an inspection meeting, it is often best to postpone the meeting, though it may be polite to allow peer pressure to act on the inspector.

Inspection meetings are limited to a maximum of 2 hours. It is found that the defect-detection rate diminishes if this time is exceeded, because the participants get exhausted and lose concentration. This time constraint also limits the number of pages that can be inspected, and experience has shown this limit to be 20 pages. These limits are frequently opposed by newcomers to inspection, but they should never be exceeded, except, perhaps, under extreme political pressure – and then only after formal protest. The cost of correction at a later stage, when the document has been used (for example, when a defective contract has been placed, or when a defective specification has been translated into a product which is not fit for its purpose) is far higher than that of having several inspections of a large document. It is the moderator's task to choose the most appropriate method, in any given situation, of co-ordinating the inspection meetings for the same document, and this should be discussed and agreed at the overview meeting. For example, at each inspection meeting there may be a review of what has taken place to date.

The optimal speed of inspection is reading the text aloud. Another reason for reading is that the attention of all participants is concentrated on the same piece of text.

The atmosphere must be harmonious, or too much energy is spent on conflicts rather than on finding defects. It is the document and not the author that is inspected. Conflict solving is

an important part of moderator training. If conflicts persist, the moderator may decide to stop the inspection.

Another key to effectiveness is the fact that inspection is intended to identify defects and not solutions. It is the author's task to find ways of correcting the defects and to discuss these with individual inspectors, if necessary. To facilitate this, many companies allow an unofficial third hour immediately after the inspection meeting. The third hour also benefits the moderator, whose duty it is to eliminate superfluous discussion at the meeting. It is easier, and less likely to provoke antagonism, for a moderator to refer a defensive author to third hour than simply to curtail discussion.

Inspections do not end with the inspection meeting. Two important things remain to be attended to by the moderator: inspection statistics (see below) and 'follow-up' on corrections. It is important that the author corrects the inspected document within the estimated time. The moderator must follow-up on this, and check that all recorded defects have been considered. The appearance of a revised draft at the scheduled time makes the inspection effort visible within the organisation.

Categorisation Of Defects

The categorisation of defects not only is an asset to quality control, but also helps the inspectors to find defects. A checklist of defect types should therefore be given to inspectors by the moderator.

A classification may be contrived to suit a particular inspection, but the following example is both comprehensive and general. The Software Quality Assurance Department of Christian Rovsing in Denmark divides defects into six types:
Missing Something which should be in the document is not there.
Wrong Something which is there is wrong.
Extra Redundancy or superfluity.
Ambiguous Something that can be misinterpreted.
Standard Non-conformity of the document with a standard or guideline.
High Level Inspection shows an error in the higher-level document of which the inspected document is a translation.

It also categorises defects into two classes of severity, minor and major, with the following definitions:
Minor The defect makes the document difficult to read locally. There is a small possibility of wrong interpretation, and the defect could produce further defects in dependent documents or products.
Major The defect causes the possibility of misinterpretation in a larger part of the document (typically 2-3 pages). The defect will probably cause further defects in dependent documents or products.

Such definitions are, to some extent, subjective, but it is the moderator's role to be clear on such matters. It is also to a company's advantage to have inspection guidelines which ensure consistency of interpretation and compatibility of statistics.

In addition, typographical errors are regarded as trivial and, though recorded and corrected, are not included in the above categorisations.

Statistics

Quality implies improvement. Evidence of improvement is found by measurement and

improvement itself is achieved by the feedback of results into the process. The collection of statistics during inspection is therefore an integral and important aspect of the inspection process.

With regard to defects, the moderator should record the numbers of major and minor defects of each type found by each inspector. Although this data is not for public view, it provides peer pressure which encourages inspectors to do a good job. Sometimes employees fear that statistics will be used for job evaluation. A manager unwise enough to use them for this kills inspection. At Christian Rovsing, only inspection-specific statistics are made generally available. A separate database, accessible only to the quality department, stores participant-specific information, in order to assist authors in finding moderators and inspectors.

Because new errors come to light during the inspection meeting and some defects are found by more than one inspector, the total number of actual defects of each type and severity in the document should also be recorded.

With regard to the process, the moderator should find out, from each inspector, the time taken to inspect the document. The duration of the meetings and the number of pages in the document are also relevant.

From these data, useful statistics, such as the following, can be deduced:
(a) numbers of major and minor defects in the document,
(b) numbers of major and minor defects per page,
(c) total inspection time (sum of each participant's time during both study and meetings),
(d) preparation time per page,
(e) preparation time per page per inspector,
(f) preparation time per defect,
(g) inspection meeting time per defect,
(h) inspection meeting time per page,
(i) numbers of major and minor defects per inspector per hour,
(j) numbers of major and minor defects per inspector, and
(k) numbers of major and minor defects per page per inspector.

The raw data and these statistics (and any others of interest) should be stored in databases. Preferably, these should be held by a central quality department or team, so that the data from all inspections are brought together. Then, averages over a period of time can be derived to give moderators, inspectors and authors an idea of quality norms. Further, a comparison of inspections over time may be made. Improvements may be observed in the quality of documents or the quality of the process itself. The cost-effectiveness of inspection can also be observed. Curves may be plotted to show, for example, the optimum number of inspectors.

EFFECTIVE USE OF INSPECTION

For maximum effectiveness, an inspection must be conducted strictly within the rules and according to the principles stated above. In particular, no more than 20 pages should be inspected at a time and the inspection meeting should not exceed 2 hours. Fagan [6] finds that defect-detection ability is restored after a 2-hour break, but that no one should participate in more than two 2-hour inspections in a day.

The choice of inspectors also has a significant influence on the quality of an inspection. If all inspectors view the document from the same perspective, some defects are almost certainly missed. It is therefore judicious for the moderator to select a team which embodies as wide a

range of expertise, and even bias, as appropriate to the document. And it is helpful if the reader is the person who will have to interpret it. For example, the reader of a requirements specification should, if possible, be the designer.

A moderator also needs to have a feel for norm values, within the company, of inspection statistics, and is then in a position to evaluate the relative quality of the document and the inspection. Figures from 57 inspections at Christian Rovsing show the following:

(a) The optimum number of inspectors (including the moderator) is four, though five can sometimes be useful. Additional inspectors do not seem to increase the number of defects found, and therefore introduce inefficiency.

(b) Administration time per inspection (mostly by the moderator in setting up the inspection) is 30 minutes.

(c) Preparation time per inspector per inspection is about 1.5 hours (for 20 pages); that is, about 4.5 minutes per page.

(d) An average of one major defect is found per 3.3 pages.

(e) An average of one minor defect is found per 0.7 pages.

It is now Christian Rovsing's practice to use the results of *(d)* and *(e)*, above, as guides, with significant deviation from them being investigated. (Better figures suggest either an above-average author or a poor inspection. The latter can be due to lack of preparation, or to a poor choice of inspectors.)

Such results as those above may change as a company gains experience, proficiency and confidence in inspections, and it is recommended that a quality department should publish results frequently and review trends. Moderators will then be able to judge inspections against the latest company averages.

THE INTRODUCTION OF INSPECTION

The successful introduction of inspection into an organisation depends largely on the management. The first step is the honest admission that documentation quality can and should be improved. The next and most important step is the active participation of managers in ensuring the quality of documents. This would normally include the introduction of standards (one being the inspection method), the insistence that no document leaves the organisation (group, section, etc.) unless it has been inspected and correctly signed off, and continued involvement to ensure that the standards are adhered to invariably.

The nominal introduction of inspection is simple: staff are sent on the course and told to use the method. However, although staff are usually keen to achieve quality, their incentive is limited unless management is seen to insist on high quality, to check documents for which they are responsible, and to reject those which are not up to standard.

The successful introduction of inspection implies a change of culture and this is evolutionary, though it may be rapid. At first, staff with a deadline to meet are likely to say, 'The document is already late, so we won't be able to inspect it before it is issued.' Unless management insists on inspection and allows time for it, improved planning is improbable. Later, when inspection is accepted, the statement is likely to be, 'The document will be a bit late because, although it has been written, we have yet to inspect it.' As inspection becomes a planned stage in the production of a document, the statement becomes, 'The document will be ready on time.' Here, 'ready' means written, inspected, corrected and signed off.

The existence of a quality department or centre can aid inspection by providing trained moderators, either from the centre itself or from a list, by providing supervision and advice, and by keeping statistics and insisting that all moderators provide defined data from their

inspections. If there is no quality centre within the organisation, management should ensure that all moderators are trained and that statistics are collected, processed and published centrally within the organisation.

CONCLUSIONS

In this article, it was suggested that attention could usefully be paid to document quality. Four complementary ways of achieving this were proposed in brief. One of these, the inspection method, was then described and discussed at length. It was noted that the role of the moderator was crucial and that all moderators should undergo appropriate training.

Inherent in the method are ways of measuring its effectiveness in the current situation and its cost-effectiveness to the business. Recommendations on its effective use were made, including which data should be collected, which statistics derived and how they may be interpreted. Advice was also offered on introducing inspection into an organisation.

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