

SOFTWARE QUALITY ASSURANCE

CHECK LIST

FOR

POTENTIAL AND EXISTING SUPPLIER ASSESSMENT

© D L Bird 2024

Contents

HINTS AND TIPS	4
TIPS AND TECHNIQUES - 1	4
TIPS AND TECHNIQUES - 2	4
TIPS AND TECHNIQUES - 3	4
TIPS AND TECHNIQUES - 4	4
TIPS AND TECHNIQUES - 5	4
TIPS AND TECHNIQUES - 6	5
TIPS AND TECHNIQUES - 7	5
TIPS AND TECHNIQUES - 8	5
TIPS AND TECHNIQUES - 9	5
TIPS AND TECHNIQUES - 10	5
TIPS AND TECHNIQUES - 11	6
TIPS AND TECHNIQUES - 12	6
TIPS AND TECHNIQUES - 13	6
TIPS AND TECHNIQUES - 14	6
MANAGEMENT RESPONSIBILITY	7
PROBLEMS	7
CHECKS	8
QUALITY SYSTEM	9
PROBLEMS	9
CHECKS	9
CONTRACT REVIEW	11
PROBLEMS	11
CHECKS	11
DESIGN CONTROL	12
PROBLEMS	12
CHECKS	12
DOCUMENTATION CONTROL	14
PROBLEMS	14
CHECKS	14
PURCHASING	15
PROBLEMS	15
CHECKS	15
PURCHASER SUPPLIED PRODUCTS	17
PROBLEMS	17
CHECKS	17
PRODUCT IDENTIFICATION AND TRACEABILITY	18
PROBLEMS	18
CHECKS	18
PROCESS CONTROL	19
PROBLEMS	19
CHECKS	19
INSPECTION AND TEST	20
PROBLEMS	20
CHECKS	20
INSPECTION, MEASURING AND TEST EQUIPMENT	22
PROBLEMS	22
CHECKS	22

PROBLEMS	23
CHECKS	23
CONTROL OF NONCONFORMING PRODUCT	24
PROBLEMS	24
CHECKS	24
CORRECTIVE ACTION	25
PROBLEMS	25
CHECKS	25
HANDLING, STORAGE, PACKAGING AND DELIVERY	26
PROBLEMS	26
CHECKS	26
QUALITY RECORDS	27
PROBLEMS	27
CHECKS	27
INTERNAL QUALITY RECORDS	28
PROBLEMS	28
CHECKS	28
TRAINING	29
PROBLEMS	29
CHECKS	29
SERVICING	30
PROBLEMS	30
CHECKS	30
STATISTICAL TECHNIQUES	31
PROBLEMS	31
CHECKS	31
SOFTWARE METRICS	31

Hints and Tips

Tips and Techniques - 1

A huge incentive for managers to adhere to a quality system, and not just concentrate on target delivery dates and costs, is to shut down a projects budget account only after a year after of two maintenance has taken place. For bespoke systems there will normally be a team fielding errors from the purchaser. Any resource consumed in rectifying errors, up to a certain point in time, should be subtracted from the original project budget. In manager appraisal, this is the figure that should be used to judge performance. If the budget has been exceed, then two things might have occurred, first; the project manager may have badly estimated the project; or second, the quality system was not used properly.

Tips and Techniques - 2

One effective way on ensuring independence in programming is to involve two members of staff. The first programs the module; the second then has to listen while the first programmer explains the logic of the module. Even if the second programmer says nothing, the very act of describing a module to another programmer always seems to result in the first programmer discovering errors. When all the errors are rectified, the second programmer then has to go away and test the module. This ensures that he or she actually listens to the narrative produced by the programmer. When the tests have finally been successful, the second programmer signs-off the module as being correct. A crafty project manager will often assign the first programmer to another programmer who he or she respects, is in awe of, or fears. In this way the first programmer almost always delivers correct program code first time.

Tips and Techniques - 3

Do not be afraid of telling your staff about war stories. Companies should not feel bad about talking about past disasters. Staffs get to know about them anyway. Use stories about past project disasters to motivate staff about the quality system. It is a good test to see whether your staff are reviewing and updating a quality system based on past experiences by asking hard questions about past project failures and whether the quality manual can now prevent them. By addressing past project disasters to get over to staff that a quality system is only a repository of best practice, rather than something there to stifle creativity.

Tips and Techniques - 4

One of the main things to look for in a quality management system is trace-ability. This is the ability to move 'effortlessly' from a document or program code to other related documents and program codes. It is also important aspect of planning, as the quality plan will detail the quality tasks that are part of the project.

Tips and Techniques - 5

When improving a quality system pay particular attention to what the staff involved in maintenance say. This staffs see the worst part of the quality system manifested in poor specifications, incomplete designs and poorly structured program code.

Tips and Techniques - 6

One technique that has been used to test out effectiveness of particular parts of the quality system is known as 'rebugging'. It is applied to technical reviews using program code. The quality assurance department intercepts any program code that is to be reviewed, and inserts a number of artificial errors into the code. They then examine the documentation of the completed code review and discover how many of the artificial errors have been discovered. The percentage of those errors discovered can be regarded as a measure of either the effectiveness of those parts of the quality system orientated to code reviews or the efficiency of the staff involved.

Tips and Techniques - 7

It is a good idea to have a company disaster list. This list would contain all the bad events that have happened to software projects over the and years, including events which can be laid at a purchaser's door and for events which were out of the control of the supplier. This list can be initially created by asking project managers to remember the bad things about their past projects. It can be updated by asking staff in project debriefings if any problems occurred during the project. This list of bad events can be read by a project manager in order to jog his or her mind the about some of the risks that could happen in a project and has the effect of concentrating the mind during the process of risk analysis.

Tips and Techniques - 8

Always express your documentation in a hierarchic way. This is most important when developing the requirements specification. For the functional part of this specification, partition the functional description into functions, sub-functions, sub-sub-functions and so on. If you do this, then staff-both from the purchaser and the supplier-are able to concentrate on one section of the functional specification at a time without getting other parts of the functional specification intruding. For example, a purchasing manager who is liasing with the supplier's staff and checking out the part of the requirements specification concerned with his or her function does not want details intruding from other functions such as accounting and delivery.

Tips and Techniques - 9

Always give reasons for directives in the quality manual. For example, in describing why an audit trail of requirement changes should be kept, mention the fact that the company almost went to costly litigation over some changes, which a customer insisted on, which were never documented and which, the customer denied all knowledge of. Computer staffs are usually happy to follow standards and procedures provided they are told the reason why.

Tips and Techniques - 10

One of the most useful methods for documenting trace ability is the *verification matrix*. This consists of a table whose columns represent the modules in a system and whose rows represent functions, which are detailed in the requirements specification. Each row documents the fact that a particular set of modules will be executed when a particular function is exercised. The design team develops the matrix after the system design has been completed. It serves two purposes: it is a quality record, which provides assurance that the functional properties of the system are implemented by the system design and it also provides trace ability documentation

Tips and Techniques - 11

A quick way to evaluate a subcontractor is to ask for the agendas of board meetings held over the last two or three years together with the minutes of any discussions on software quality. If there are no quality discussions, then that is a poor sign. If there are some discussions, but they are scheduled near to the end of the meeting, that is a slightly better sign, but not ideal. If the discussions about software quality occur at the beginning of a board meeting, and are primarily about prevention and improvement, then that is an excellent sign.

Tips and Techniques - 12

It is useful practice to include in the project plan a set of assumptions that the supplier is making about the behaviour of the purchaser together with a statement that if these assumptions are invalidated, then the supplier cannot guarantee the specified delivery date. Some examples are: that any purchaser-supplied product is correct; and that the purchaser will return documents which have been sent for approval within a certain time and will not cancel meetings.

Tips and Techniques - 13

If you were really confident that some purchaser-supplied product is of a very high quality, then some form of quick testing would be in order. One form of testing which does not require very much resource is known as *random testing*. With this form of testing the supplier uses data produced by software, which generates random numbers, characters and strings. If the software does not crash and a small subset of the outputs from the random testing examined by the supplier are correct, then it is safe to assume that the software is of a high quality. However, it is worth warning you that this technique should only be used if you have a high confidence in the quality of the purchaser supplied software.

Tips and Techniques - 14

Always attempt to include a directive to your staff in test procedures which asks them to explain why they have chosen certain test data, This is of most value in procedures governing unit and integration testing which are relatively informal processes, For example, there are three main testing strategies used for generating test data: normal data derivation, error guessing and boundary data generation. The first, normal data derivation is the construction of well-behaved test data. The second involves the development of test data, which, in a sense, is in error; for example, floating point data for a command, which expects integer or string data. The third is the development of data, which lies on the boundary of two functions. For example, a command may carry out one function if a parameter is less than 200 and another function if the parameter is greater or equal to 200; in this case a test value of 200 should be used.

MANAGEMENT RESPONSIBILITY

PROBLEMS

If this section of ISO 9001 is not adhered to, then major problems occur which affect all parts of the company. A list of the problems is:

- A quality system, which is used at the whim of individual project managers, leads to a poor software product being delivered. Good managers will employ the quality the quality system well. Poor managers will only use those aspects of the quality system, which they believe will not hinder the delivery of a system on time and to budget. Normally the latter type of manager will deliver on time and to budget; however, the software that their projects produce will usually be error-ridden.
- A company without a quality manual does not have a central reference document, which describes to new staff how software is developed in that company. Valuable time will need to be spent in communicating this information.
- Without standards and procedures, development tasks will be carried out in an ad hoc way. Good staff will, as a matter of course, use best practices. Poor staff will not. Since one error can kill a software system this will result in errors and late delivery - even if a project employs good staff.
- Without directions about addressing quality factors and using quality controls relevant to these factors, project managers are in danger of either having too many quality controls on a project or, more likely, too few.
- Without support for a quality system at a high level in a company few members of a staff will take the quality system seriously.
- A company that does not regularly review its quality system will discover that it will become irrelevant to their technical and business needs very quickly.
- A company which does not have a specified director responsible for quality will have major difficulties in communicating business policy changes which affect the quality system to quality assurance staff.
- If regular reports are not being received at the board level from the quality assurance function, then the board is unable to sanction major resources to improve the quality system.
- If the company does not have a designated member of staff responsible for the day-to-day running of the quality system, then there will be little, if any, control over projects; there will be inadequate information flow to the board; the development of medium-term quality assurance policy will be ignored; and little career development for quality assurance staff will take place.
- If the company does not have a designated member of staff responsible for the day-to-day running of the quality system, then staff will feel that the communication gap between them and the board is so large that there is little point in carrying out activities such as providing suggestions to improve the quality system.
- If the company does not have a designated member of staff responsible for the day-to-day running of the quality system, then developmental staff will feel that the company does not take quality assurance too seriously.
- Without a central member of staff worrying about quality system improvement, there is a reduced probability that the quality system will evolve in harmony with changes in software technology and changes in company policy.
- Without backing from the board, via a high-level policy statement, which is prominently displayed, development staff will feel that the company does not take quality assurance seriously.
- Without an adequate induction programme, which seriously addresses the training of staff on quality assurance topics, a company will experience a cynicism about the role of quality assurance from their staff. A cynicism embodied in the remark I heard once

from a programmer that 'the role of quality assurance in this company is to stifle our creativity'.

CHECKS

The following should be found in a system, which is certified, to ISO 9001:

- A documented quality system containing standards and procedures, together with descriptions of quality controls and their associated documentation, and instructions on how to apply these quality controls.
- A designated member of the board of a company is responsible for quality assurance.
- Quality reports are a major agenda item at meetings of the board of directors.
- Adequate levels of resource are delegated to the quality assurance function.
- Regular reviews of the quality systems that are aimed at checking its effectiveness.
- A designated member of staff is responsible for the day-to-day running of the quality system.
- Regular audits of projects to check whether agreed quality controls are being followed.
- The board of a company issues a high-level policy statement on software quality assurance, with the statement being displayed prominently on company publications and premises.
- Every new member of staff undergoes an induction programme that contains a substantial amount of detail on the company's quality system.

QUALITY SYSTEM

PROBLEMS

The problems, which are encountered if this part of the standard is not adhered to, are very serious:

- Without a documented quality system the application of quality controls, standards and procedures are an ad hoc process resulting in huge variability's in the quality of software delivered from project to project.
- An undocumented quality system means that conscientious project managers can spend valuable time making up standards and procedures for their own projects. There will be the risk that these will not be of the highest standard, since the specific expertise of quality assurance staff might not be used.
- Without directions on how to use the quality system in order to develop a quality plan, there is the danger that existing standards and procedures will be used without taking into account project-specific factors. This means that quality factors such as reliability and interoperability will not be adequately taken into account.
- A quality system that is not continually reviewed will eventually become out of date because of changes in software technology, hardware technology, and modifications to a company's business and corporate policy.
- An undocumented quality system sends clear messages to staff about the attitude of a company to quality assurance.
- If a quality system is undocumented then there is no documentation to give to staff say during induction, which describes how a company manages projects, develops software and applies quality assurance. This would result in the training department developing documentation, which would not be needed if the quality system were properly documented. A good check on the quality of a quality manual is whether you feel that it can be given to new, raw staffs that join your company.
- If projects are not adequately audited according to the quality controls agreed by the project manager and the quality assurance function, then there is a temptation to omit the controls by the manager in a quest for early or on-time delivery of the software product at the expense of quality.

CHECKS

- A quality manual exists which is given to every member of staff and which acts as a description of how the company manages projects, develops software and applies quality controls.
- A quality manual that contains standards and procedures for *every* developmental, managerial and quality assurance activity-even those, such as prototyping, which may be performed infrequently.
- Regular reviews of the quality systems that take as their input, a number of sources including project debriefings, reports from maintenance staff and R & D reports.
- Regular audits of projects are carried out by quality staff to check for adherence to the agreed quality controls that are embodied in the quality plan.
- A standard and procedure for the quality plan which details its format and how it is to be produced. This usually involves the project manager carrying out a risk analysis and is a by-product of the process of organizing and planning a project.

- A member of the board is responsible for quality system improvement.
- There is a formal group responsible for improvement of the quality system.
- Guidance exists for selecting adequate quality controls for a project.
- A substantial amount of time on training courses for new staff is spent on the quality system.
- Every project uses its own quality plan; it does not just take the quality manual off the shelf.

CONTRACT REVIEW

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- A contract will be signed for a system, which the software supplier cannot deliver without either losing money or compromising on quality.
- Risks will occur which will either result in the software supplier losing money or having to sacrifice quality in order to make a profit.
- Changes to the requirements specification or statement of requirements are not noted and tracked, leading to the eventual development of a system, which does not satisfy user requirements.
- A bid is made for a project which, based on faulty initial costing, leads the supplier to either lose money or compromise on quality.
- Because of the absence of standards and procedures for technical feasibility analysis a system is contracted which does not meet a constraint or set of constraints. Such systems are often seriously deficient and give rise to legal proceedings. A good example is the system, which is deficient in response time, where the supplier was unaware until the later stages of the project of this deficiency.
- Project bids are so poorly structured that the company loses many contracts which it had a good chance of gaining.

CHECKS

- The quality system provides facilities, via standards, procedures and guidelines for project-specific feasibility investigation.
- Standards and procedures exist for technical feasibility investigation.
- The quality system addresses the execution of tasks, which make up the process of outline project planning.
- Standards and procedures exist for outline requirements analysis and design specific to the bidding process.
- Standards and procedures exist for pre-bidding costing and the process of checking this cost.
- Standards and procedures exist for pre-bidding risk analysis.
- The quality manual provides directions for establishing a pre-development audit trail and contains standards and procedures for maintaining the trail. For example, staffs are able to track the changes in the requirements specification, which occurred during the process of establishing a requirements specification from a statement of requirements.
- Standards exist which describe the layout of those core aspects of bidding documents, which will not vary from project to project.
- Procedures are in place for the review of bidding documentation.
- Procedures exist for the review of the contract between the supplier and the purchaser.

DESIGN CONTROL

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- A poorly expressed requirements specification which gives rise to an incorrect design, system test specification, and program code and user documentation.
- A poorly constructed design, which does not match user functions and gives rise to program code, which is in error.
- A design, which does not implement non-functional attributes such as response time adequately.
- Poorly specified modules, which give rise to program code that is in error, or at least wastes programmer time when the module specification is queried.
- Poor correspondence between a design and a requirements specification that results in more resources than is necessary being spent on validation and reworking.
- Poor correspondence between a design and a requirements specification that results in more resources than is necessary being spent on maintenance.
- Inadequate standards for functional validation resulting in errors slipping through, and only being detected at the later stages of software development such as system testing. The detection and rectification of errors at such a late stage in a project is much more expensive than if the errors were detected close to the point when they were committed.
- Inadequate standards for non-functional validation. This leads, at best, to unnecessary, major reworking during the later stages of a project. At worst, it can lead to the delivery of unusable systems.
- Poorly specified interfaces between the design team and other parts of the project, for example the staff charged with requirements analysis. There are two results of this: first, unnecessary effort is spent in communication; and second, errors are committed in the inadequate, informal communication channels that will be used if a formal communication channel is not set up.
- Inadequate change control, leading to designs that are out of step with the requirements specification. This leads to the development of program code, user documentation and systems, which are out of step with customer requirements.

CHECKS

- Standards and procedures exist which describe the process of constructing the requirements specification and matching it up with the purchaser's statement of requirements.
- Standards exist which describe the form and structure of the requirements specification and the system design. If the supplier uses a detailed design notation, then a to standard should exist for this too.
- Standards and procedures exist which detail all the validation activities that a supplier uses to validate a design against a requirements specification. These activities will include prototyping, technical reviews, the calculation of response time, the calculation of file occupancy figures and simulation.

- Planning standards and procedures insist that adequate communication channels are set up between designers, analysts and the purchaser. These channels should be documented in the project plan.
- Design and requirements specification standards insist that there is a trace-ability between functions expressed in the latter and the modules specified in the former.
- Adequate change control procedures are in existence, and the system design specification and requirements specification are expected to conform to these procedures.

DOCUMENTATION CONTROL

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Developmental staffs use documents, which are out of date and, consequently, will develop systems, which do not match purchaser requirements or do not match the system's design.
- Developmental staffs spend needless time chasing up the right version of a document or chunk of program code.
- Changes to a system are applied haphazardly and are not documented. This either results in a system, which does not meet its requirements or the expenditure of large amounts of extra resource in order to ensure that it does.
- Changes to a system cause errors in other parts of the system, which should have remained unchanged. This leads to systems, which are very error-prone.
- Staffs apply unsanctioned changes to a system. This often leads to the development of error-prone software.

CHECKS

- The quality manual offers guidance to the project manager about the identification of configuration items.
- The quality manual contains a standard for describing configuration items in the project plan.
- The quality manual contains a procedure, which describes the steps necessary for developing a configuration management system for a particular project, together with a standard, which describes how this system is described in the project plan or the quality plan.
- A procedure exists in the quality manual, which details how the communication channels between the change control board, and staff involved in development or servicing are set up and maintained.
- A standard exists for the documentation that is sent to the change control board describing a proposed change.
- A procedure exists which details how the change control board organizes its business.
- A standard exists which details how the results of a change control board decision, or set of decisions, are communicated to developmental staff.
- A procedure exists which governs the process of carrying out a change sanctioned by the change control board and validating that change.
- A procedure exists which describes how the application of a change and its validation is checked and signed off.
- A standard exists which describes how the current configuration of a system is expressed in terms of its current configuration items and their versions.

PURCHASING

PROBLEMS

The problems, which are encountered if this part of the standard is not adhered to, are:

- Faulty software components are incorporated into a system. These either contain errors and are of poor quality, or give rise to a large amount of resource expenditure when the supplier rectifies the error.
- Standards and procedures are used by a subcontractor which might be adequate for development but which provide problems for maintenance staff who may have to maintain a system that is expressed in two notations: the supplier's and the purchaser's.
- A subcontractor produces poor requirement specifications, resulting in either poor quality software on which large amounts of resource are expended in order to bring the quality to acceptable levels.
- Inadequate monitoring of a subcontractor's developmental progress, leading to missed delivery dates and a subsequent slipping of developmental schedules.
- Poor system and acceptance tests are specified for subcontracted software leading to error-prone software being incorporated into a system.
- Inadequate technical documentation is produced by a software subcontractor leading to increased resources being required for maintenance of the system into which the contracted software is to be inserted.
- A poor selection of subcontractor leading to the development of poor quality contracted software.
- Poor quality product is purchased. Since the supplier has little control over bought-in software, such as a spreadsheet package, this leads to a serious degradation of software quality, which cannot usually be rectified.
- Documents or software which are so poorly documented it is difficult to determine their origin. This leads to high levels of resource being expended when, for example, attempting to find out information required for the maintenance task.

CHECKS

- Procedures exist which instruct the project manager to insist on the employment of the same standards and procedures used in a project for the requirements specification of any subcontracted software.
- Procedures exist which instruct the project manager to insist that a subcontractor employs similar progress-reporting procedures as those used on the project, which uses the subcontracted software.
- Procedures exist which instruct the project manager to use the same standards for the system and acceptance tests employed to judge the functional and non-functional correctness of the subcontracted software as used for validating the overall system.
- Procedures exist which instruct the project manager to insist that a subcontractor uses the same, or similar, documentation standards as those in the development of the system, which is to incorporate subcontracted software.
- Procedures exist which describe the information gathering exercises that need to be carried out prior to selecting a subcontractor.

- The quality system provides guidelines, which provide advice on how to select a subcontractor.
- Procedures exist which govern the interface between a project and any internal purchasing function such as a purchasing department.
- Standards and procedures for project debriefing insist that the project manager produces a report about subcontractor performance.
- The quality system provides guidelines, which enable the project manager to decide on the level of validation that a purchased software product should receive.
- The quality system should provide standards and procedures, which govern the validation that a purchased product receives. Normally these will be similar to the standards and procedures used for system and acceptance testing.
- Documentation standards for entities such as the requirements specification, system design, program modules and system tests insist that not only the staff who developed the tests are identified, but also whether they are employed by the supplier or are staff of a subcontractor.
- The subcontractor employs the same level of configuration management practices as used by the supplier.
- The interface between a project's configuration management system and that of the suppliers is precisely the defined.

PURCHASER SUPPLIED PRODUCTS

The problems, which are encountered if this part of the standard is not adhered to, are:

PROBLEMS

- Inadequately documented product is used in a system, leading to extra resource being spent during development detecting errors; delays to the project while errors are rectified by either the supplier or the purchaser and an error-prone system being produced.
- Error-prone software is integrated into a developed system resulting in an overall error-prone system.
- Staffs expend extra resources in determining the source of inadequately identified software.

CHECKS

- Standards and procedures exist for the pre-validation and checking of any product supplied by the purchaser - both software and its documentation.
- Guidelines exist which advise the project manager what to do when poor documentation and software is supplied by the purchaser.
- The risk analysis procedure includes actions to be taken if the purchaser delivers poor software or documentation.
- Guidelines for project planning describe the options, which can be exercised if a software project has to cope with poorly specified or error-prone software.
- Guidelines exist which direct the project manager and legal staff on the measures to be taken in or- taken in drawing up a contract for a system for which poorly specified or error-prone purchaser supplied software is to be included.
- Guidelines exist which advise the project manager what actions need to be taken during bidding, for a project, which will include either poorly-specified or error-prone purchaser supplied software.
- Guidelines exist which provide advice on the level of testing to apply to purchaser-supplied software and that standards and procedures are available, which guide the process of testing.

PRODUCT IDENTIFICATION AND TRACEABILITY

PROBLEMS

The problems, which are encountered if this part of the standard is not adhered to, are:

- Time is wasted in retrieving documents, which have inadequate identification.
- Documents are used for developmental activities, which have not yet been validated and are, hence, non-conforming. This would give rise to other documents or program code that is in error.
- Code is included in a delivered system that is non-conforming.
- Errors are not removed from a system after modification to program code, or a document such as a system design, has taken place.
- Maintenance staff incurs extra effort when functional enhancements are added to a system.
- Maintenance staff commits errors when functional enhancements are added to a system.

CHECKS

- Standards insist that every document and item of program code is properly identified.
- Version numbering, project identification and item identification information is included in each configuration item.
- Standards exist which make it relatively easy to trace from a function to the code, which implements the function.
- Standards exist which make it relatively easy to trace from a module to the functions which the module helps implement.
- Standards exist that make it relatively easy to trace from a function to the test documentation for that function.
- Standards exist which make it relatively easy to trace from testing documentation to the functions that are tested.
- A procedure exists that insists that the developer places documentation under configuration control as well as program code.

PROCESS CONTROL

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Without adequate standards and procedures for process identification and documentation the project manager has major problems in costing a project.
- Without adequate standards and procedures for process identification and documentation the project manager has major problems in monitoring the progress of a project supplier in terms of time and resources.
- Without an adequate means of documenting the relationship between processes the project manager will find major problems if he or she has to re-plan a project.
- Without an adequate means of documenting processes the project manager has major problems in determining the feasibility of a project in terms of resources available and resources required.
- Without adequate work instructions staff carry out substandard work leading to errors in the tasks they have currently been assigned to.
- Without adequate standards which, for example, define the form of a particular document such as a system design, staff assigned to tasks such as requirements specification paid for expend unnecessary resources and commit errors which would not have occurred with better standards.
- Without a procedure for identifying special processes there is the danger that the software company will sign a contract that contains requirements that they are unable to guarantee can be met. If a procedure for identifying special processes exists, then the software supplier has less chance of being involved in litigation when the product of a special process is unable to meet requirements.

CHECKS

- Standards and procedures exist which describe how processes in a software project are identified and documented. These standards and procedures are usually contained in that part of the quality manual concerned with planning.
- Standards and procedures exist for the reporting of completion of a particular process and the amount of resources expended.
- Standards exist for the description of work instructions for each type of process in a software project.
- Standards exist which define the layout of major items in the software project, such as the system design and the code of modules.
- A procedure exists which enables a project manager to identify special processes during planning, and ensures that the software supplier does not commit himself or herself to a delivered system whose properties depend on special processes.

INSPECTION AND TEST

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Poor items of software from other sources are incorporated into a final system, with these items giving rise to major quality problems such as exhibiting errors in functionality.
- Inadequate direction is given to staff carrying out unit testing. This results in the production of modules, which are in error.
- Poor quality records are produced from unit testing. This gives rise to problems in providing assurance that the system is of a high quality, and allows programming staff to be less thorough than they would be if good quality records were produced.
- Inadequate direction is given to staff carrying out integration testing. This results in errors being present in the interfaces between modules and between the system and the outside world.
- Poor quality records are produced from unit testing. This gives rise to problems in providing assurance that the system is of a high quality and allows staff charged with unit testing to be less thorough than they would be if good quality records were produced.
- Inadequate tests are generated for unit and integration testing. This leads to residual errors, which will either be present in the final system, or will take much more resource to remove during system and acceptance testing.
- Inadequate system testing takes place, with the result that errors, which should have been detected during this testing phase, are detected in front of the purchaser during acceptance testing.
- Inadequate quality records are generated by technical reviews. The absence of such records will provide a lower level assurance of the quality of a system and lead to residual errors. Their absence also removes a potential source of data that can be used to evaluate the operation of a quality system.
- Poor quality records are produced from system and acceptance testing. This gives rise to problems in providing assurance that the system is of a high quality and allows staff charged with system and acceptance testing to be less thorough than they would be if good quality records were produced.
- System and acceptance tests do not reflect the functional and non-functional requirements specified in the requirements specification.

CHECKS

- Standards and procedures exist which detail how requirements in the requirements specification are extracted, documented and expanded out into system and acceptance tests.
- Standards and procedures exist which detail how system tests and acceptance tests are applied and the results of the test documented.
- Standards and procedures exist which detail how unit tests are applied and how the results of the tests are documented.
- Standards and procedures exist which detail how integration tests are applied and how the results of the tests are documented.

- Procedures exist which detail what should happen when a test fails.
- Standards and procedures exist which detail what a project manager should do when his or her software project contains software from other sources. These standards and the procedure should cover the tests that have to be carried out in order to discern whether this software is of a comparable quality to that generated by the project.
- Standards and procedures exist which direct the project manager on the contents of the test plan and how to develop this plan.

INSPECTION, MEASURING AND TEST EQUIPMENT

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- The supplier develops software-testing tools, which are in error and which do not adequately support the testing process. At the very worst such tools may provide erroneous evidence that a test was successful.
- Inadequate specification of the properties of a testing tool is produced, resulting in the development or purchase of a tool, which does not carry out its functions.
- Inadequate checking of a testing tool resulting in errors, which affect the validation, carried out by the supplier.
- Tools are purchased from inadequate sources, which do not carry out their promised functions. This could either lead to project delays or to errors not being detected during testing.
- Changes to testing tools cause errors, which delay a software project or result in the delivered product containing errors.

CHECKS

- The project planning standards and procedures specify that all internally developed means testing tools are produced using at least the same degree of quality control as the project in which they are to be used.
- The planning procedures include a section on the specification of testing tools, which are either bought in from outside suppliers or are developed internally. This section could be subsumed in a general section about the process of buying in or developing any software used for support.
- Guidelines exist which enable the project manager to decide whether a software-testing tool is to be developed internally or purchased.
- The configuration management standards and procedures specify that any internally developed testing tools should be regarded as configuration items.

INSPECTION AND TESTING STATUS

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Modules are integrated into systems that have not been fully tested. This will result in errors being inserted, which will require more resource to detect than if they were discovered during the programming task.
- Work is started on a system design based on a requirements specification that has not been adequately checked out.
- Work is started on programming, based on designs that have not been adequately checked out.
- Not enough information is available to the project manager to allow him or her to track progress on validation.

CHECKS

- The main check is that for every project the documentation standards adopted should insist that the test status of every configuration item and module, if they are not configured items, can be easily found by development staff and the project manager.

CONTROL OF NONCONFORMING PRODUCT

PROBLEMS

The main problem that this part of the standard is intended to address is of prod user documentation being released to the purchaser or to system and acceptance testing staffs, which has not been properly validated. If your quality system is weak in this respect then there will be a high number of error reports generated during system and acceptance testing or a high level of purchaser problems detected during operation. Normally a good configuration management system satisfies the requirements of this part of the standard.

CHECKS

- Standards and procedures exist for the identification of modules as conforming or nonconforming.
- Standards and procedures exist for the identification of user manuals as conforming or nonconforming.
- Standards and procedures exist for the identification of internal documents such as system designs and requirements specifications as conforming or nonconforming.
- Standards for acceptance testing and system testing include documentation, which can be consulted to determine the status of subsystems or the overall system.
- Standards are in place which allow staff to quickly discern what the state of a project is in terms of the number of items which are conforming and nonconforming.
- Procedures exist which instruct staff that discover errors during validation to flag the items that caused the error to be marked as nonconforming.
- Procedures exist which instruct staff to check on the status of all the items, which make up a software system before release to the purchaser.
- Procedures exist which instruct staff to check on the status of the user manual before it is released to the purchaser.

CORRECTIVE ACTION

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Inadequate procedures governing the feedback of information from staff that has detected problems. These give rise to errors not being rectified, or too much effort being spent on discovering what the error was, or what needed to be addressed.
- Inadequate procedures and standards governing the interface between staff who detect errors and staff responsible for configuration management. These give rise to errors not being notified to the project and inadequate validation of the changes, which address those errors, which have been notified.
- Poor information from the analysis of defects leads to important information not being used by staff charged with improving the quality system. This results in the quality system evolving less efficiently than it might if the information was available.

CHECKS

- Standards exist which govern the nature and layout of information generated when an error is detected.
- Project planning procedures exist which enable the project manager to define the interface between the configuration management systems used on a project and the staff charged with validation.
- Procedures exist for immediate feedback from projects to the quality system when a serious deficiency in a component of the system is detected.
- Guidelines exist which detail how information from the validation process can be used by staff that are charged with the improvement of the quality system.
- A standard exists which describes the nature of the information to be included in a project's defect log and procedures exist which detail how that log is updated.

HANDLING, STORAGE, PACKAGING AND DELIVERY

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Time is wasted in looking for poorly identified documents.
- Documents, which have been base-lined, are updated in an unorganised manner. This leads to errors by staff using these documents because circulated documents such as the system design may not be up to date.
- Valuable project documents are destroyed or lost because of circumstances such as fire.
- Software is destroyed or degraded due to virus attack.
- Systems are released to the purchaser, which contain wrong components.
- Inadequate communication between staff who are supporting purchasers and who are maintaining a system.
- Inadequate communication between the purchaser and staff involved in support.

CHECKS

- Project planning standards exist which describe the form of a project library.
- Numbering conventions are included in standards for all the main document code produced by a project.
- Procedures exist which restrict access to the project library.
- Procedures exist which describe the safe storage of both project documents and program code.
- Standards exist which describe the various configurations that a software system be released in.
- Procedures exist which direct staff to check that the configuration of a released system matches the configuration, which was specified to be released.
- Standards exist which govern the communication between staff that carry out the support function and the maintenance function.
- Standards exist which govern the communication between staff charged with support and staff charged with maintenance.
- Standards exist which govern the communication between the purchaser and the staff who carry out support.
- Guidelines exist which help the project manager decide on a quality plan for support, given that the software supplier will have signed a contract for support - often at the same time as the contract for development.
- Procedures and standards exist which enable staff charged with support to generate statistics on the level and severity of the errors notified by the purchaser.

QUALITY RECORDS

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- An incoherent quality plan is produced which may result in many validation activities not being carried out at all, some validation activities being carried out inefficiently and other validation activities being only partially executed.
- A poor quality plan that is not giving the project manager enough indication of the level resources-hardware, software and staff-required for validation. This either leads too many staff being allocated to validation or too few.
- Inadequate quality records are generated. This means that both project management and the purchaser would have great difficulty discovering whether a system had been adequately validated.
- A poor quality plan is produced which leads to inadequate quality controls be associated with the project.
- Poorly specified test documentation, which results in not enough information, being given to testers and almost certainly leads to tests being poorly carried out.
- Poor testing standards, which result in inadequate coverage of the functional I non-functional properties of a system during acceptance and system testing.
- Poor module testing and integration testing standards, which result in a system being sent to the system and acceptance testers that still have major errors. This result an increased level of resource required for these activities.

CHECKS

- Guidelines exist which provide advice to the project manager on constructing a q~ plan.
- Standards exist which specify the form of the quality plan.
- Procedures exist which govern the construction and development of the quality plan.
- Standards exist for all the documents generated by quality control-based activities such as technical reviews.
- Procedures exist for the conduct of all activities associated with quality controls.
- Standards exist for all testing documentation including verification requirements, designs, test specifications, test procedures and test reports.
- Procedures exist that result in subcontractors producing similar quality record those produced on the project that uses the subcontractors. These procedures could be included in those, which relate to the process of contracting subcontractors.

INTERNAL QUALITY RECORDS

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Poor or infrequent auditing results in projects not adhering to the agreed quality controls. This normally results in software which contains errors and which does not meet purchaser requirements.
- Poor auditing leads to staff perceiving a lack of importance of quality in a company.
- Inadequate auditing removes a useful technique for external checking on the progress of a project.
- Poor or non-existent auditing leads to valuable information, which could be used to improve the quality system and improve developmental tasks being lost.

CHECKS

- Guidelines exist which inform quality staff when and what to audit in a project.
- Procedures exist which describe how an audit is to take place.
- Procedures exist which describe how a spot check is to take place.
- Standards exist which describe the documentation generated by an audit or a spot-check.
- Procedures for quality planning describe how audit points are identified and how are documented in the quality plan.
- Procedures exist which detail the steps that are to be taken when a minor infringement is discovered during an audit or a spot check.
- Procedures exist which detail the steps that are to be taken when a major infringement is discovered during an audit or a spot check.

TRAINING

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Tasks are executed poorly because the staffs allocated to a task are not adequately qualified to carry it out.
- The workforce of the company becomes gradually outdated in skills.
- The company is unable to tender in particular application areas because of a lack of knowledge of those areas.

CHECKS

- Guidelines exist which help the project manager allocate the most suitable staff to technical tasks.
- Guidelines exist that enable a company to determine its future training needs.
- Part of the standards and procedures for project planning describe how the work experience and training experience of allocated staff is to be displayed in the project plan.

SERVICING

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Changes applied after release, which are not adequately quality assured result in the gradual degradation of the quality of a system.
- Versions of a system are sent to the purchaser containing errors in functions, which previously were correct.
- Supplier staffs spend a large amount of time discovering which version of a software system a customer was previously sent.
- The wrong version of a system is sent to the purchaser after a modification or a series of modifications have been carried out.
- The supplier continually violates the provisions of a service contract because of an inadequate servicing plan.
- Functional enhancements are carried out under the guise of error eradication due to inadequate procedures for screening problem reports.
- Problem reports get lost or disappear because of inadequate communication mechanisms, or because the wrong person from the purchaser's side spoke to the wrong person from the supplier's side.

CHECKS

- A guideline exists which provides advice on the development of a service plan based on purchaser requirements.
- Procedures exist which deal with the processing of problem reports from the purchaser.
- Standards and procedures exist which specify how communication is to be organized between the supplier and the purchaser during servicing.
- Procedures exist which specify how data is to be collected during servicing.
- Standards exist which specify how the data collected during servicing is to be presented.
- Procedures exist which specify how staff's carrying out the servicing function interacts with the configuration management system adopted for servicing.
- Procedures exist that describe how a project is to be set up which implements enhancements to a system.
- Procedures exist that describe how enhancements to a system are to be costed.
- Procedures for regression testing exist for use during servicing.

STATISTICAL TECHNIQUES

PROBLEMS

The problems that are encountered if this part of the standard is not adhered to are:

- Inadequate feedback from projects on important statistics such as the degree of slippage of a project.
- Inadequate feedback on the quality of the delivered product. This leads to a lack of confidence in the supplier by the purchaser.
- A value source of data, which could be used for quality system improvement, is lost.

CHECKS

- A guideline exists which provides advice on the collection of error statistics.
- Standards and procedures exist for gathering and presentation of error statistics for errors, which are generated during development.
- Standards and procedures exist for gathering and presentation of error statistics for errors, which are notified to the developer after delivery.
- As part of the project planning standards and procedures, a project manager is instructed to include information about task timing and task resourcing in the project plan.
- Standards exist for the documentation generated when a task has been completed.
- Procedures exist which ask staff to fill in a task completion document when a task has been completed.
- Guidelines exist which detail the possible uses of well-tried product metrics.

Software Metrics

An increasingly important area of research, which is now bearing fruit on real software projects, is that of software measurement. Software metrics are measurements which can be extracted from a product of a software project such as during a system design phase. A metric is used to measure aspects of a product, which can theoretically be used to control some quality factors. For example, the depth of nesting within control structures contributes to readability of the modules; a high depth of nesting results in code that is difficult to read and understand and hence difficult to modify during future maintenance activities.

Other techniques can include metrics that set an upper size to module lengths so that programmers during development do-not exceed metric limits.