Section 1: The strategic approach

The professional tester will need a good general knowledge of testing and the influence that he or she could and should have on the testing done throughout the development and support of software systems. The professional tester is a key person for the success of a project and should be involved from the very start.

The professional should have a good grasp of when and how testing fits in to the different life cycles. He or she will be working in projects that follow various life cycles and typically will meet the three common ones: sequential, incremental and iterative (RAD). The professional should be able to present the arguments as to how the early test planning may be balanced with the later actual testing using the 'V' model. The professional will use various standards and he or she will find that ISO 12207 can be used as an example of the 'V' model.

The professional should be able to define the different test levels and approaches from component testing through to acceptance testing. The intermediate levels will include integration testing, functinal system testing, non-functional system testing and whole system integration or release testing. He or she should also be able to describe the importance of relating the exit and entry criteria for each level of testing.

The professional should be able to present the arguments for including or excluding different levels of testing. Once the levels have been determined the professional should be able to define the objective and scope of each level. There will need to be a comprehensive list of test deliverables, test techniques, test tools, testing standards, templates for various documents and pproaches, defined responsibilities and clearly-stated entry and exit criteria. Of course so much of testing is iterative and the test professional should be prepared for the iterative nature of testing with both re-testing and regression testing.

Although it is not a tester's responsibility the professional tester should check that there exists organisation-wide change and configuration management procedures. The professional tester should be able to take a general approach to testing and from this create a specific strategy that is suitable for the specific project. The strategies chosen will be based on various factors, especially the risks associated with failure of any part of the development or deliverable from the development. It should be noted that the specific project could be for new development or for the maintenance of an existing system. the professional will need to ensure that there is the appropriate inclusion of all or some of the testing activities within a chosen strategy.

It may be that from time to time the professional tester becomes involved in the creation of a corporate strategy for testing and quality control. He or she will need to be able to influence management and help management create a suitable policy for quality in general and testing in particular. The professional will need to be able to create specific site or location test strategies as well as strategies for individual projects or even whole series of projects.

Typically the strategies that might be formulated will cover many issues. Critical to establish are strategies for traceability of test objectives to user-required functionality, formal test specifiaction and design techniques to be used with procedures to be followed and mandatory standards to be met.

The professional tester will need to be familiar with both external and site-specific standards. Those external standards that may apply will include ISO 12207, BS 7925, IEEE 829, IEEE 1044.

Section 2: Risk-based testing

Everyone now accepts that the study of risk is an essential element of test planning, design and execution. The professional tester will need to be well aware of the concepts of risk-based testing.

It is relatively straightforward to perform a simple risk and hazards assessment and apply this to the test planning and design work. When done properly this should maximise the effectiveness of testing. It is very useful if the professional tester can develop reasoned arguments focussing on such issues as the risks posed by the various parts of the software in a system; which risks should be reduced and why; how and by how much the risks should be reduced by testing and what testing should be applied in order to reduce the risks appropriately.

As with faults and potential failures the testing planned is to minimise the possibility of something going wrong. The focus for the tester may range from the process rule and process event to a system or a collection of systems. It may be that the professional tester is the only person actively involved in the assessment of the risk. In order to gain management attention it will be found that the focus must be on the potential consequence of failure such as the cost and knock on effect. The argument is that failure costs will be high and difficult to contain yet testing costs are significantly smaller and well defined.

As the test results are documented they will emphasis potential failure and, combined with the results of hazard analysis, can be used to determine the risks associated with the system before implementation. Satisfactorily run tests can trigger work that brings about the reduction of risk both by reducing the potential consequences of an incident and by reducing its likelihood. The professional tester must remember that testing is a sampling activity and as such only ever covers a small proportion of the possible data that the system will process. By using risk analysis it is possible to chose test techniques and prioritise tests that maximise the effectiveness of the samples chosen.

The professional tester should also be aware of more rigorous techniques where risks are higher and be prepared to specify the use of test techniques appropriate to the level of rigour demanded. Of course there is the ever present problem that testing rarely completes on the date demanded or predicted in a plan. The problem of dealing with development slippage and the delivery deadline remaining fixed is never far from the professional tester. The tester will need to deal with the pressure to release and the attractiveness of ignoring the per-determined acceptance criteria. Management may be happy to base decisions on partial and optimistic test results so the test report produced by the professional must objectively link the test results to the risks of early system release. The report will cover the tests run, the defects discovered and fixed, the defects discovered and not yet fixed and of course the tests not run. The professional tester will need to be able to present this material to senior management and decision makers.

Section 3: Test planning and estimating

Test planning and estimating are the skills covered in this issue of the magazine. The first of this series of articles emphasised the need to be able to set out a broad strategic approach to testing, the second covered the principles of risk and the need to plan the testing to reduce the identified risks.

The professional tester will need to be able to create a test plan that is based upon what is to be delivered throughout the development and support of the system. The professional must be able to use plans, schedules and activity assignments in a formal planning framework such as PRINCE and be familiar with techniques such as CPA and established standards including ISO 12207 and IEEE 829.

The plans should be at various levels such as strategic, tactical and operational and must be detailed enough to form the basis for budget approval and assignment of work to testers. The test objectives and test deliverables must be fully traceable within this formal test plan. The professional will use the plan to satisfy management, developers and users that adequate testing will be performed. The plan will be used to define and communicate the contributions of everybody who is expected to have an involvement in the testing work. The plan must establish the test objectives within a formal document and ensure the correct balance of planned tests covering functionality, the non-functional attributes and the risks to be contained.

The high level test plan may cover both new development and system enhancement and contain lower level test plans such as component, integration, systems and acceptance test. The focus must be on qualification testing as found in ISO 12207. The plans must include enough detail for the design and creation of the actual tests. The professional must catalogue the deliverables at the different levels.

The test deliverables will include the various plans and schedules, the test environment description and set up procedures, the test scripts, test data, resources needed, test tool usage and test reports.

The professional must also be able to work within a fixed allocation of time and create a plan adjusted so that suitable test execution can be achieved. This work will be based on an assessment of the minimum tests needed to achieve the different test objectives and use factors previously established such as risk, complexity, criticality, and the objective of the current test level. This material will need to be available in summary form for the project board and is upported by considerable detail of the project board call for a justification of the requested budgets and resources.

Also it is essential that the professional ensures that the correct configuration is tested as well as ensuring that changes are tested. The professional should be well aware of the reasons why planning should be done as early as possible and the vital contribution test planning can make to the satisfactory development of correct solutions to business problems. There should be emphasis on testability of all deliverables and the early project status indicators created by early test planning. The testing professional will ensure the early visibility of potential problems through the formal and comprehensive test plan.

The professional will need to be able to influence management using reasoned arguments such as the potential cost and general project problems associated with the late start to test planning. There must be strong emphasis on the difference between planning the testing using early deliverables such as specifications and late deliverables such as actual software. The professional must be able to analyse the plan and, for really large projects, produce an incremental test approach based on business requirements. This approach is essential for large development projects and projects where the development is incremental or iterative. The professional should also be well aware of the iterative nature of planning.

Multi-million pound failures are again in the news and again both the big bang approach plus the emphasis on budget cutting (especially on testing) leads to huge waste of resources. Time and again it is found that an early involvement of the professional tester will introduce the level of realism that leads either to the early cancellation of ridiculous projects or the realistic assignment of resources together with strong and traceable quality control.

The plans produced by the test professional should be within an agreed test strategy and using the agreed test objectives. There needs to be an emphasis on the integration of the test objectives within the agreed testing strategy and full traceability back to the risks identified during risk analysis. The detailed plans need measurable test conditions, coverage to be achieved and agreed completion criteria for all testable items.

The professional needs to be able to draw a distinction between the most effective tests and the most efficient tests and the professional should be able to use design techniques that lead to the creation of effective and efficient tests.

There is always the problem of generating more tests than can be run with budget limitations so prioritisation of tests to complement test design techniques based on most desirable features and most undesirable risks is an important skill. The professional tester should be well aware of rigorous and standard

test design techniques such as documented in the Software Component Testing Standard (BS 7925).

Prioritising is done to ensure that the most important tests are designed and executed in the available test budget and to optimise limited resources. Where risks are higher the professional should be able to choose test design and creation techniques that have a better chance of detecting defects. Of course there is the probability that these techniques are more expensive, needing more experienced testers, and perhaps use specialised tools. On balance the professional will use more stringent test techniques for critical systems; using formal rather than informal reviews of all documents and tool supported branch coverage rather than statement coverage during component testing.

As well as recording what is to be tested the test professional will identify and document what is not to be tested and use the scale of the risk to determine how much effort should be committed to the planned tests. The testing professional will also manage the revision of the test objectives as the work proceeds.

Estimating the testing work is difficult and, when calculating the resources required, the test professional must be careful to differentiate between an estimate, quote, budget and target. The professional must be aware of the difficulties in estimation and be able to use various estimation models. Of course there will be the refinement of the plans as a result of budget allocation.

The professional must estimate carefully as the estimate will be analysed and used as a basis for test budgets. The estimate is only an approximate calculation or judgment based on a professional understanding of a subject expert. On the other hand a quotation may become an estimate that is contractually guaranteed. This guarantee will be the basis of a budget that is an allocation for the work and a target as a desired time or cost for completion of an activity or project. The professional must understand the basis for estimates, targets, quotes and budgets. Of course there are the influences of politics, commercial objectives and other factors on the prediction of the number of tests, effort and/or time required for the work, and number of iterations or cycles required.

It is useful if the test professional is aware of the causes of some high profile failures. The professional will use various techniques; informal techniques such as intuition and experience; formal techniques based on formulae that might exist in a company or development methodology as well as function points, company standards and metrics.

Typically there is a big difference between time taken to document tests and the time it takes to run the tests because of the unpredictable quality of the test item. The use of accumulated data from previous, comparable, test activities will help the professional estimate the number of iterations (re-test events). The creation of the chart showing what test is to be run, its dependency and when it is to be run (Gantt Chart) will help the test professional cope when time is strictly limited. Critical Path Analysis (CPA) should be used to manage the testing.

Section 4: Specifying and designing tests

This article covers the process of specifying and designing tests. It is essential that the testing professional is able to specify tests that are both possible and economical to run. The test must have an objective that is traceable to a test condition that is justifiable in business terms. The business basis for the condition may be in terms of an unacceptable risk that must be shown to be contained or a desirable business objective that leads to business process improvement. The test objective must also be recorded in the test plan along with the deliverables associated with the test.

The testing professional will need to devise the test in a way that is appropriate to the level at which the test is to be performed. Typically the levels of testing are; user, the user acceptance test; designer, the system test; and programmer, the unit and link or integration tests. Despite the level of the test it is essential that full traceability is maintained.

A formal approach to the specification of a test is recommended. The standard BS 7925-2 specifies a series of methods depending on the test objective and the test object or test item. IEEE 610 uses the term test item which can be considered to be a development deliverable that needs to be tested. IEEE 610 also uses the term test case specification to mean a document that specifies all that is needed to run the test. The professional will need to ensure that the linkage of the test case specification to the test plans, and the established conditions that need to be demonstrated, is correctly maintained. Maintaining traceability of the tests being designed to the user requirements and the risk containment plan is a key responsibility of the tester. The linkage of the test to the source documents (such as requirement, functional or design specifications or code) depending on the type of development or enhancement deliverables being tested will enable all involved to evaluate the importance and desirability of individual testing activities. Each test case specification should include a statement of the test environment, the test input(s), preconditions, post-conditions, expected outcome and cross-reference the test condition(s).

The testing professional will have to be able to identify, justify and use suitable techniques for the creation of test data. There also needs to be a formal statement of test running procedures appropriate to the test item being tested. The coverage required must also be identified in the test plans. There must be the formal recording of the test conditions in the test case specification document. There might be a separate evaluation of the risks in the use of undocumented sources of test material. The professional tester will also need to be aware of the problems of lack of both formal documentation and formal testing materials when working in a RAD project. RAD is typified by the lack of documentation and the lack of testing.

The test professional must be able to construct tests using recognised test design techniques; there must be specific familiarity with test techniques as defined in BS7925-2. As a minimum the professional must be able to use Equivalence Partitioning, Boundary Value Analysis and State Transition Testing. The test case specification must also clearly state the expected coverage and the professional should be able to use the coverage techniques defined in BS7925-2, including statement and decision coverage. The professional must be able to adapt the techniques so as to be suitable for system, integration and acceptance testing. The professional must also be able to specify tests for the non-functional attributes at these levels. Of particular importance is the testing of performance in a heavily loaded multi-user environment and usability testing. The big challenge for the professional tester is to adapt the techniques to the type of system to be tested. The techniques are widely applicable, but adaption will be needed as the tester moves from web testing to the testing of safety critical and embedded systems.

The professional must be able to make a formal and justified recording of test values (test data items) in the test case specification. The skills of the tester must include the design of tests, the selection of test data values to achieve the completion criteria required by the test specification and the formal documentation of the test that exercise the selected test conditions. The tester must ensure that the selected values are consistent with the objectives of the test.

The test environment must be formally defined and match the expected eventual live environment as close as possible. The professional must insist on the use of the term 'replicate' as in 'the test environment must replicate the live environment'. As well as the test environment the test professional must specify the test starting or test entry criteria. The whole test documentation needs to be at least to the level defined in IEEE 829. IEEE 829 is currently undergoing revision; this is long overdue as 829 is a reasonable paper-based approach but very much deficient when used for large, complex applications.

The professional tester needs to be familiar with defining the test environment and entry criteria (such as previously run tests), the equipment, the tools, the staff, the general resources and the test documenting procedures. The professional must be familiar with the use of the formal test plans and the linkage of the planned tests to the entry criteria. The professional must also be able to administer the testing and the test environment.

Finally the test professional must be able to define and use formal procedures such as might be needed to be ISO 9000

compliant. The compliance would be in terms of 'say what you do', 'do what you say' and then 'show that you have done what you said you would do' approach. The documentation would be expected to cover procedures and instructions to carry out the testing work. The work also needs to be referenced in the test report which is a fundamental component of test documentation.

The next article will cover test execution, entry and exit criteria, documentation and reporting. This will be followed by an article on people skills including reviews as well as monitoring and managing the testing. Reviews are particularly important but often incorrectly taught, with the result that the review becomes divisive and a serious issue of confrontation. The incorrect teaching of the inspection process still causes big problems.

Section 5: The mechanics of test execution

Testing can be viewed as a controlled experiment and just like an experiment the preparation needs to be precise, the execution managed and the results carefully recorded. The testing professional will need to use a repeatable process for the execution of the devised tests.

There must be a repeatable and defined system for executing the test and this will start with the activities needed to ensure that the test environment is correct and that it closely represents the intended environment of the test item. Associated with the preparation of the test environment is the checking that all entry criteria have been met, any incorrect test environment issues have been resolved and failed entry criteria corrected. The test environment should have been defined in the test plans and specific requirements recorded in the detailed test documentation.

The professional will need to be able to judge when the state of the test environment has a significant influence on the test results. This influence will need to be analysed and recorded in the test report. The professional tester will need to be aware of the problem of conflicts between the operating system, the application under test and other software components. The professional tester will need to be on his guard against the issue of apparent faults in the application that are really with the test environment and not with the application under test.

It is possible that the state of the test environment may invalidate tests and much attention to detail is needed for the correct specification and creation of a suitable test environment. As well as tools, test harness, simulators and other applications there may be the need for physical office space, furniture, workstation(s), networks, printers and system software so the professional will need to be able to manage the controlled build and installation of all this as well as the specific test item. The professional will also need to ensure that the procedures for change and configuration management of the test item or system under test and the test environment are working and that an audit trail of changes is maintained.

The professional will execute tests according to established test procedures, this should be such as to ensure that there is complete auditability of the tests, as well as repeatability for re-test and regression tests as needed. There must be procedures for including additional tests identified as a result of running the planned tests. There may also be the need for ensuring confidence in the tests by the use of witnesses. The professional should be able to manage the practical aspects of using a formal test witness process. The test professional must be familiar with the detailed nature of the operational test plans; the day to day test running work and the conduct of the actual testing (manual or automated) according to the procedures and documents identified in IEEE 829. Testing is an iterative process and tests need to be repeated as defects are corrected, this causes the revision of test plans including the planned sequence of tests and of course the budgets for resources.

The standard IEEE 829 describes the contents and use of a number of documents and the test professional must use at least a Test Log and Test Incident Report similar to those defined in 829. The required detail will have been identified in the early strategy documents and management will use the test log as a source of information for a post implementation review and the development of further testing work.

The professional must ensure that an accurate comparison of the actual and the expected results is performed. There must be the analysis of discrep-ancies and any mismatch between expected and actual results reported as incidents. There must be the careful checking of test results against planned test completion criteria. The professional will need to be able to identify how to restart the test process from earliest activity necessary in order to meet agreed completion criteria. There will also be a need to check the impact of suspended tests on the schedule along with the implications for the critical path. There will need to be a formal check of the coverage achieved.

The professional should be familiar with the content and use of the Test Incident Report (IEEE 829) and use additional data to assist the resolution of incidents. Clearly it is critical that all relevant factors are recorded as soon as they are observed in a traceable manner. The professional will be aware of the problem over loss of visible output: symptoms; circumstances; actual system status and outputs, and hence be well aware of the need to capture every detail. The professional will use the review process to decide what should be done about the recorded incident. The review can be used to track and manage actions through to closure. There is often a problem where issues are ignored so the professional will need to maintain a formal record of the relationship between the incidents, conditions being tested and the risks to be contained.

The test professional will probably be the person to manage the review of each Incident Report using representatives from developers, testers and users as appropriate. The test professional will also need to merge incidents that are undoubtedly different symptoms of the same cause into one incident report.

Incident severity classification is a difficult issue and the professional will need to be aware of different classification

schemes that might be adopted as well as classification standards such as IEEE 1044. The professional will need to have a classification scheme that correctly communicates the risk issues to the decision takers. The classification system will need to have a science behind it and contain information as to time to fix, cost to fix, cost if not fixed, time to re-test and performance implications for the live running of the system. There will need to be the periodic review of the classified incident reports, decision on actions based on severity and priority in conjunction with acceptance criteria. The professional may well be involved in the assignment of individuals or organisational units for action and the monitoring of the change in status of the incident as work proceeds. The professional will be aware of the importance of keeping each incident up to date with changes in timely manner, and to ensure that all such changes are recorded in the Summary Log.

The professional tester will be aware of the fact that the decision to install, continue as with more of the same, rework or reject the overall system, is not taken by the tester. The decision taker is possibly the project manager or more likely the project sponsor. Project sponsors need the best possible information upon which to base the decision, thus an incident reporting system that has low, medium and high as grades conveys little useful information. It is because of the need for better decision taking that the professional tester will develop a comprehensive, traceable and auditable incident grading system.

It may also fall to the professional tester to establish the cause of each incident (or sample of incidents), as well as the gathering of metrics to support the production process improvement recommendation. There is a need to allocate to each incident report a code representing its cause and this may well be based on the IEEE 1044 standard catalogue of faults.

The test professional may well be the person to manage every incident through to closure from the identification of when an incident has been determined to be a fault, the Incident Report maintenance and fault tracking through to completion.

The professional tester may from time to time have to use staff other than the test team and even manage the team who have the task of rectifying the fault. This will mean the joint use of the incident reporting and fault tracking system as well as the mechanism for monitoring the status of the test items. The work done to ensure that all actions are taken and incidents closed within the time budget will also need monitoring. There is also the task of progressing exceptions along with accurate recording of status, severity, priority and cause. There is also the ever present amendment of test schedules based on the analysis of test issues and re-work of test items with the implications for the critical path and dependent testing work.

The professional should be able to analyse the incident reports to provide metrics from which prediction and confirmation of when testing can stop and to develop charts showing the pace of rectification and the pace of testing. This work also has implications for the test plan and the release date. The plot of incident detection and resolution rates to show trends over time will enable the professional to determine the effectiveness of incident resolution. The various plots and indices created by the test professional should provide management with suitable data for management decisions.

In general traceability and the auditablity of tests is set to become a major issue. The professional tester would do well to pay attention to both requirements traceability and test traceability. The overall management of software projects is set to move more and more towards the use of test reports that cover all deliverable items from the requirements documents onwards.

Section 6: People skills, including the review as a test technique

Professional testers have many techniques available to them, but the most valuable of these is the review. Everything produced for the development and support of a system can and should be reviewed. The professional should know what documents should be reviewed and these will include test documents and other project documents.

There are different review techniques and the professional tester should know when to use each, as each has strengths as well as weaknesses. Different types of review or inspection can be done on each type of document to achieve different goals. The four versions of the review that are easy to identify are the informal review, the walkthrough, the technical review and the inspection.

The professional tester should be able to introduce the informal review, including the unwritten roles, responsibilities and expectations. The informal review can act as a strong team building activity as long as the key points of the informal review are understood and introduced to the team. The key points are zero management involvement, run when needed, two or more involved and the emphasis on finding solutions and providing feedback. The informal or buddy review is a peer review, inasmuch as the skill levels are similar and there is strong mutual respect.

The walkthrough is a standard testing activity performed by a group of people. The professional should be able to set objectives, define the roles and responsibilities, play to the strengths and avoid the weaknesses of the process. The professional should be able to modify the walkthrough process to cover the many different documents that may be reviewed using the walkthrough. Walkthroughs are a great way of talking through the issues, communicating key points to the other members of the team and ensuring good communications.

The technical review process has powerful strengths and some weaknesses, all of which should be known to the professional tester. The tester should know how the document for review should be distributed to the participants, the review objectives and roles assigned to the reviewers, preparation done and a technical review of the document held. The technical review procedures should be formally recorded and variations on the basic procedure available for use on the many deliverables that are produced during any development and support of a system. A key point of a technical review is the focus on specific technical issues that are common to all at the review. A technical review may be called to review security issues, while a different review with different attendees may be called to review usability issues. Again, the solution is on solution-finding. The technical review may be managed by a person called a moderator.

The professional should also be able to conduct an inspection (often called a Fagan Inspection and very like a proof-reading process), ensuring the correct allocation of roles and responsibilities of the moderator (leader of the inspection), the reader and the inspector(s). The strengths and weaknesses of this approach should be well understood by the professional. The collection of statistics about time spent by each participant, the issues raised and the estimates for remaining work should be done by the professional tester.

The professional tester should be able to conduct a comparative study of all four types of review and detail the way cultural issues may influence what types of review are acceptable, effective and successful.

The professional tester will know that he is often an unpopular figure and the test team seen as a dead end job. The role of the tester is often only seen as critical and destructive, and so the professional must work to overcome this misunderstanding. There is a strong relationship between the maturity of the organisation and the way that the role of the tester is regarded, so the tester should endeavour to raise the maturity of the processes within the organisation. To this end the tester must understand the basic models for the management of teams; the specific management of professional test teams; the role of independent testing and the independent test team; the problems of staff selection, the staff training needed, as well as the motivation and management of individual testers. The test professional must be well aware of the different skills that need to be present in a professional test team; the demands for accuracy by the test team and how this makes additional demands on management skills.

Communication is vital, and the testing professional needs specific interpersonal skills such as the giving and taking of criticism, written and oral skills, communications in meetings, creating reports of reviews and the general management of the tester-developer relationship. Occasionally there will be the resolution of conflict between the creator of a deliverable and the tester who finds faults in the deliverable. The professional will need methods for dealing with quality issues that vary from excellent to appalling as well as integrity and other demands made on him. There is always the problem of the professional tester in a particularly demanding assignment such as the testing of safety critical systems. There is the expectation that testers are honest, reliable, impartial, accurate, objective and thoroughly professional in the execution of the duties. There is also the issue of who tests the testers, as well as the social and work pressures on the tester who is forever finding faults in the work of others. Meetings are a particular problem and there will be specific testing meetings that the tester might organise, chair or be involved in. Politics will always be present and this has an impact on the work of the tester as well as the way he communicates the test progress to management.

Section 7: The principles and use of test tools

Professional testers should be up to date with current thinking on the use of tools to assist and support the testing effort. This will encompass the use of automation throughout the life of a system from project initialisation through to system disposal. Typically there will be tools for use at specification and design stages, tools for use at code development, tools for use on developed code or systems in current use and tools for use in the enhancement and maintenance of mature systems. There have been problems and disappointments with attempts at automation and the professional must be aware of the these problems. The typical problems that the professional will meet include wrong culture for the introduction of tools, tools introduced by so-called experts who do not really understand the principles of testing, too many tools, tools of the wrong type, tools introduced under sales pressure, tools introduced after superficial requirements analysis, unsuitable tools for the established mode of working and just occasionally too few tools so the tool set is incomplete. Tool implementation within the organisation must be done with regard to the maturity of the development processes, the maturity of the testing processes, the maturity of the organisation with regard to automation and the availability of support at critical times. The professional should understand how to provide continued support in the use of tools after tool introduction has been completed.

The professional should be able to conduct a comprehensive software test tool selection process; knowing what test activities are best done using tools as well as knowing the steps necessary to select tools and amendments of the selection process dependent on the size of organisation. The professional should know who to involve in the process and how to manage the tool selection team. The professional should be able to identify requirements, quantify current testing challenges, provide an analysis of whether tool support would help, able to explore different solutions to the problems and provide an assessment of the correct time to introduce a tool.

The test professional should understand how to establish a comprehensive approach to the building of a good automated testing regime using formal processes. The test professional must ensure that the test automation regime is well understood by all who will use it and that there is correct training in the regime and in the use of the tool and supporting processes.

There has to be the identification of constraints such as environment, commercial supplier considerations, costs, political aspects and quality of the tool, as well as an analysis of what can be economically built by existing developers. There must be an understanding that the internally developed task-specific tool may well be more beneficial than a general purpose and richly featured commercial product. The professional should know where to look for information, how to evaluate features and how to develop a short list. The professional should be able to perform a feature comparison and produce a tool evaluation report with reference sites and demonstration of the tool in use.

The professional should be able to make and present a business case for the tool, identifying the potential value of the tool and realistic costs as well as the problems and potential modes of failure.

The professional should be able to specify the roles in the tool implementation process: the champion, the change agent, the management sponsor, the tool custodian, the implementation team and their tasks. There are the other activities such as publicity and the planning of a pilot project. This is followed by the evaluation of the pilot project and the planning of the full implementation. There are other issues such as the interfaces to other systems, people issues and the time taken to achieve satisfactory integration within the established processes.

The professional will have the task of showing the increased benefit from the introduction of tools. He must therefore be aware that using test automation does not necessarily improve the quality of test, only the speed of execution. The emphasis must be on the introduction of techniques to improve the effectiveness as well the efficiency of the testing done.

Section 8: Test process assessment and improvement

Once the various tasks that testers carry out have been assembled into a defined process, the task of process improvement can be started. The test professional should therefore be aware of process improvement as a philosophy and be able to apply a generic improvement approach to the various testing tasks. Process improvement is done in order to modify both the effectiveness and the efficiency of the process being examined. Available to the professional are existing formal process improvement models such as CMM (Capability Maturity Model) and SPICE (Software Process Improvement and Capability dEtermination, the ISO/IEC 15504 standard). The professional should know how to extend CMM to a Test Process Maturity Model (TMM) and introduce test process improvement (TPI) as required.

Naturally there is a need for an initial assessment of the situation before a start on process improvement is made. It may even be that the professional tester needs to introduce a formal test process before improvement can be started. There are many models for process improvement available and we might use the following as an example:

- Identify test required and establish traceability
- Define strategy
- Plan coverage and completion criteria
- Analyse test object
- Design test
- Schedule test
- **Execute test**

Such a generic process is equally applicable to user acceptance testing and to one line changes of code in programs. It is essential to have processes established for the important system test, and of course integration and unit tests. Thus the testing professional needs to select a model that has a minimum the following:

1. Recording the test with a unique reference code. This code is used for many purposes including traceability to provide the link between the test and the justification for the test via business benefits and business risks, budget justification, status reporting, test scheduling and test execution.

2. Establishing a suitable strategy with overall completion criteria. This strategy may be specific to the particular test object, established for a particular project or project deliverables, defined at corporate level or even defined externally to the organisation and required for external compliance requirements such as with safety critical work. This strategy may cover many aspects including reporting and documentation.

3. Creation of a plan that is comprehensive and has a suitable level of detail including detailed completion criteria for the test in accordance with the strategy and overall completion criteria

4. Analysing what tests and testing methods can and should be used to meet the established completion criteria within the defined strategy. This analysis will establish the test conditions, that is those conditions that need to shown as true in order for each individual test to be considered complete.

5. Design the test to meet the planned test requirements. This covers selecting suitable test data with expected outcomes, defining the test environment, selecting tools and selecting test procedures suitable to carry out the execution of the test.

6. Scheduling the test once the test object is available. The schedule is established in the test plan but a good process will recognise that the actual assignment of test to test object and tester to carry out the test happens when the test object is declared ready for testing.

7. Executing the test as defined, analysing the outcome and recording the test status and the status of the test object.

The test process must include suitable status indicators at all stages and these will constitute the test progress reporting mechanism. It is well known that there is a chance that tests find defects and these defects may be fixed. The fix, once finished, results in the need for re-testing or even regression testing to be performed. This requirement for iteration means that the formal test process chosen must have suitable provision for repeating tasks within the process, especially scheduling and execution.

Once the selected process is in place the test professional at least has a process that can be improved if this is considered necessary. Before any improvement work starts the professional should establish a clear need for process improvement. This need should be expressed in measurable and auditable terms that are related to the current situation. The process improvement approach chosen must include mechanisms to assess the process modifications towards (or away from) the quantified goals. The professional will be the member of staff monitoring the testing process. This monitoring may be through the measurement of the issues raised and defects found as well as other means of monitoring the process.

Typically, once a system has been implemented, or a series of system modifications have been concluded, the management team will use the post implementation reviews to assess the processes used for the work done. It is during the post implementation review that management often choose to establish goals for process improvement. The process improvement goals may well extend to the test processes as well as the normal development processes. There is clearly a need for all project development and testing staff to be involved in process improvement and this may well need to be facilitated by the professional tester. The test professional is well placed to carry out this work as the tester will have documentation that identifies both the defects found (during development and operational use) as well as the source of the defect (the error made during a development process). Project metrics such as actual effort and elapsed time compared to estimates for effort required should be used. Typically project metrics cover defects found both in testing and in operational use as a basis for test and other process improvement work. The management team should create a formal action plan for process improvement and the test professional should be assigned the assessment of the testing process as part of general process improvement; all this requires management commitment. This initial assessment of current process capability provides a baseline against which changes to the process should be measured.

It will be obvious to all involved that there are many ways to solve a specific problem and hence the need to examine examples of the various approaches to typical test challenges. Each approach will include descriptions of the chosen solution(s), the actions needed by various people, an assessment of the political situations that might occur, the influence on budgets, influence on project time scales and changes in the use of resources.

Improvements in the testing process may be in the following areas: test traceability, specific test analysis and design work, specific test scheduling and execution activites, test tools, test platforms, test results analysis and test status recording and reporting. Improving the test process may also be achieved by improved management commitment as well as through skills development in staff involved, using courses on advanced test techniques appropriate to the work undertaken.

There will be an analysis of the impact of each potential solution on the full set of quantified goals. The management team will need to determine whether or not enough improvements have been identified to meet all the required goals and assess the impact of the chosen solutions. There is also the need for the prioritisation of solutions into short and long term action plans with the creation of recommendations for further investigation.

In general, specific actions will be assigned to individuals to carry out defined process improvements and monitor progress toward the defined goals. Roles and responsibilities may include a sponsor, a management team, software engineering and a software testing process team.

The professional will recognise the importance of feedback and hence will provide a summary of findings and recommendations to all those who contributed information and opinions to the assessment. Feedback for quantified objectives should include regular updates on progress made towards planned goals. If the impact of an implemented solution was less than expected the professional must provide a re-assessment of the process improvements planned. There may need to be a re-assessment of priorities based on what happened with previous process changes.

Feedback for suggested solutions and process improvement ideas should be given to those who raised the ideas. Progress reports should be created with sections devoted to the solutions that are being implemented, reasons and status for solutions that will not be implemented at this time, and reasons and justification for solutions that have been rejected.

The test professional will be aware that, to be effective, process improvements need to be seen to be implemented and it is not just the process documentation that needs to be updated. The professional should ensure that anyone affected by a process change should be informed and given training in the new process. The standard ISO 9000 and CMM level three and above both require that processes should be monitored and enforced. Process improvement is a never ending activity so the test professional needs to ensure that the test process improvement is not seen as a one-off event. Further improvement work for all testing activities should be planned. There are business benefits from continuous process improvement (CMM level five) and the test professional needs to be seen to play a part in this work.

Geoff Quentin, Technical Editor