A Framework for Managing Quality on System Development Projects

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Abstract--While project performance is generally evaluated in terms of the "iron triangle" of schedule, cost and quality performance, guidelines for project quality management are lacking. Practitioners developing complex engineering systems employ several *techniques* to manage quality but project management literature merely emphasizes quality management *processes* and provides few guidelines regarding appropriate techniques. Where these techniques are addressed, they tend to be borrowed from high-volume production and statistical quality control, while providing few guidelines for the management of quality on non-repetitive project endeavors such as system development. In this paper a framework for managing quality on system development projects is proposed.

The strong link between techniques for Project Quality Management and Project Risk Management is also highlighted.

I. INTRODUCTION

When project management took form in the 1950s the emphasis was mainly on scheduling and budgeting. In later decades project management drew increasingly from knowledge in a variety of other disciplines and project management has since been redefined to include knowledge areas such as human resource management, risk management, procurement management, communications management and quality management. In the early 1950s quality management was seen as merely screening or sorting of products that had already been manufactured to separate good ones from the bad and the emphasis has since changed to processes to prevent defects and failures. Several movements contributed to the development of quality management and one significant movement is Total Quality Management (TQM) that aims to improve the overall effectiveness and competitiveness of the organization. The Six Sigma movement that started in the 1980s provides a more structured approach than TQM.

The notion of 'project success' is somewhat vague and, despite much debate, no universally accepted set of criteria to measure project success exists. Project performance is therefore generally still evaluated in terms of the "iron triangle" of schedule, cost and quality performance [2]. Although quality is such a central element of project management, Kloppenborg & Opfer [17] reported that coverage of the topic of quality in project management journals was low during the period 1994 to 1998 and decreased even further during the period 1999 to 2003 while Crawford [10] also reported a decline in articles in project management journals that address quality management.

Different project types, and even different phases of a specific project, require different techniques or "tools". The objective of this paper is to address the neglected area of techniques for the management of quality on the early phases of projects to develop engineering systems.

In this paper the coverage of quality in project management literature is first described and then the application of statistical methods in managing project quality is discussed. This is followed by a proposed framework for the management of quality on system development projects. Finally one technique, Failure Mode and Effect Analysis (FMEA), is used to illustrate the relationship between project quality management techniques and project risk management techniques.

II. CURRENT FRAMEWORKS, STANDARDS AND TEXTS

A. Coverage of Project Quality Management in standards

The emphasis of current project quality management frameworks and standards is to a large extent on processes rather than on tools and techniques. Where tools and techniques are addressed in standards, material is often borrowed from high-volume production and, while these techniques do have some value, they are only applicable to certain types of project and are even limited to specific phases of those projects. In the case of system development projects, techniques mentioned in existing standards need to be supplemented by other techniques as discussed below.

The APMBOK [1] does not refer directly to any technique but does refer to some textbooks and to ISO standards. The British standards BS 6079:1996 [4] and BS 6079-2:2000 [5] mention configuration management that could be considered a quality management tool used on system development projects. These standards also mention some outputs of general project management methods such as the work breakdown structure but no further reference is made to tools or techniques that should be used specifically to ensure the quality of project deliverables. ISO 10006 [15] discusses project management processes, including processes such as scope development and control that are essential for project quality but there is no explicit reference to techniques that could be used to promote and ensure quality on projects. ISO 9001 [14] is a well-known guide for the establishment of process-based quality management systems in general but does not address project management specifically.

TABLE 1: PROJECT QUALITY MANAGEMENT TOOLS AND TECHNIQUES MENTIONED IN PMBOK [23]

Quality Planning	Quality Assurance	Quality Control
Cost-benefit analysis	Quality planning tools and techniques	Cause and effect diagram
Benchmarking	Quality audits	Control charts
Design of experiments	Process analysis	Flowcharting
Cost of quality	Quality control tools and techniques	Histogram
Additional quality planning tools		Pareto chart
		Run chart
		Scatter diagram
		Statistical sampling
		Inspection
		Defect repair review

The *processes* described in the PMBOK Guide [23] are useful and generically applicable to most projects. The *tools* or *techniques* mentioned for project quality management are listed in Table 1 and discussed later on in this paper.

B. Coverage of Project Quality Management in textbooks

In Table 2 some well-known textbooks are listed and comments made on their coverage of project quality management in general and of techniques specifically.

The book by Milosevic [17] justifies some discussion. In a chapter on quality planning he discusses the flowchart technique and indicates project phases and decision points in the project management process. He also discusses the affinity diagram that can be used to identify the key issues of a project. In a second chapter on quality control he discusses the quality improvement map (a systematic approach to problem solving and quality improvement), the Pareto chart, cause-and-effect diagrams and control charts. Some of these techniques, including Milosevic's use of the Pareto diagram, are addressed later on in this paper.

In addition to general project management texts such as the ones referred to above, the author is aware of two books that address Project Quality Management as the central theme. The first of these books, by Kloppenborg and Petrick [18], provides a useful overview of generic Project Quality Management under the headings of *Introduction to Project Quality Management, Project Quality Initiation, Project Quality Planning, Project Quality Assurance, Project Quality Control, Project Quality Closure,* and *Summary and Challenges*. These authors address the quality management philosophy and process comprehensively and discuss some techniques such as control charts, house of quality, Ishikawa diagrams and Pareto diagrams.

The second book by Carruthers [6] introduces the subject of quality in the context of projects, including the application of the principles to system design and development. He focuses on engineering projects, provides ample case studies and describes "tools for quality in projects" such as auditing, training, statistical quality control techniques, quality plans, inspection and testing, non-destructive examination, document handling and control as well as benchmarking. Some of these tools (or techniques) are incorporated in the framework proposed below.

Coverage of project quality management techniques in some textbooks is more comprehensive than in standards and address the general quality management approaches and philosophies but provides only limited guidance regarding techniques that could be used to manage quality on projects, specifically projects aimed at developing new engineering systems.

TABLE 2. COVERAGE OF PROJECT QUALITY MANAGEMENT IN SOME GENERAL PROJECT MANAGEMENT BOOKS

Authors	Title	Reference	Chapter included in text?	Comments on discussion
Cleland D I & Ireland L R	Project Management – Strategic Design & Implementation, 4th Ed.	[7]	No	No discussion.
Clements J P & Gido J	Effective Project Management	[8]	No	No discussion.
Gray & Larson	Project Management – The Managerial Process, 3rd Ed.	[12]	No	Only two paragraphs on quality.
Kerzner H	Project Management – A Systems Approach to Planning, Scheduling & Control, 8th Ed.	[16]	Yes	Elaborates on several tools mentioned in the PMBOK Guide and also discusses aspects such as quality circles.
Maylor H	Project Management, 3rd Ed.	[19]	Yes/No	One chapter covers both Cost & Quality Planning. No techniques mentioned.
Meredith J R & Mantel S J	Project Management – A Managerial Approach. 6th Ed.	[20]	No	No discussion.
Milosevic D	Project Management Toolbox – Tools and Techniques for the Practicing project Manager.	[21]	Yes	Two full chapters
Reiss G et al	Gower Handbook of Programme Management	[24]	Yes	Chapter on programme assurance and quality addresses higher-level assurance and includes programme audit
Shtub A et al	Project Management – Engineering, Technology, and Implementation	[26]	No	12 pages. Mainly principles of approaches by Deming, Juran, Crosby.

III. USE OF STATISTICAL METHODS IN PROJECT MANAGEMENT AND PROJECT QUALITY MANAGEMENT

As indicated earlier in this paper, statistical methods are emphasized in project management standards. Statistical methods find wide application in project management in general and also have value in project quality management. Examples of application of statistical and probabilistic methods to project management in general (as opposed to Project *Quality* Management specifically) include for example:

- The PERT method of analyzing project schedules (a stochastic approach that takes statistical variability of activity durations into account)
- Analysis of risks (based on probabilities of occurrence of risk events)
- Statistical methods such as statistical sampling, scatter diagrams, run charts (line graphs to indicate trends) and control charts are also used to track project *costs* and *progress*. A plot of cost or schedule index, for example, is a run chart. These statistical methods are useful to assess and improve the stability of project management processes.

In many instances statistical methods are also useful in Project Quality Management. Statistical sampling, scatter diagrams, run charts and control chart techniques are of use for example to control the quality of weld joints and the quality of concrete cast on large construction projects. Furthermore, these techniques are useful in projects where the objective is to develop systems for high-volume production – be it of items manufactured in high-volume batch production such as coins or ammunition or of continuously produced products such as chemicals.

In the TQM movement the application of statistical process control methods was found to reduce variability inherent to a process and also to lead to an improvement in the mean performance of the process [9]. As Project Quality Management originated from the TQM movement, authors tend to emphasize statistical process control methods and neglect other useful methods.

A project is, by definition, a once-off endeavor and in general many aspects of a project can obviously *not* be assessed statistically. The techniques mentioned above are therefore of limited value to manage quality in many projects. In the case of projects to design and develop engineering systems, several other techniques are generally used. Technical performance measurement (TPM) for example is a well-known technique that is much more appropriate to assess quality on system development projects than the overemphasized control chart but is unfortunately not yet mentioned in standards related to project quality management and is also underemphasized in other project management literature. Histograms including Pareto charts are useful but the example of a Pareto chart in the PMBOK Guide [23] lists types of defects on the x-axis and the frequency of occurrence (number of defective cases) on the y-axis. This is obviously borrowed from high-volume production as most projects would not have such high incidences of any defect. Milosevic [17], however, uses the X-axis of the Pareto diagram to describe different types of quality problems while Kloppenborg and Petrick [18] use the X-axis of the Pareto diagram to describe "data collected". Unlike the PMBOK standard [23], these authors therefore expand the use of the diagram from analysis of defects (that is typical of operations management environments) to be more useful on most types of project.

While the statistical techniques are sometimes useful during the *construction* of a large system, they are largely irrelevant during the early phases of the same project. Ironically, quality is normally primarily determined during the early stages of a project.

Design of experiments is described in the PMBOK Guide [23] as a "statistical method that helps identify which factors may influence specific variables of a product or process". Modeling (including experimental models, prototypes, pilot plants, computer simulation models, three-dimensional scale models, full-scale models and mathematical models) is a much wider concept and is much more widely used in the development of engineering systems but is unfortunately not yet recognized in PMBOK Guide [23] and other standards.

Flowcharts are used to indicate the steps in a procedure and their relationships and are commonly used in project management – a project schedule network diagram is one example. Flowcharts have some application in project quality management for example when a process has to be developed but, as in the case of the statistical methods, the use of flowcharts in project quality management in general is relatively limited.

As discussed above, coverage of techniques for project quality management in standards is unsatisfactory. Better coverage of quality management techniques for projects in general is conceivable but the framework proposed in this paper is limited to techniques for managing quality on projects to develop engineering systems.

IV. PROPOSED FRAMEWORK FOR SYSTEM DEVELOPMENT PROJECTS

As indicated above, project quality management involves approaches or philosophies, processes and techniques to ensure and improve quality. The philosophies as well as the processes are described well in literature. Techniques to manage project quality have however not received the same attention and where techniques are addressed, the emphasis is mainly on statistical process control. In this section a framework of project quality management techniques is proposed. The framework includes statistical process control techniques but also incorporate a variety of other techniques that are often used by practitioners.

Management is to a large extent planning and control. Therefore, one would expect project quality management to also address these two elements. Quality Assurance (QA) is sometimes seen as a comprehensive program which includes both planning and quality control [23]. The view taken in this paper is however to define Quality Planning, Quality Assurance (QA) and Quality Control (QC) according to the Shewhart cycle or Plan-Do-Check-Act cycle [11]. QA is defined as the "Do" element and QC as the "Check-Act" elements. Project Quality Management thus comprises of three elements: Quality Planning, Quality Assurance (executing the plan) and Quality Control (QC) as illustrated in Figure 1. QC is the process of ensuring that Quality Assurance corresponds with the plan and in Figure 1 QC overarches Planning for Project Quality and QA to illustrate this relationship.

If QA is the "healthy lifestyle" to prevent nonconformities, QC is seen as checks to verify that the healthy lifestyle is pursued as well as the "medicine" to eliminate (or preferably to prevent) defects and other nonconformities when the healthy lifestyle proves insufficient.

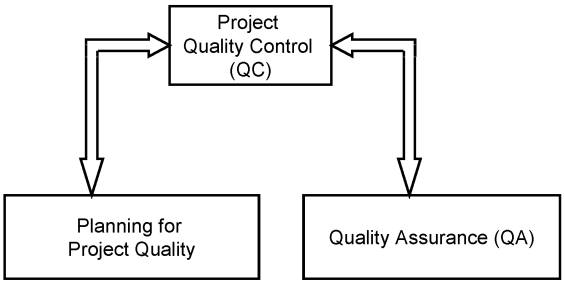

Figure 1. Quality Management Processes

A. Project Quality Planning

Quality planning should include decisions regarding actions required to meet quality requirements and the planned quality actions often entail the use of specific QA and QC techniques. The QA and QC techniques therefore need to be decided upon during quality planning. In the case of projects to develop new systems, Project Quality Planning involves decisions regarding:

- Requirements that need to be met (as embodied in agreed specifications and standards), including benchmarking against other projects.
- Actions required in the overall project plan to meet the required specifications and standards, including the tools and techniques that would be used in QA and QC.
- Metrics to be used to determine whether the specifications and standards have been met.

It is important to note that quality activities should form a well-integrated part of the overall project plan. They are not being planned in isolation by some quality manager, but rather by the whole project management team. Quality activities are also typically executed by the majority if not all of the project team members, not just by staff from a Quality Division.

Another facet of Quality Planning is decisions on how the individual project under consideration could aid the continuous improvement of company-wide policies and procedures to enhance company-wide quality. Project work related to continuous improvement is addressed by the QA aspects discussed next.

B. Quality Assurance

QA is not only required on each individual project to ensure compliance with requirements, a second element is inter-project continuous improvement that is facilitated by systematic project close-out. Hence, in a project environment, QA consist of *Project Quality Assurance* plus *Continuous Improvement.* While QA on a project is concerned with a specific project only, continuous improvement improves the organizational competence to manage projects and advances the maturity of project quality management. The framework in Figure 1 is therefore extended to indicate the two elements of QA as indicated in Figure 2.

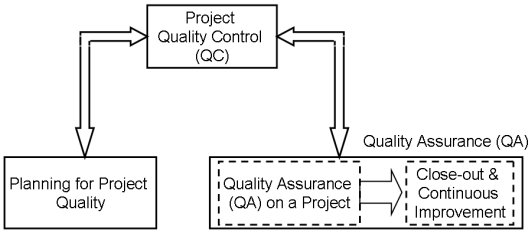

Figure 2. Four elements of the project quality management process

Lessons learned during close-out of an individual project should contribute to the company-wide project management policies and procedures. The requirements for a company-wide quality management system are described in ISO 9001 [14]. The modern way is to integrate company-wide project management policies and procedures into a project management methodology. Each phase and eventually the project have to be closed out. During close-out meetings the lessons learned (about successes and failures) should be analyzed and documented. Close-out meetings and close-out reports are important ways of ensuring that the planned quality requirements have been met. The reports also serve as guidelines for future projects and thus contribute to continuous improvement.

Tools for close-out and continuous improvement include:

- Project close-out meetings where lessons learned are acknowledged and documented
- Close-out meetings of project phases, similar to the final project close-out meeting
- Reports resulting from the close-out meetings
- Reports on non-quality costs, i.e. costs associated with nonconformities such as the cost of scrap, rework, retest, replacements, warranty repairs, liability, and lost sales as a result of a damaged reputation

- Reports reviewing defects describing the nature of the deficiency uncovered and the steps required to repair or replace the item.

The above tools address the continuous improvement aspect of QA while the following tools and techniques can be used for QA on a specific system development project:

- Authorization of project and kick-off meeting
- Authorization of individual project phases
- Configuration management system
- Configuration identification
- Quality function deployment
- The house of quality
- Design reviews
- Audits
- Classification of characteristics
- Failure mode and effect analysis (FMEA)
- Modeling and prototyping (including laboratory tests and other experiments)
- Technical performance measurement (TPM)
- Inspection
- Checklists
- Training of project team members

The above techniques are described in more detail elsewhere [22] and are discussed only briefly below.

Authorization: A project should be authorized only after feasibility studies have indicated that, amongst other criteria, the risk of not meeting the required quality is tolerably low. Development of systems is performed in phases, typically Pre-feasibility, Feasibility, Concept Design, Detail Design, Construction or Manufacturing, Commissioning and Handover Phases. A central tenet of risks reduction and of quality management is that cost increases drastically over from the early stages to the Construction/Manufacturing phase and that the successful completion of each phase contributes to reducing the risk (including quality risks) of later phases. Setting of criteria for authorizing work on each project phase is therefore an important aspect of Project Quality Planning. Each individual phase has to be authorized and when the key stakeholders are satisfied that appropriate detailed plans, including a quality plan for the phase, exists. During kick-off meetings of a project or a project phase the planned quality requirements should be emphasized.

Configuration Management is a set of policies and procedures to manage the physical and functional attributes of a system. It includes configuration identification to define the configuration of the system and control aspects to manage and keep track of changes in the planned configuration. While configuration identification procedures should form part of QA, the elements of configuration relating to control could be considered as QC elements.

Quality Function Deployment (QFD) is a technique to define customers' technical requirements and to keep the project team focused on these by integrating cross-functional project teams and activities [3] while the *House of quality* is used to convey the means by which the system under development will meet the specified requirements [13].

Design reviews (not to be confused with general project reviews) are used at various stages of system development to ensure that requirements have been correctly identified and that a proposed design will meet the requirements [22].

Unlike design reviews that are restricted to the validation of designs, a*udits* are used to verify that management processes and technical process (such as manufacturing processes) comply with prescribed processes, procedures and specifications. While *inspections* are often used as quality control tool during final acceptance, inspections could form part of audits and to ensure that specific components meet requirements before they are integrated into the larger system.

As a result of the Pareto principle, a relatively small number of characteristics can be expected to have a major effect on the quality of a system. Limited resources should therefore be applied to these "critical few" and *Classification of Characteristics* is a technique that provides guidelines to achieve this.

Failure Mode and Effect Analysis (FMEA) is a technique to determine in what ways a system might fail as well as what the effect of the potential failures might be. This technique is described in more detail later on in this paper. FMEA provides inputs to classify characteristics.

Modeling and prototyping: System developers use a variety of models such as experimental models, prototypes, pilot plants, computer simulation models, three-dimensional scale models, full-scale models and mathematical models that simulate aspects of the system under development to reduce the risk of quality failures [22]. Modeling and prototyping provide estimates for Technical Performance Measurement (TPM).

Technical Performance Measurement (TPM): Progress in performance measures (such as the power that would be generated by a fourth generation nuclear power plant under development or the weight and acceleration of a new vehicle) are tracked by means of TPM. Progress to date or current performance as well as technical performance at project completion are estimated and compared to specified requirements.

Checklists are often used to record perceived quality risks and quality problems that had been experienced on prior projects.

Training in all the above techniques as well as in project-specific technology and company-specific procedures and processes obviously forms an important part of QA.

C. Project Quality Control

Two facets of project quality control are planned QC work and ad hoc problem solving. Planned QC work consists of activities that can be planned to a relative level of detail beforehand. Ad hoc problems are obviously unforeseen hitches, and contingency reserves in budgets and schedules

should make provision for activities to investigate and rectify such problems. QC activities include:

- Configuration control (mentioned earlier)
- Inspections on the product and its components at different stages and defect reporting
- Acceptance testing and final inspection of samples or, for example in the case of brake systems of heavy vehicles, on all systems produced. In many instances inspections form part of acceptance testing.

Ad hoc problem solving includes the investigation and handling of all nonconformities that are discovered and includes a variety of problem solving methods. Ishikawa diagramming is a cause-and-effect technique commonly referred to in project quality management literature. It should however be noted that at least two other types of cause-and-effect diagrams exist, namely causal loop diagrams [25, 28] and current reality trees [27]. The Ishikawa diagram is the simplest of the three types and is often adequate to analyze a simple quality problem. As the name indicates, causal loop diagrams make provision for complexities of loops of causes that affect one another positively or negatively. Causal loop diagrams are used in computer simulations of complex problems. Current reality trees apply "hard logic" by addressing the sufficiency of causes to lead to specific effects. These diagrams also form one element of the Theory of Constraints Thinking Processes problem solving method.

D. The Proposed Framework

The proposed framework is summarized in Figure 3.

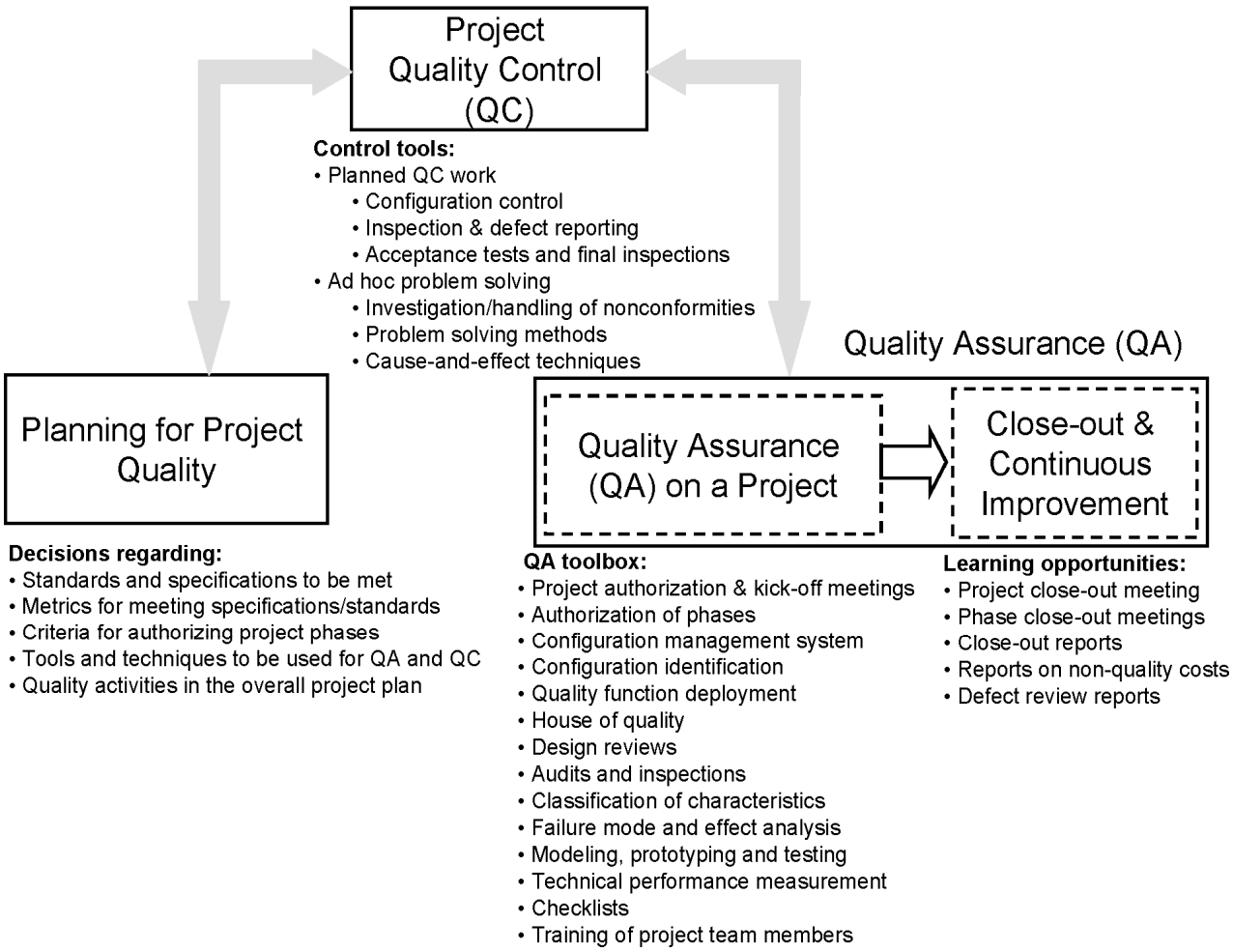

Figure 3. Proposed quality management framework for system development projects
Adapted from Nicholas and Steyn [22]

V. PARALLELS BETWEEN PROJECT QUALITY MANAGEMENT AND PROJECT RISK MANAGEMENT

Project Quality Management has to do with avoiding and mitigating the threat of defects and exploiting the opportunities of improving processes and products. Likewise, Project Risk Management is concerned with coping with threats and the exploitation of opportunities. Quality management is limited to risks related to the deliverable or product such as the risk of technology not being appropriate and the risks of the end item or process not being producible, reliable, and testable. Risk management, on the other hand, addresses a variety of other, "non-technical" risks as well. These typically include the risks related to delays, overspending, negative side-effects caused by the project and changes in the business environment (e.g. market conditions, competitor actions, changes in government regulations and changes in exchange rates). Poor quality is however sometimes the root cause of other issues such as delays and cost overruns.

Several *principles* apply equally to both risk management and quality management and certain *techniques* are also suitable to be used in both these knowledge areas. Examples include the Pareto principle, cause-and-effect diagramming and statistical methods.

Failure mode and effect analysis (FMEA) is one example of a technique that illustrates the similarities between quality management and risk management. This technique is limited to the analysis of the risk of technical system failures, but the process corresponds well with the general risk management process as illustrated in Table 3. It is clear that this so-called quality management technique addresses technical risks while the typical risk management method has a wider scope and addresses non-technical risks as well.

TABLE 3. THE QUALITY MANAGEMENT TECHNIQUE, FMEA, ILLUSTRATES SIMILARITY WITH RISK MANAGEMENT (ADAPTED FROM TUTOR MATERIAL OF [22])

Risk management element	Corresponding element of FMEA
Identify risks Uses methods such as brainstorming, the WBS and cause-and-effect diagramming.	Identify risk of failures of equipment. Methods: List components and identify possible ways in which the components or the system might fail. Also uses methods such as brainstorming, the Hardware Breakdown Structure and cause-and-effect diagramming.
Assess risks Evaluates the likelihood of occurrence of a *risk event* and the impact of an occurrence. Combines likelihood and impact to rate the risk consequence or risk exposure. Often ranks the risks.	Evaluates the likelihood of occurrence of a *technical failure* and the impact of an occurrence. Combines the likelihood and the impact to rate the criticality (consequence or risk exposure). Often ranks the potential failures.
Plan responses to risk events with a relatively high consequence. A variety of different responses exist, including avoidance and reduction of either the likelihood or the impact.	Plan how to respond to the failures with a relatively high criticality (consequence). The main responses are (a) total avoidance of the failure and (b) reduction of either the likelihood or the effect (impact).
Track and control risks	FMEA focuses more on the analysis steps but it goes without saying that the analysis is not an end on its own – it is done so that actions will be taken and these actions have to be monitored and controlled.

Not only FMEA, but also other techniques mentioned above contribute to risk management. Both FMEA and design reviews are used to identify technical risks (that might lead to commercial, environmental and other risks). The use of prototypes and models as well as the contributions that close-out meetings make to continuous improvement are often considered aspects of quality management though it also contributes to the reduction of technical and other risks.

It therefore seems reasonable to state that, although Project Quality Management is a specialized field, it can be considered a subset of Project Risk Management.

The interactions between quality and risk management stress the importance of *integrated project planning*. Not only should quality planning fully integrated with risk planning, it should also be integrated with other areas of planning such as for procurement, human resources, and communications. All these elements of the integrated project plan should be included in the project scope and WBS and provided for in the project schedule and budget. During project control the interrelatedness of the different disciplines should also be taken into account.

VI. CONCLUSION

While performance regarding project quality, time and cost are the most common criteria for assessing a project, Project Quality Management is a much neglected aspect in journal papers. Standards provide generic processes for project quality management and for organization-wide quality management systems but coverage of appropriate techniques is unsatisfactory. While the philosophies and processes described in literature might be universally applicable, the techniques described in standards and textbooks are mainly borrowed from high-volume production and their use is limited to specific phases of certain types of project. In the case of projects to develop engineering systems, the techniques described in standards and textbooks can be

supplemented by a variety of other techniques. In this paper these techniques are integrated into a useful framework.

Project Quality Management cannot be divorced from other aspects of project management. The failure mode and effect analysis technique is an example that illustrates the strong relationship between project risk management techniques and project quality management techniques.

REFERENCES

[1] Association for Project Management; *Project Management Body of Knowledge*, 4th Edition, Cambridge, UK: APM, 2000.

[2] Atkinson, R.; "Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria," *International Journal of Project Management,* vol. 17, no. 6, pp. 337–342, 1999.

[3] Bounds, G., Yorks, L., Adams, M. and Ranney, G.; *Beyond Total Quality Management.* New York: McGraw-Hill, 1994.

[4] British Standards Institute; *BS 6079:1996. Guide to Project management.* London: BSI, 1996.

[5] British Standards Institute; *BS 6079-2:2000. Guide to Project management – Part 2: Vocabulary.* London: BSI, 2000.

[6] Carruthers, M. C.; *Principles of Management for Quality Projects.* London: International Thompson Press, 1999.

[7] Cleland, D. I. and Ireland, L. R.; *Project Management – Strategic Design & Implementation*, 4th Edition. New York: McGraw-Hill, 2002.

[8] Clements, J. P. and Gido, J.; *Effective Project Management.* Mason, OH, USA: Thompson South-Western, 2006.

[9] Cooke-Davies. T. J., Schlichtler, F. J. and Bredillet, C.; "Beyond the PMBOK® Guide," *PMI Annual Seminars and Symposium,* Nashville, TS, 2001.

[10] Crawford, L.; "Uncovering the trends in project management: Journal emphases over the last 10 years," *International Journal of Project Management* vol. 24, pp. 175–184, 2006.

[11] Deming, W. E.; *Out of the Crisis*. Cambridge, MA: MIT Center for Advanced Engineering Study, 1986.

[12] Gray, C. F. and Larson, E. W.; *Project Management – The Managerial Process*, 3rd Edition. New York: McGraw-Hill Irwin, 2006.

[13] Hauser, J, and Clausing, D.; "The house of quality", *Harvard Business Review,* pp. 63–73, May-June 1988.

[14] International Systems Organization; *ISO 9001, Quality management systems – Requirements*, 3rd Edition, Geneva, Switzerland: ISO, 2000.

[15] International Standards Organization. *ISO 10006, Quality management – Guidelines to quality in project management*. Geneva, Switzerland: ISO, 1997.

[16] Kerzner, H.; *Project Management – A Systems Approach to Planning, Scheduling & Control*, 8th Edition. Berea, OH: John Wiley & Sons, Inc. 2003.

[17] Kloppenborg, T. J. and Opfer, W. A.; "The current state of project management research: trends, interpretations, and predictions, *Project Management Journal,* vol. 33, no. 2, pp. 5-18, 2002,

[18] Kloppenborg, T. J. and Petrick, J. A.; *Managing Project Quality*. Vienna, Virginia: Management Concepts, 2002.

[19] Maylor, H.; *Project Management*, 3rd Edition. New York: Prentice-Hall, 2003.

[20] Meredith, J. R and Mantel, S. J.; *Project Management – A Managerial Approach*. 6th Edition. New York: Wiley, 2006.

[21] Milosevic, D. Z.; *Project Management Toolbox – Tools and Techniques for the Practicing project Manager.* Hoboken, New Jersey: John Wiley & Sons, 2003.

[22] Nicholas, J. M. and Steyn, H.; *Project Management for Business, Engineering and Technology.* London: Butterworth-Heinemann, 2008.

[23] Project Management Institute; *A Guide to the Project Management Body of Knowledge,* 3rd Edition, Pennsylvania: PMI, 2004.

[24] Reiss, G., Anthony, M., Chapman, J., Leigh, G., Pyne, A. and Rayner, P.; *Gower Handbook of Programme Management.* Hampshire, UK: Gower Publishing Company, 2006.

[25] Sherwood, D.; *Seeing the forest for the trees – a manager's guide to applying systems thinking.* London: Nicholas Brealey Publishing, 2002.

[26] Shtub, A., Bard, J. F. and Globerson, S.; *Project Management – Engineering, Technology, and Implementation,* Upper Saddle, NJ: Prentice-Hall, 1994.

[27] Steinkopf, L. J. *Thinking for a Change – Putting the TOC Thinking Processes to Use*, New York: St Lucie Press, 1999.

[28] Sterman, J. D. *Business dynamics: Systems Thinking and Modeling for a Complex World,* New York: McGraw-Hill, 2000.

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