Audit system: Concepts and practices

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ABSTRACT *With the introduction of ISO 9000 and ISO 14000 registration schemes in the past decade and a half, the application of quality and environmental audits has soared. Namely, the audits are used to verify compliance of quality and environmental management systems with the ISO standards. However, concerns have been raised in recent years about the usefulness of such an application for continuous business improvement, inconsistencies of audit processes and results, and the value of compliance audits in understanding complexities of business systems. In order to address concerns of a like kind, this paper advocates the implementation of the systems approach in auditing. The purpose is twofold. Firstly, it is to illustrate how various interrelationships among audit elements essentially form a unique, underlying, integrated and generic audit system. Secondly, the paper addresses the advantages of using the systems approach in auditing. This includes a more dynamic and adaptive audit, harmonization and integration of discipline-specific audits and corresponding audit guidelines, as well as a sound conceptualization of audit quality, reliability and maintainability.*

Introduction

As we are entering the 21st Century, there is much debate in quality auditing circles about the role and purpose of audits in the overall quality management movement. Questions are being raised about the usefulness of audits for quality improvement, the need for external registration of quality systems using third-party audits, as well as the integration of quality with environmental, health and safety, and financial audits. While everyone seems to agree that audits should be applied as a continuous improvement tool (e.g. see Burr, 1997; Hunt, 1997; Karapetrovic & Willborn, 1998a; Russell & Regel, 1996; Willborn & Cheng, 1994), the actual application is quite treacherous. In other words, easier said than done. As Russell (1997) would put it, "somewhere between the delivery of the auditor's product, and the customer's use of the product, there is a breakdown".

This breakdown is aggravated by a widespread belief among auditors and their clients that audits are simply to verify compliance with agreed standards, without assessing the suitability of these standards or the effectiveness of the quality system to meet quality objectives (Beeler, 1999). Unfortunately, such an anachronistic belief leads us back to the

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'good part–bad part' quality control of the 1920s, where the auditor solely passes a judgement whether a quality system conforms (or not) to the specified standard, and gives the reasons for the judgement. When the time for the next audit comes, the same standard is used. This resembles a high jump competition where everyone repeatedly jumps over a bar set at a constant (low) height. But in the meantime, the standard might have been changed. Moreover, the bar, meaning the audit demands/requirements, is not necessarily raised. In order to improve, the bar must be raised, meaning the standards must be changed and improved. However, international standards take a very long time to change (about 5 years), and some companies cannot wait that long. Pair this with the high cost of multiple-facility registration, and it comes as no surprise that over 50 large multinational companies have decided to declare self-compliance to the ISO 9000 international standards by the year 2005 (Zuckerman, 1999a). Their message is simple: "If we only need to comply, we don't need external auditors to tell us that. We are in the business of improvement, and not blind compliance". In a well-planned and managed audit system, a competent auditor must strive to identify improvements. As Jay Bigler, Quality Manager of an American Manufacturer of industrial pumps states; "The auditors are excited about being actively involved in the improvement process" (Zuckerman, 1996b).

Particularly scrutinized are the close relationships that quality audits share with quality assurance schemes, such as the world-renowned ISO 9000 standards. Although quality auditing is not a new discipline, dating back to the 1960s, most organizations have encountered quality audits only during or after the introduction of ISO 9000 quality systems. In that respect, audits have 'caught' and are still riding the 'ISO 9000 wave' in quality assurance. Soon after the first edition of ISO 9000 series in 1987, an international quality auditing guideline was approved (ISO 10011: 1990). In a parallel, yet closely linked process, both the quality assurance and quality auditing standards are being revised at the international level under the guidance of the International Organization for Standardization. Recently, however, this process has taken a new turn. There have been many calls from industry to attempt harmonization and integration of quality and environmental management systems, as well as the respective audits (Karapetrovic & Willborn, 1998b; Wilkinson & Dale, 1999). And while the auditing side seems to be moving in that direction (ISO committees are currently working on a new integrated audit standard), there are currently no plans to merge the management system standards, namely ISO 9001 and ISO 14001. The dichotomy becomes apparent: in the past, audits have been 'dragged' by corresponding management systems. Now, the opposite is happening.

The questions and pressures keep mounting. How will integrated audits work in a non-integrated environment of quality and environmental management systems? Should quality audits follow the 'compliance only' scheme entrenched in the current ISO 14010/11/12 environmental auditing standard, even if it means reducing the leverage for quality improvement? How will sets of quality and environmental audits (also called audit programmes or cycles) be managed? How will quality audits fit the new 'process' model of the year 2000 revision of the ISO 9000 standards? In other words, should the audits be conceptualized using the same process model, or should they remain with the old 'content' model structure of the ISO 9000: 1994 standards?

As we can see from the above, most of the questions really relate to the lack of a proper conceptualization of audits and management systems, and misunderstandings of the links between them. This paper attempts to answer these questions, i.e. provide an insight into the conceptualization and interrelationships of audits and respective management systems, using the systems approach. It is argued that a quality audit must be seen as a system itself, and a part (or a subsystem) of the quality management system, which is a subsystem of the generic management system.

Systems approach to auditing

"Auditors must raise their sight and skills to focus on systems ... Auditors must escape the narrow, and largely self-imposed, confines of compliance auditing" (Beeler, 1999). Do auditors in general know what is meant by the term 'system'? Quality auditors surely understand the 'Quality Management System', as it is described in the current ISO 9000 documents. But this is a mere description rather than an explanation and application of the actual concept and model of a 'system'. Such a narrow approach, however, has been changed in the revised ISO 9001: 2000 document, where a process model has been implemented as a major improvement. The process model is basically identical with a system model, as a 'system' is a set of interdependent, goal-oriented and driven processes and related resources (Karapetrovic & Willborn, 1998c). If auditors must focus on the management system, and must determine, through an audit, both its compliance to audit criteria and possible improvements, it stands to reason that they have a clear grasp of the concept and reality of a system. Moreover, the auditors must recognize any audit as a system in order to perform the audit properly and reliably. The systems approach will help auditors and all participants in an audit to overcome current inconsistencies of audit results and many other complaints rendered against such audits (Bishara & Wyrick, 1994; Hirzel, 1998; Stratton, 1995).

Although "virtually anything and everything in our real or conceptual world can be perceived as a system, or at least as a part of one" (Karapetrovic & Willborn, 1998c), an audit cannot be conceptualized as a system unless we understand:

- Different interconnections among its elements.
- Its place among related supersystems and subsystems.

The first condition is a consequence of the fact that every system must have a purpose, or an 'emergent property', that a simple collection of its elements would not be able to provide (Harrington *et al.*, 1999). Without an audit plan and some understanding of what they are supposed to do, a group of auditors armed with checklists and digital cameras cannot be branded an audit system. Therefore, the constituting system elements must be somehow interrelated. Secondly, a system does not stand alone in the universe. It is connected to other systems that exist beyond the system's boundaries, and can be at the same complexity level as the original system, superior or inferior in the hierarchy. For instance, a quality management system is superior to the internal quality audit system, which in turn consists of a set of individual quality audits.

Figure 1 illustrates the application of the systems approach to explain the hierarchy of different systems related to auditing, as well as the interrelationships among the elements of such systems. The management system, which can be defined as a set of interdependent directing, organizing, planning, controlling and improvement *processes* that function harmoni- ously, using human, material and information *resources* in order to achieve set management *objectives* (Karapetrovic & Willborn, 1998c), is placed at the top of the hierarchy. If the objectives relate to the quality of product or service, we can refer to this system as a 'quality management system'. On the other hand, if the objectives are mainly to improve safety performance, or to control environmental impacts, then safety and environmental manage- ment systems are conceptualized. An organization can also design and maintain integrated management systems that are able to manage several aspects, such as product/service quality, environment, occupational health and safety (OH&S) and social responsibility, in a simultaneous fashion. Regardless of the specific management aspect, a management system is a complex whole of many elements that can be systems themselves. These subsystems are assigned specific objectives and goals that relate to the global objective of the management
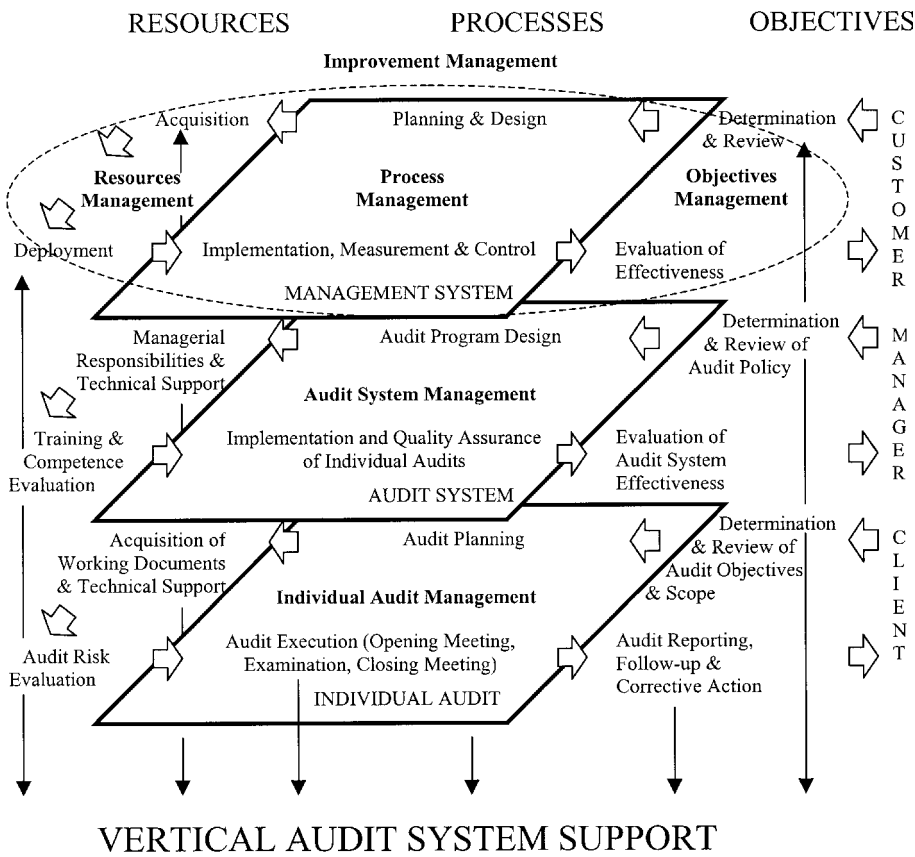
Figure 1. *Hierarchical view of audit-related systems.*

system. For instance, in a quality management system, the role of determining and reviewing customer requirements for a product or service is usually assigned to the marketing function (or subsystem), product and process design is the responsibility of the engineering system, and so on (Fig. 1). Likewise, the roles of assessing and examining the management system for its suitability to meet objectives and its compliance with relevant benchmarks and standards are given to the audit system.

In an identical manner in which a management system is planned, designed and improved, the audit system (Fig. 2):

- Determines the overall audit policy and objectives.
- Transforms the policy and objectives into a meaningful programme of individual audits.
- Acquires and deploys the required auditors, hardware, software and infrastructure resources.
- Performs and assures the quality of individual audits.
- Assesses its effectiveness in meeting the audit policy, including the required policy changes.

Analogous to a management system, an audit system can focus on a particular discipline-specific audit only (e.g. quality or environmental audit), or can embrace several types of audit
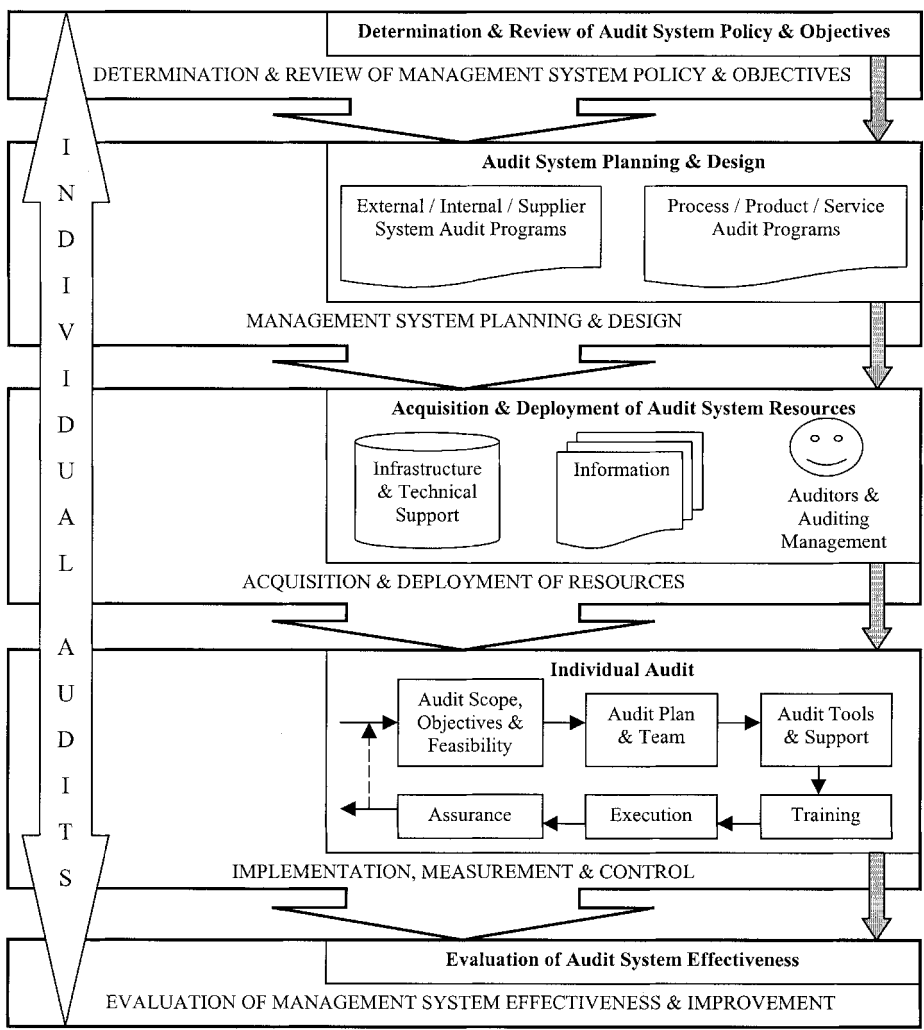
Figure 2. *Sequential interrelationships among the audit-related systems.*

programmes in a more generic and integrative approach. For instance, large organizations commonly manage internal and external audit programmes, as well as quality, environmental, OH&S, accounting and other discipline-oriented programmes. On the other hand, many a small business today manages only an internal quality audit programme for the purposes of ISO 9000 registration, while some have recently ventured into environmental assessments in accordance with the ISO 14000 standards. Regardless of the size of the organization, the extent of auditing activities carried out in it, or the hierarchical level (management system, audit system, individual audit: Fig. 1), understanding that an audit is a system is of the utmost importance.

Continuing top down in the hierarchy, the systems view applies in the same manner to the individual audits as it does to an audit programme, or an underlying audit system. Various interrelated auditing processes, such as audit planning, resource allocation (including auditor competence), as well as the actual auditing and reporting of audit results, comprise an
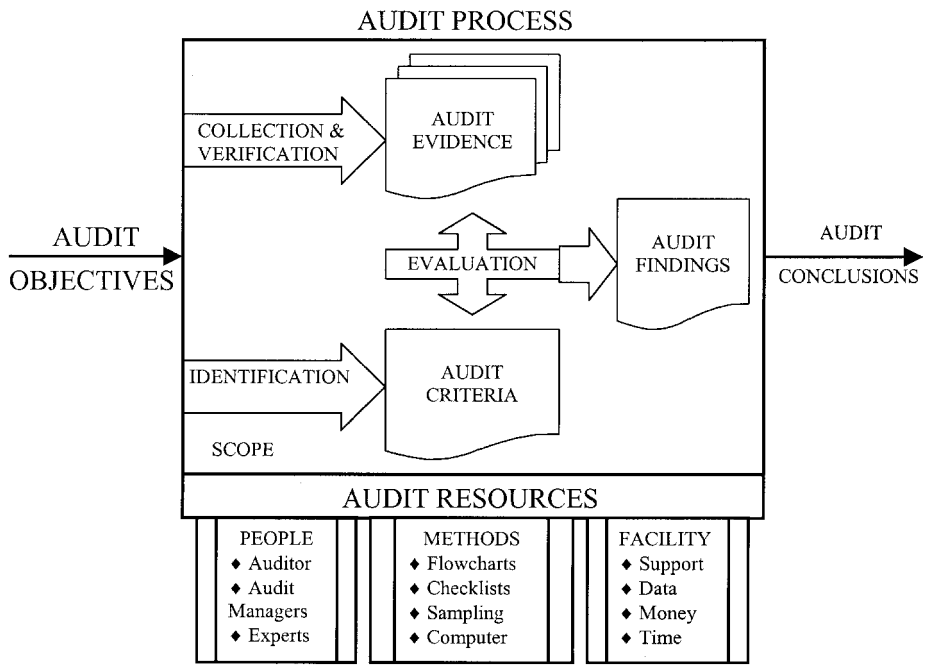
AUDIT PROCESS

Figure 3. *Generic audit practice.*

individual audit. While the auditing processes and required resources are fairly generic across quality, environmental, OH&S, accounting and other types of audits (Willborn, 1993), it is the diverse objectives that define and drive individual audits as systems. As Fig. 3 shows, any particular type of auditing involves a common set of processes, namely the identification of audit criteria (e.g. ISO 9001 standard), collection and verification of audit evidence and comparison of the evidence against criteria. This comparison results in audit findings, which are then reported to the client and subsequently followed-up on through appropriate corrective and preventive actions. Audit resources, including qualified and competent auditors, auditing methodologies, such as flowcharts, checklists and computers, as well as time and finances, are also universal across quality, environmental and other types of audits. The interested reader is referred to Karapetrovic and Willborn (1998a) and Willborn (1993) for a more in-depth comparison of the different aspects of discipline-specific audit systems and corresponding guidelines. While individual audit objectives must be aligned with the overriding audit policy, which in turn must agree with the overall management policies and goals, individual audits may have differing objectives and scope. For instance, while a quality audit may have an objective of examining the improvement possibilities in a particular department, and an environmental audit may aim at eliminating adverse impacts and pollution, they both have to comply with the overall organizational audit policy to improve continuously business performance. As an audit always involves uncertainties and risks, the systems view of the auditor will help to make proper decisions in all phases of the audit. Such a decision might even induce a change of the audit goal and scope when warranted and required. Another valuable outcome of an applied systems view in an individual audit is that it is systematically related to other audits, such as preceding or succeeding audits in an internal audit programme. We shall discuss this topic more broadly later in the paper.

When an auditor realizes and understands that the systems view connects all activities and decisions in the audit, focusing on the 'big picture' will have a positive bearing on the auditor's competence and actual performance (Bishara & Wyrick, 1994; Hirzel, 1998). Actually, the same insight basically led to the new process model of ISO 9001: 2000. We can only hope that the new guideline on integrated quality and environmental system auditing, currently developed under the auspices of the International Organization for Standardization (ISO), will follow in the same footsteps.

Audit system integration

The dynamic and adaptive features of a well-planned and implemented audit system will facilitate and simplify suitable and effective integration of audit programmes and individual audits. This would help to solve the major problem many companies are facing today, namely the ever-increasing stream of different types of mandatory external audits, and particularly of management systems audits. "The explosion in the number of audits being performed in industry at large has served to highlight even further the problems of multiple assessment . . . To reduce these costs, it would obviously be beneficial if schemes were introduced whereby an assessment of a company by a single organization would satisfy the needs of many" (Sayle, 1988). In addition to the demands for reducing the number of audits, industry and other interested parties are pressing for the introduction of joint (Russell, 1997), simultaneous or even integrated audits (Karapetrovic & Willborn, 1998a). While simultaneous audits involve separate audit teams for quality and environmental assessments, performing the audit at the same time, joint audits require further co-ordination and alignment of such teams, even to the point of having a single team under the same management. However, integrated audits would call for auditors who are qualified and competent to perform audits of integrated management systems. In an attempt to meet the users' requirements for streamlining management system auditing, the standard writing bodies have embarked on an effort to enhance the compatibility of different audit guidelines. This is especially the case for the ongoing revision of the ISO standards for auditing quality systems (ISO 10011: 1990) and for environmental management systems (ISO 14010/11/12: 1996). In effect, an audit system is called for.

All audits that comply with current ISO auditing guidelines share some common features and are based on the same set of principles. One could therefore assume that integrating these formal guidelines and the individual audits and audit programmes is an easy task. This, however, does not seem to be the case. The current revisions, along with the effort to achieve improved compatibility, extend over several years, indicating that some problems have still to be resolved. Why not recognize the value of introducing and applying the systems view for these audits? The application of the 'process approach' in the revised ISO 9001 (2000) standard is practically identical with the 'systems approach' that we recommend. The ISO 14001 (1996) environmental management system was originally developed using the 'process' or Deming's plan-do-study-act approach. It therefore stands to reason that the evolution of the systems view in the ISO 9000 management system standards should also be adopted for the related audit guidelines. Figure 4, adapted from Karapetrovic and Willborn (1998a), illustrates how the current audit guidelines can be integrated using the systems approach. The required internal and external audits are then systematically described as closely related systems. The integration of audits with each other and with the management systems to be audited is fairly obvious and does not require much new technical insight and knowledge. If this basic and implied integrative nature is clear, the specific form and extent of audit integration is a fairly straightforward decision.
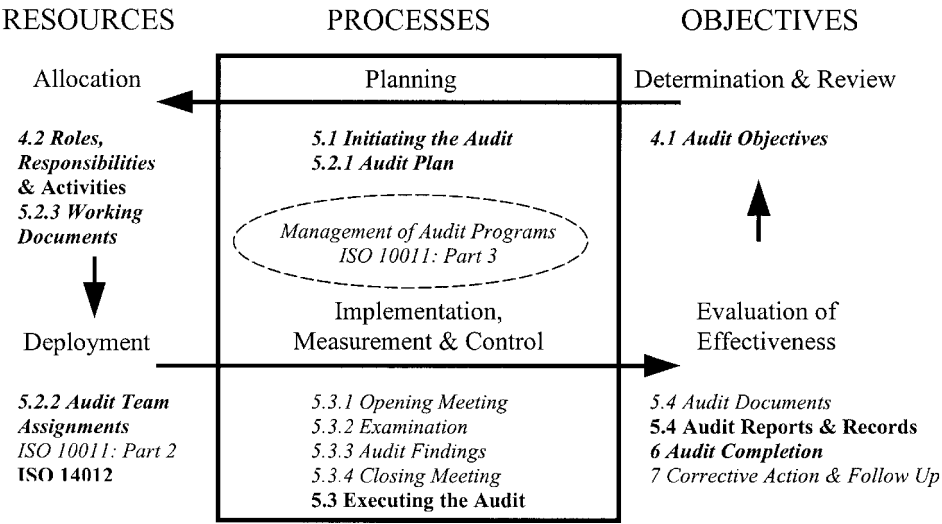
RESOURCES   PROCESSES   OBJECTIVES

Allocation   Planning   Determination & Review

4.2 Roles,   *5.1 Initiating the Audit*   *4.1 Audit Objectives*
Responsibilities   *5.2.1 Audit Plan*
& Activities
5.2.3 Working   *Management of Audit Programs*
Documents   *ISO 10011: Part 3*

                      Implementation,   Evaluation of
Deployment   Measurement & Control   Effectiveness

5.2.2 Audit Team   *5.3.1 Opening Meeting*   *5.4 Audit Documents*
Assignments   *5.3.2 Examination*   **5.4 Audit Reports & Records**
ISO 10011: Part 2   *5.3.3 Audit Findings*   **6 Audit Completion**
ISO 14012   *5.3.4 Closing Meeting*   *7 Corrective Action & Follow Up*
                      5.3 Executing the Audit

Figure 4. *Integrating ISO 10011 (1990) with ISO 14010/11/12 using the systems view.*

Assuming that an audit system is established, alternatives range from simple compatibility of audit policies and objectives to full integration of audit programmes and individual audits. 'Compatibility' would mean that no contradictions exist in different audits to be managed and to be performed. In this case audits are performed separately but remain an entity of the respective audit system. A complete amalgamation of audits in the form of integrated audits is feasible and practical in simple situations that often prevail in small business.

Apart from the integration of discipline-specific audits, the systems approach can be applied to foster continuous improvement of business performance, as well as the increased effectiveness of the audit system. Each of the following sections contains two parts. While the first part, named 'concepts', explains the main ideas and provides a theoretical background for the implementation of the systems approach in auditing, the second part, 'practices', mainly furnishes guidance on the application of discussed concepts.

Audit system control and improvement

Concepts

If we closely examine auditing of the past and present, one particular concept becomes apparent. Namely, an audit is always conducted against some benchmark, standard, regulation, guideline or set of rules, branded under the common name of 'audit criteria'. This feature, under the scrutiny of the systems approach, leads us to the conclusion that an audit system is based on the closed control system with a negative feedback loop. To start, audit criteria are entered as input into the auditing system (Fig. 5). Examples of the audit criteria include the ISO 9001 and ISO 14001 standards, as well as the Malcolm Baldridge National Quality Award (MBNQA) guidelines. The auditing process and resources are then deployed to evaluate whether a management system (quality system if ISO 9001 is applied, environmental system in the case of ISO 14001) meets these criteria. Therefore, the actual status of the management system (actual output) is measured and compared with the set audit criteria (desired output). Audit criteria are called 'desired output' because they represent in essence
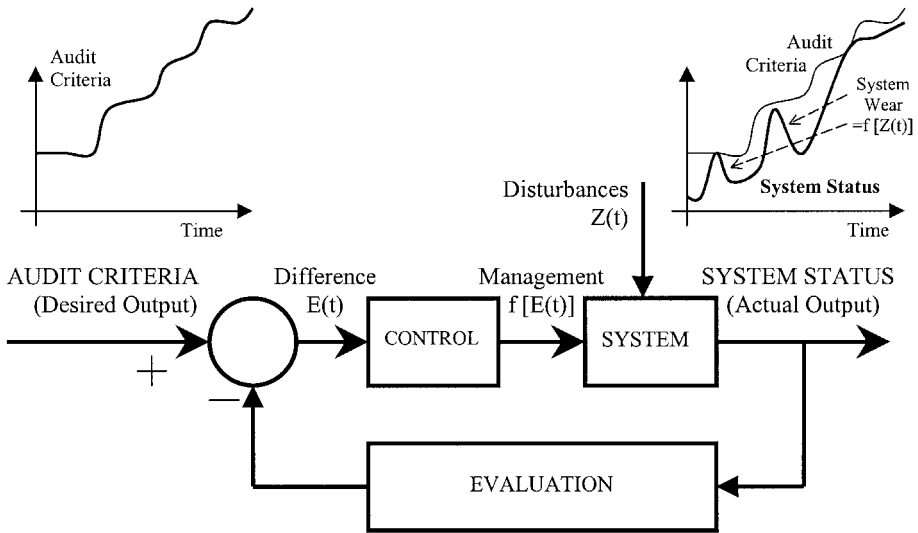
Figure 5. *Audit as a closed control system with a negative feedback loop.*

what we want the management system to be. Where the audit shows the discrepancy between the actual status and the audit criteria, corrective and preventive actions are taken to eliminate the causes of the discrepancy. The management system is then guided on the basis of audit results. In control theory terms, the regulatory function of a closed system depends upon the difference of the actual and desired output (labelled as $E(t)$ to denote time dependence).

The audit system model, as described above, contains three important characteristics. Namely, the audit system is:

- Dynamic.
- Adaptive.
- Composed of interdependent audits.

The first characteristic indicates the ability of the audit system to change with the environment, and not to remain static and rigid in its procedures or objectives. It is also able to adapt to the conditions in the environment in such a way that it ensures meeting of audit policy and objectives. Finally, the audit system consists of individual audits that are interrelated and dependent upon each other. When put together, all three characteristics ensure the focus on continuous improvement of audits, as well as related management systems. The following section addresses this issue in more detail.

Practices

As we mentioned above, auditing implies a searching, independent and objective examination of the management system against audit criteria. Naturally, one should expect that after some time, the management system will reach the stage where it completely corresponds to the set criteria. Contrary to popular belief, however, a passing mark on a registration audit does not necessarily mean full compliance. Firstly, depending on the registrar, several 'minor' non-compliances are usually allowed and do not have a bearing on the decision to award the certificate of compliance. Secondly, in any individual audit, an auditor can only examine a selected sample of the management system in question, not the whole system. Therefore, an

audit conclusion: "this management system fully complies with the stated criteria" is not statistically correct without declaring a level of confidence (say 99%) under which the conclusion was reached. As Willborn (1996) states: "A claim to find all existing errors (deficiencies) cannot reasonably be made, nor can it be expected". Even if such a level of confidence is reached that removes any reasonable doubt in the existence of discrepancies, the management system will inevitably experience a wear-out, causing an outburst of new deficiencies (Fig. 5: top right corner). With time, personnel will stop following certain procedures, especially if they think the procedures were not necessary in the first place, such procedures will not be updated, and bureaucracy and inefficiencies will flourish. In the words of Pyzdek (1999): "ISO 9000-registered companies routinely produce poor quality, Baldridge Award winners go bankrupt, Deming Prize winners have dismal records of customer satisfaction".

Sadly, many organizations waste valuable resources on fixing discrepancies of their worn management systems (MSs) with the existing criteria, not realizing that the problem may also be that the criteria (commonly MS standards) are obsolete, deficient and/or ineffective to achieve the organizational objectives. As Willborn and Cheng (1994) point out, "insisting on adherence to invalid standards can create considerable harm and costs". This static view of auditing is characterized by the assessment of mere compliance to fixed standards at predetermined times. On the contrary, a dynamic and adaptive systems approach is grounded in a continuous change and improvement of the audit criteria, as well as auditing method-ologies, resources and processes (Peters, 1998; Willborn, 1990; Willborn & Cheng, 1994). This allows the management system to be guided primarily by improvement objectives. The actual status of the management system is continuously measured and compared with the desired status, and the system is managed on the basis of detected discrepancies. The desired management system status is represented by time-dependent audit criteria (Fig. 5: top left corner), enabling the management system repeatedly to set and strive to meet new and improved objectives. Therefore, the systems approach in auditing requires the shift of focus from a set of criteria that has been met to another, improving upon the elements of the management system that have not been included in the first set of criteria. For instance, a company can shift from the ISO 9000 standards to MBNQA, which is stronger in the so-called 'soft', behavioural side of quality.

Continuous changes and improvement of audit criteria also demand a greater focus on the most important issues within the audited management system, causing a priority-based audit system of interdependent individual audits, rather than a procedural system of independent audits to be applied. The differences between these two approaches are illustrated in Fig. 6. The procedural approach schedules audits at equidistant intervals of time (e.g. every 6 months). Immediately before the audit, the system is at point A (Fig. 6, left), still far apart from the desired level of performance, indicated by a management system standard. After the audit identifies areas for improvement, corrective actions bring the level of the system to point B. Owing to wear and tear, by the time the next audit is scheduled, the system status is reduced to point C. Subsequent to the scheduled audit, the level of performance may finally reach the desired criteria (point D) after, for example, 8 months. Conversely, a priority-based dynamic system plans individual audits according to the expressed need, not on the basis of a fixed schedule (Fig. 6, right). The level of implementation of the corrective actions initiated by the first audit is continuously monitored, and a follow-up audit, focused on the areas where the most significant improvements are required, is scheduled. The goal is to detect and prevent the inevitable decay of the management system before it can inadvertently affect performance. This allows the management system to reach the first desired level of performance much faster than a procedural system could. Once that
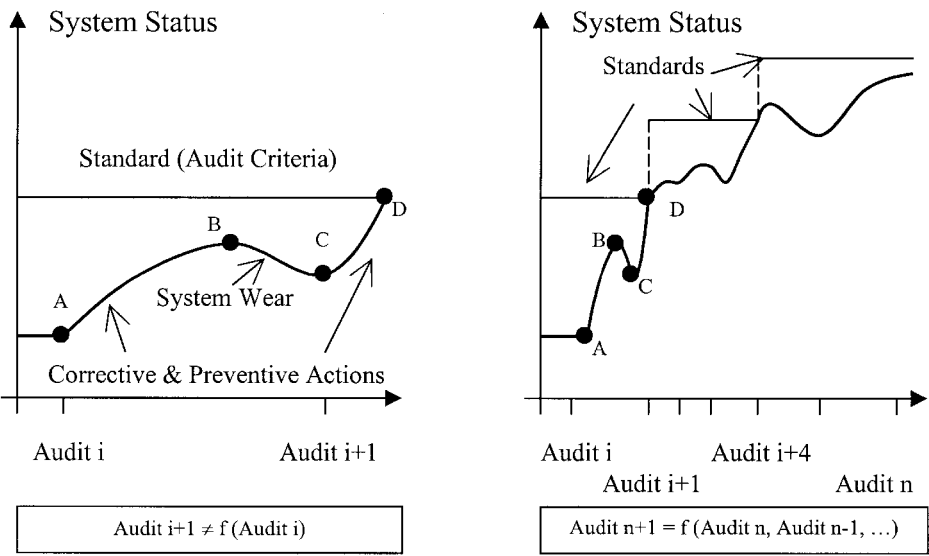
Figure 6. *Interdependent versus independent series of audits.*

level is achieved, new audit objectives and criteria may be set in the effort for continuous improvement.

Inherent in the concept and practice of an audit system aimed at continuous improvement are quality assurance and effectiveness. Moreover, reliability of audit results and maintenance of proper auditing performance are other important and valuable outcomes of a well-managed audit system.

Audit reliability and maintainability

Concepts

An important advantage of the systems approach in auditing is that it allows the conceptualization and measurement of audit reliability and maintainability. Audits, like any other systems, may fail to achieve set objectives. The characteristic of audits that describes the probability that an audit will perform its intended function for a certain amount of time is called 'audit reliability'. Once an audit fails, it has to be restored to the operational mode. 'Audit maintainability' is the probability that an audit will be returned to the original operational mode after it has failed.

To illustrate these concepts, let us assume that an audit plan for a particular quality system audit in a hospital proposes auditors X, Y and Z to conduct the audit over three working days. The plan was communicated to the hospital, and was agreed upon. A day before the opening meeting, auditor X contacts the team leader Z and complains that he only found out that morning about the assignment, and that he does not feel competent to perform the audit since his expertise and experience exclusively includes manufacturing organizations. Auditor incompetence is an example of an audit failure. In this case, the failure was caused in the audit planning stage, because the team leader should have verified that all members of the audit team had adequate qualifications and competence. All actions aimed at correcting this error would be in the realm of 'corrective maintenance' of the audit. For
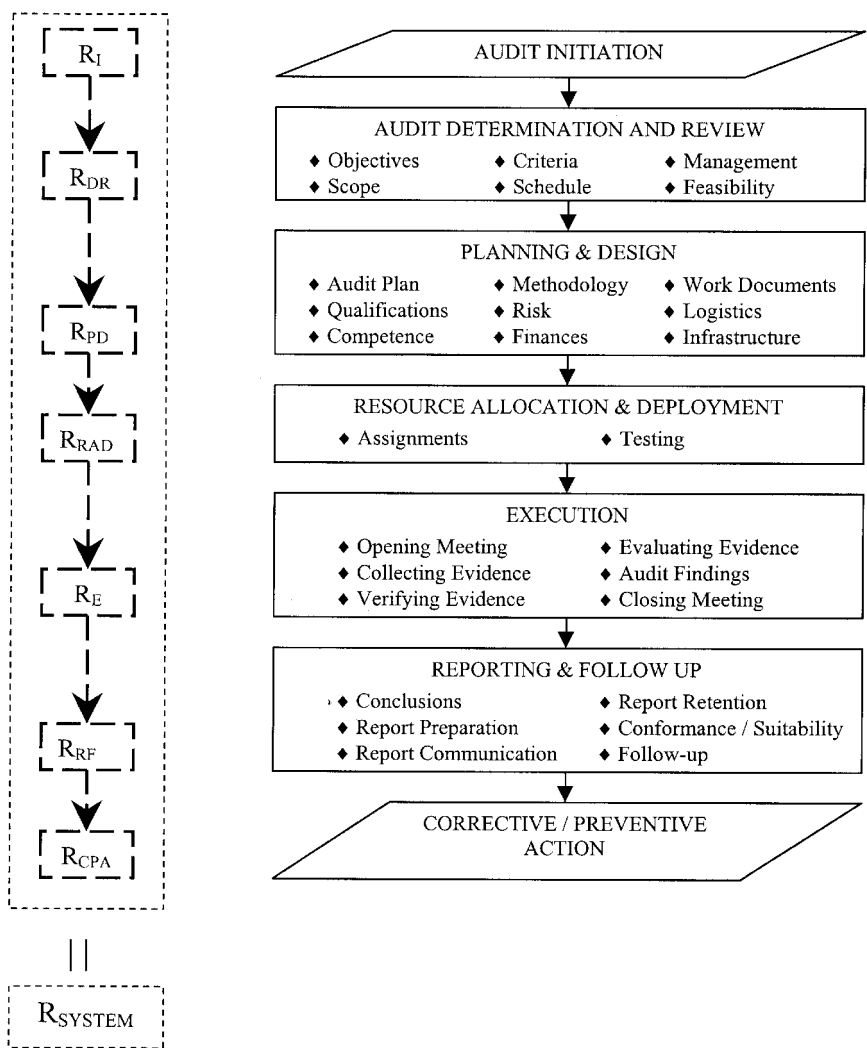
Figure 7. *Audit flow and audit system reliability.*

instance, the auditee and the client are informed about the issue, and an alternative auditor with adequate experience in health care (or a 'technical expert' according to ISO 10011 (1998)) is assigned. Maintainability of the audit system with respect to such a failure would reflect its ability to make a competent auditor available for the task at short notice. In the situation that an auditing organization has assigned its only auditor competent to perform quality audits in health care, and it turns out that this auditor is unavailable, audit maintainability would be very low and costly (probably another auditor would have to be subcontracted at a greater cost).

Another example of a possible audit failure follows. An auditor conducts an examination of the product identification and traceability requirement of the ISO 9001 (1994) standard, in accordance with section 4.8. According to the audit plan, she only has about an hour to perform this task. The audit is executed in a large mechanical equipment manufacturing company, and the number of parts and products that must be uniquely identified is

overwhelming at over 2000. Therefore, the auditor decides randomly to sample 10 parts in order to be confident that at least 98% of all parts are properly identified. Finding that all of the sampled parts are indeed marked, the auditor concludes that the quality system complies with this ISO 9001 requirement. However, such a judgement may be questioned, since the selected sample size appears to be inadequately small. According to the formula given in section A3.4.5 of the Canadian Q395 standard (CSA, 1981), sample size is determined as $\log(1-C)/\log P$, where P is the desired acceptable performance level (in this case 98%) and C is the auditor's confidence limit. We can quickly observe that, with the sample size of 10, the auditor can only be about 19% confident that 98% of parts are adequately identified. For a better confidence limit of, say, 85%, almost 114 parts should have been checked.

   As these two examples show, auditing errors can basically occur throughout the audit process, from audit conception, through execution and reporting, to corrective and preventive action. Apart from occurring at the individual audit level, audit failures are common in audit programmes, as well as the design and implementation of the audit system. The following section addresses these issues in more detailed and practical terms.

Practices

The audit process consists of a series of interrelated actions. Audits are planned at the audit system, programme and individual audit level, and are executed, controlled and improved. Unfortunately, these actions can contain errors that negatively affect the audit effectiveness, i.e. the ability of the audit to meet set objectives. With the flow of auditing activities, the errors tend to accumulate and multiply, causing the audit ultimately to fail. Therefore, the reliability of the audit system can be modelled as a product of reliabilities of its components. As such, similarly to a chain, the audit is only as good as its weakest component. If this component fails (say audit planning is inadequate), the whole audit system is bound to fail as well.

   Figure 7 illustrates the main activities of an individual audit according to the systems view. In order for the audit to be relatively failure free, it must be properly initiated by an audit client or as a provision of a particular audit programme or system. Although errors are rare at this stage, they can still occur. For instance, an environmental audit programme may stipulate that individual audits are to be performed every 6 months in January and June. However, in the case that a comprehensive audit was performed in May because of significant changes in the product line, for instance, scheduling another audit in June would probably incur an unnecessary waste of resources. As such, it could be considered a failure. The next step is the formulation of audit objectives, scope, schedule and audit criteria, as well as the review of audit feasibility and management. Possible errors are many. Audit objectives may be ambiguous, qualitative, hard to measure, or obsolete. For instance, 'continuously striving at performance excellence' is probably a better mission statement than a measurable audit objective. Insisting on fixed audit objectives for a long period of time, such as emphasizing compliance when improvement is badly needed, may also render them obsolete. Audit scope may be too broad or too narrow. For example, an audit scope could identify a particular location with 2000 employees to be audited against the ISO 9001 standard by a single auditor in one working day. Although such an audit is possible, the confidence in audit results would certainly be questioned. Another possible mistake is the proclamation that the audit is feasible when, in fact, it is not, or the corollary of rejecting an audit when it is possible to complete it within given constraints. Errors of this kind, known as type II and type I errors, respectively, can be prevented by adequate review of audit objectives and scope, and the ability of existing resources and methods to meet them. This includes the planning of satisfactory auditor

and audit team qualifications (education, training, experience) and competence (ability consistently to meet set audit objectives).

In the planning and design stages, an audit plan is prepared, and audit resources are provided for. Particularly important for audit reliability is the selection and design of the methodology to be implemented in the execution of the audit, as well as the estimation of audit risks. Methods include flowcharts, checklists, computer-aided auditing techniques, statistical sampling, performance measurement tools, and so on. Selected methodology should be able to prioritize significant elements of a management system under specific circumstances, which allows the auditor to concentrate on the areas crucial for the company's performance. Much too often, quality auditors assign and spend equal amounts of time for the examination of, for instance, control of customer-supplied product (4.7 of ISO 9001: 1994) and design control (4.4), although obviously these two elements are not equally important in most companies. Or they dwell in an area with only 10% share in the company's operation, while another one with a much higher share is left almost untested. Similar errors can be expected in environmental, safety and any other type of audit. Audit risk is defined as the probability that an audit will result in an incorrect finding (CSA, 1994), and is essential to providing confidence to the client and the auditee in the quality of audit processes and results. A common error is to underestimate such risks, causing an auditor to generate incorrect, misleading and/or incomplete information to the client (Willborn, 1996). Specific maintainability measures in this case include the implementation of audit quality assurance procedures, mandatory review of confidence levels and sample sizes when collecting and verifying audit evidence, as well as a pre-execution testing of methodology.

After audit assignments are given to auditors (an example of failure occurring in this activity was depicted in the previous section), an audit is executed. Audit evidence is collected and verified, and subsequently compared with the audit criteria to form audit findings (Fig. 3). Deficiency in performing any of these tasks, such as not verifying the collected evidence, constitutes a major audit failure. According to Willborn (1996), audit evidence must be reliable and sufficient, and must also consider the audit risk. It should be obtained by validated auditing techniques (e.g. observation, interview, computation and forward/backward/cross analysis), and be collected within the audit scope. In comparison of the audit evidence with the criteria, an auditor must be objective, unbiased and base his/her findings on sound methods whenever possible. Auditor inconsistencies, indicated in the possibility of different audit findings under the same circumstances and criteria, is a major problem (Stratton, 1995). Improvements in the standardization of auditor qualifications and competence in order to address this issue are indeed desirable and urgently required.

Finally, the audit results are reported to the client, and ensuing preventive and corrective actions initiated. As in all the previous stages, client satisfaction is of paramount importance. Auditors should be able to provide conclusions on the compliance of a management system to audit criteria and, if required, on the effectiveness of the system to meet stated objectives. They should also provide opportunities for continual improvement in the form of conducting follow-up audits on the implementation and effectiveness of corrective and preventive actions, which are an integral part of the audit system. More detailed information on the audit improvement process can be found in Russell and Regel (1996), Russell (1997) and Willborn and Cheng (1994).

Similarly to the individual audit level, auditing organizations should ensure that their audit programmes, and ultimately the audit system, are reliable and maintainable. Naturally, due to the serial relationship of the audit system elements, the higher the level, the greater the chance of failure. Adequate determination of responsibility and authority for managing audit programmes, timely planning and allocation of resources, quality assurance procedures

and continuous evaluation of audit management effectiveness are all excellent prerequisites for an effective audit system. In efforts to ensure a high level of audit system effectiveness, auditors should use available audit guidelines, and continuously benchmark for best audit practices. Part 3 of the ISO 10011 (1990) standard, the new ISO 19011 guideline, as well as the wealth of literature on accounting (financial) audits, provide a good start.

Conclusion

As a profession, auditing has developed across different management disciplines in the last 50 or so years. Today, you can audit quality, environmental, safety, health, risk, accounting, reliability and maintenance management systems according to relatively well-established and discipline-specific auditing guidelines. However, it seems that the increasing complexity and number of different types of required audits have created considerable costs and confusion in many businesses, without automatically bringing the expected level of business improvement. In other words, requirements and guidelines for audits are many, but solutions to business problems are very few.

In order to facilitate the application of audits for continuous improvement, reduction of inconsistencies in the audit processes and results and the use of synergy effects when different discipline-specific audits are harmonized and integrated, this paper has presented a systems approach to auditing. Various interrelationships among audit system objectives, processes and resources have been illustrated across different levels of the hierarchy of audit-related systems. Three main levels were depicted: management system, audit system and individual audits. Subsequently, the application of the systems approach in fostering continuous improvement, integration of quality and environmental auditing, as well as the increased reliability and maintainability of audits, was addressed. Concepts and main ideas for each application were discussed, followed by more detailed and practical explanations. It is argued that the future of auditing lies in the integration of discipline-specific audit schemes on the basis of the systems theory.

References

BEELER, D.L. (1999) Internal auditing: the big lies, *Quality Progress*, 32(5), pp. 73–78.

BISHARA, R.H. & WYRICK, M.L. (1994) A systematic approach to quality assurance auditing, *Quality Progress*, 27(12), pp. 67–70.

BURR, J.T. (1997) Keys to a successful internal audit, *Quality Progress*, 30(4), pp. 75–77.

CSA (1981) *Quality Audits (Can3-Q395–81)*, National Standard of Canada, Canadian Standards Association, Etobicoke, Ontario.

CSA (1994) *Guidelines for Environmental Auditing: Statement of Principles and General Practices (Can-Z751–94)*, Canadian Standards Association, Etobicoke, Ontario.

HARRINGTON, H.J., CARR, J.J. & REID, R.P. (1999) What's this systems stuff, anyhow?, *TQM Magazine*, 11(1), pp. 54–57.

HIRZEL, R.C. (1998) A systems approach to auditing systems, *Proceedings of the 7th Annual Quality Audit Conference*, Louisville, Kentucky, pp. 50–55.

HUNT, J.R. (1997) The quality auditor: helping beans take root, *Quality Progress*, 30(12), pp. 27–33.

ISO 9001 (1994) *Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation and Servicing*, International Organization for Standardization, Geneva, Switzerland.

ISO 9001 (2000) *Quality Management Systems—Requirements: Committee Draft 2*, International Organization for Standardization, Geneva, Switzerland.

ISO 10011 (1990) *Guidelines for Auditing Quality Systems: Parts 1, 2 and 3*, International Organization for Standardization, Geneva, Switzerland.

ISO 10011 (1998) *Guidelines for Auditing Quality Systems*, ISO/TC176/SC3/WG7/N94-rev.3, International Organization for Standardization, Geneva, Switzerland.

ISO 14001 (1996) *Environmental Management Systems—Specifications With Guidance for Use*, International Organization for Standardization, Geneva, Switzerland .

ISO 14010 (1996) *Guidelines for Environmental Auditing—General Principles of Environmental Auditing*, International Organization for Standardization, Geneva, Switzerland.

ISO 14011 (1996) *Guidelines for Environmental Auditing—Audit Procedures-Part 1: Auditing of Environmental Management Systems*, International Organization for Standardization, Geneva, Switzerland.

ISO 14012 (1996) *Guidelines for Environmental Auditing—Qualification Criteria for Environmental Auditors*, International Organization for Standardization, Geneva, Switzerland.

KARAPETROVIC, S. & WILLBORN, W. (1998a) Integrated audit of management systems, *International Journal of Quality and Reliability Management*, 15(17), pp. 694–711.

KARAPETROVIC, S. & WILLBORN, W. (1998b) Connecting internal management systems in service organizations, *Managing Service Quality*, 8(4), pp. 256–271.

KARAPETROVIC, S. & WILLBORN, W. (1998c) The systems view for clarification of quality vocabulary, *International Journal of Quality and Reliability Management*, 15(1), pp. 99–120.

PETERS, J. (1998) Some thoughts on auditing, *TQM Magazine*, 10(1), pp. 4–5.

PYZDEK, T. (1999) Quality profession must learn to heed its own advice, *Quality Progress*, 32(6), pp. 60–64.

RUSSELL, J.P. (Ed.) (1997) *The Quality Audit Handbook* (Milwaukee, WI, American Society for Quality Control (ASQC), Quality Press).

RUSSELL, J.P. & REGEL, T. (1996) After the quality audit: closing the loop on the audit process, *Quality Progress*, 29(6), pp. 65–67.

SAYLE, A. (1988) *Management Audits*, 2nd Edn (Milwaukee, WI, ASQC Quality Press).

STRATTON, J.H. (1995) Auditor consistency: What improvements are underway?, *Proceedings of the 49th Annual Quality Congress Transactions*, Cincinnati, Ohio, pp. 1064–1065.

WILKINSON, G. & DALE, B.G. (1999) Integrated management systems: an examination of the concept and theory, *TQM Magazine*, 11(2), pp. 95–104.

WILLBORN, W. (1990) Dynamic auditing of quality assurance: concept and method, *International Journal of Quality and Reliability Management*, 7(3), pp. 35–41.

WILLBORN, W.O. (1993) *Audit Standards, A Comparative Analysis* (Milwaukee, WI, Quality Press (ASQC)).

WILLBORN, W. (1996) Report on audit methodologies and other audit standards, *ISO/TC176/SC3/WG7/N26*, Canadian Standards Association, Etobicoke, Ontario.

WILLBORN, W. & CHENG, T.C.E. (1994) *Global Management of Quality Assurance Systems* (New York, McGraw Hill).

ZUCKERMAN, A. (1999a) Standards battles heat up between United States and European Union, *Quality Progress*, 32(1), p. 39–42.

ZUCKERMAN, A. (1999b) ISO 9000 revisions are key to knowledge age excellence, *Quality Progress*, 32(7), pp. 35–39.