AC 2009-812: AN APPLICATION OF CUSTOMER-SATISFACTION STANDARDS IN ENGINEERING MANAGEMENT COURSES

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An Application of Customer Satisfaction Standards in Engineering Management Courses

Abstract

This paper discusses the use of two international standards for quality management in engineering education, more specifically in teaching four engineering management courses. However, neither one of these standards is the commonly-recognized ISO 9001. Rather, they are the still widely-unknown, but quickly-applicable, ISO 10001 and ISO 10002. The respective guidelines for codes of conduct and complaint handling were deployed to establish and follow three codes for student satisfaction and quality assurance, as well as to setup and use a simple system for handling unsolicited student feedback and improving course delivery based upon it. Illustrations of the use of the codes, together with sample results of code performance tracking and student surveys on the usability of these codes, are provided. Examples of the feedback received from the students and its processing through a standardized system are also displayed.

Introduction

The applicability of ISO 9001 as the most widely-known generic quality assurance standard in engineering education has been fairly well researched, although ISO 9001-based quality management systems themselves are still not commonly used in engineering courses or programs. Examples of the related studies and applications can be found in Cheng et al. (2004)[1], Shariff (2006)[2], Sakhtivel and Raju (2006)[3], Heitmann (2000)[4] and other similar papers. However, a number of new standards now exist that can be deployed for the same purpose of providing quality assurance to students, professors, administrators and other stakeholders, but can be much more easily applied than ISO 9001. Such efficient application is possible due to their streamlined and effective focus on a single component of a quality management system, for instance complaint handling and internal auditing[5]. Examples of these standards coming from the International Organization for Standardization (ISO) include the four guidelines for customer satisfaction, namely ISO 10001: 2007 for codes of conduct, ISO 10002: 2004 for complaints handling, ISO 10003: 2007 for dispute resolution, and the upcoming ISO 10004 technical specification for monitoring and measurement, as well as the ISO 19011: 2002 guideline for auditing.

Customer satisfaction standards from the ISO 10000 series are especially interesting for application in engineering teaching, as they can be targeted on different "customers", for example, engineering students, course instructors, teaching assistants, support staff, accreditation bodies, professional associations and industry. In addition, they are usable at various levels of educational delivery, from individual lectures and labs, through courses to programs and beyond. For instance, codes designed and implemented according to the ISO 10001 standard can be used by professors to guarantee prompt responses to student questions, adequate coverage of prerequisite material to fellow instructors, equitable distribution of marking duties to assistants, on-time delivery of grades to registrars, compliance of course components with the established criteria to accreditation bodies, appropriately-set technical exams to engineering associations or sufficient skills of course graduates to the industry. ISO 10002 can be implemented to setup a system for handling feedback from these and other "customers", and consequently improve

teaching based on the analysis of such feedback and ensuing corrective and preventive actions. Guidance given in ISO 10003 can be used to augment or connect an ISO 10002-based system to the existing faculty or university procedures on the external resolution of teaching-related disputes. Finally, ISO 10004 is clearly applicable to the development and use of various surveys of students and other "customers" in order to measure, monitor and ultimately improve their satisfaction with teaching.

This article describes an application of a selected set of guidelines from two such standards, namely ISO 10001 and ISO 10002, in engineering management courses at a western Canadian university. Therefore, the application was focused on the students taking these courses as "customers", on the individual courses as "products", and on the professors, with teaching assistants in one case, as "organizations" using the standards. Since the courses did not have laboratory, seminar or tutorial components, the standards were applied to classroom lectures and the related teaching and learning outcomes. The following section provides a brief outline of the study. Subsequently, the use of ISO 10001 in developing and incorporating three codes and the related code system is illustrated. Handling student feedback with the help of ISO 10002 is discussed next, together with a description of specific instances where the code and feedback systems can be linked. Various examples of code performance records and measurements, as well as feedback forms and corrective actions, generated during the study are included. The article is concluded by underlying the possibilities for future use of ISO customer satisfaction standards in engineering education.

Overview

During one academic term in 2008, a total of four courses taught by the authors were included in the study, specifically an undergraduate compulsory engineering economics and financial management course with 140 students (course "A"), two graduate courses on quality (course "B") and production (course "C") management, which also serve as senior undergraduate technical electives, taken by 26 and 50 students, respectively, and a graduate course on the design and integration of standardized systems with 9 students (course "D"). ISO 10001 principles, framework and guidelines were used to plan, develop, implement and maintain codes for student satisfaction with the course delivery, while ISO 10002 was applied to resolve and follow-up on the individual student complaints, suggestions and other feedback in the course.

Because these standards were designed for universal, efficient and focused applications (e.g., see section 1 "Scope" of ISO 10001: 2007[6] and ISO 10002: 2004[7] or Dee et al., 2004[8]), an interpretation or replacement of only a few generic terms from section 3 "Terms and Definitions" of the standards, such as the previously-mentioned "customer", "product" and "organization", was necessary. Therefore, "*customer satisfaction code of conduct*" (term 3.1 in ISO 10001: 2007) can become "Student Satisfaction Code of Conduct" (SSCC or S^2C^2), defined as "*promises, made to students by a professor, concerning his/her behaviour, that are aimed at enhanced student satisfaction and related provisions*"[6] (underlined words are replacements of the original generic terms). When interpreted more broadly to include any feedback received from students about the course, rather than just their complaints, term 3.2 "*complaint*" from ISO 10002: 2004 can be taken as "*expression of (dis)satisfaction made to a professor, related to*

his/her course, or the feedback – handling process itself, where a response or resolution is explicitly or implicitly expected"[7].

Following the "Guiding Principles" and the "Framework" provided in sections 4 and 5 of ISO 10001: 2007, respectively, the objectives, processes and resources for the application of three S^2C^2s, as well as the codes themselves, were planned and developed in accordance with section 6 of the standard. The S^2C^2s included the "response" code, which guaranteed the professor's response to a student inquiry within a set time, as well as the "review" and "schedule" codes, which promised prompt review of projects, assignments and exams, and conformance to the set lecture schedule, respectively. Subsequently, the first two codes were implemented in all four courses, while the schedule code was used in courses "A", "B" and "D". The implementation followed the guidance of section 7 of ISO 10001: 2007. Code maintenance was undertaken in accordance with section 8 of the standard, including the tracking and publication of the professor's performance against the codes, as well as the collection, analysis and follow-up on student feedback on the codes through, for example, surveys and unsolicited feedback regarding the effectiveness of the code promises and redress actions.

Such unsolicited feedback on the codes, but almost exclusively on other aspects of the course, was managed in course "A" through a system established on the basis of sections 4, 5 and 6 of ISO 10002: 2004, which are analogous to the identically numbered and named sections in ISO 10001: 2007. While specific complaints, such as the unavailability of a sufficient number of textbooks in the bookstore, or suggestions, for instance to include the text of homework problems on the course webpage, were resolved through the application of a process suggested in section 7 of the standard, the emphasis was on the use of individual feedback for the process and course maintenance and improvement, as per section 8 of ISO 10002: 2007. Throughout the application, linkages between the ISO 10001 and ISO 10002 - based systems were established (e.g., see Dee et al., 2004[8]), also in course "A", in order to provide for their integration and hence the related benefits. Some of these linkages will be illustrated in the following sections on the use of ISO 10001 and ISO 10002, respectively.

ISO 10001

An S^2C^2 system based on the planning, design and development (section 6), implementation (section 7) and maintenance and improvement (section 8) processes suggested in ISO 10001: 2007[6] (also see Annex F) is depicted in Figure 1. Specific sub-sections of the standard that each activity follows are given in the dotted bottom-right corners of the activity rectangles.

Naturally, objectives that the system and the ensuing codes should accomplish are contemplated first. In this case, among other objectives, the system was meant to augment student satisfaction with teaching through the use of ISO 10001 and to study the application of this newly-developed standard in undergraduate and graduate, but also compulsory and elective, courses. Since it was assumed that prompt responses to student questions outside of the class, timely return and review of marked coursework, as well as adequate and paced coverage of lecture material to facilitate coursework and learning, would augment student satisfaction, as these are some of the logical and widely-applied teaching practices, they were taken as examples of objectives for the setup of the "response", "review" and "schedule" S^2C^2s, respectively.

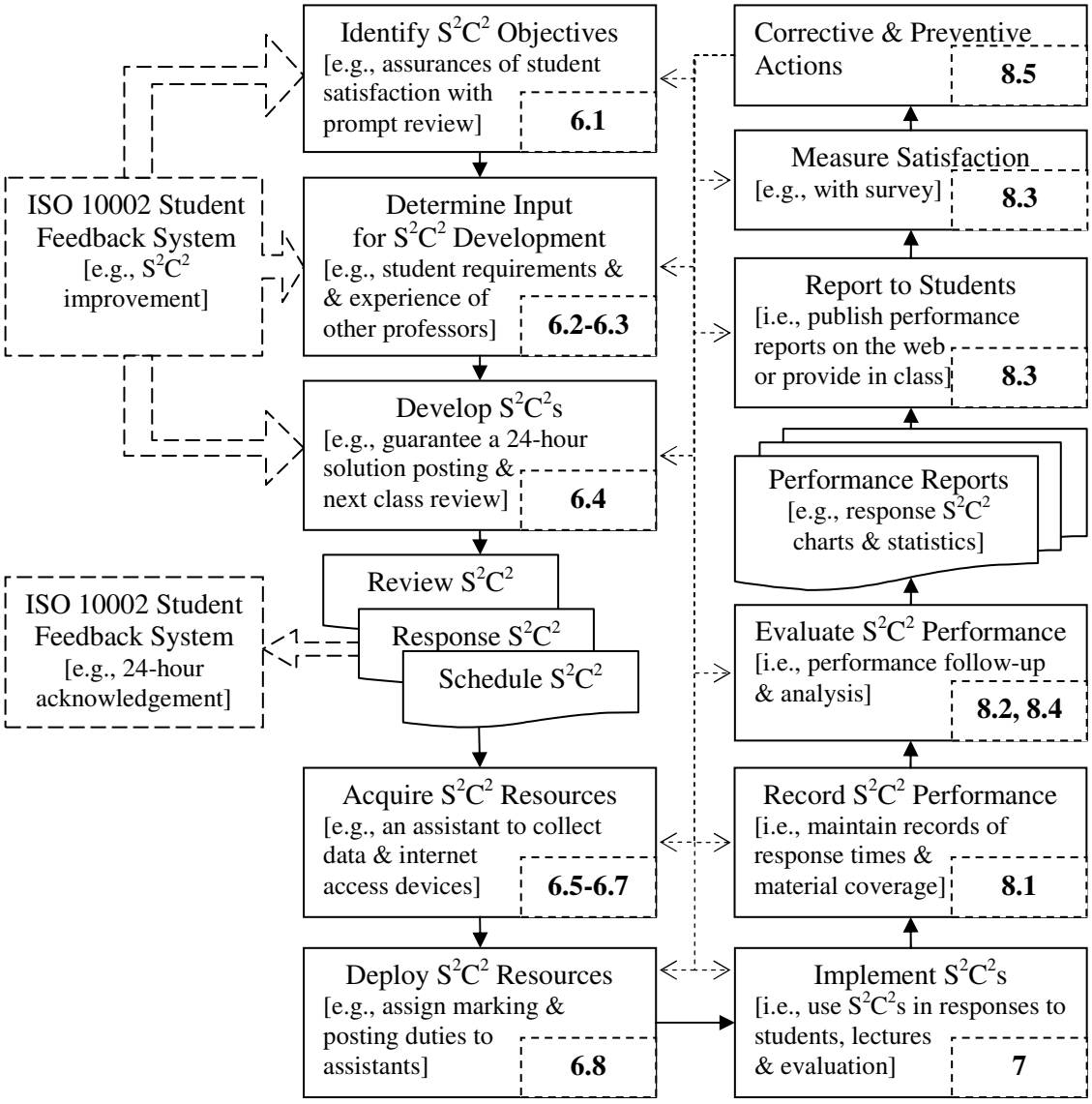

Figure 1: An Example of an ISO 10001 – Based S^2C^2 System for a Course

The next step recommended by the standard is to collect information for an adequate and effective code development. For example, suitable lengths of time to include in the "response" and "review" guarantees were chosen (24 hours and the next class in a weekly lecture schedule in course "B", respectively), and an appropriate redress in the event that the "schedule" guarantee is not fulfilled was selected (gap closure within the following class in course "D").

Figure 2 illustrates the S^2C^2s which were applied in the four courses, together with the various code elements required by ISO 10001: 2007[6] (also see Annex H), such as the promise itself, professor's specific action in case that he/she does not meet the promise, the period during the academic term that the promise is valid, any limitations to the promise, and details on how students can give feedback to the professor regarding the S^2C^2. Although the codes contained essentially the same promises, other elements (called "*code provisions*" in ISO 10001[6]) were

different between the professors. For example, in course "C" taught by one of the authors (indicated with underlined words in square brackets in Figure 2), the redress did not include a chocolate bar or a snack as in the three courses taught by the other author (words specific to this author's courses are indicated by italic letters in Figure 2), while the code limitations were defined more precisely (e.g., "both weekends" during the reading week).

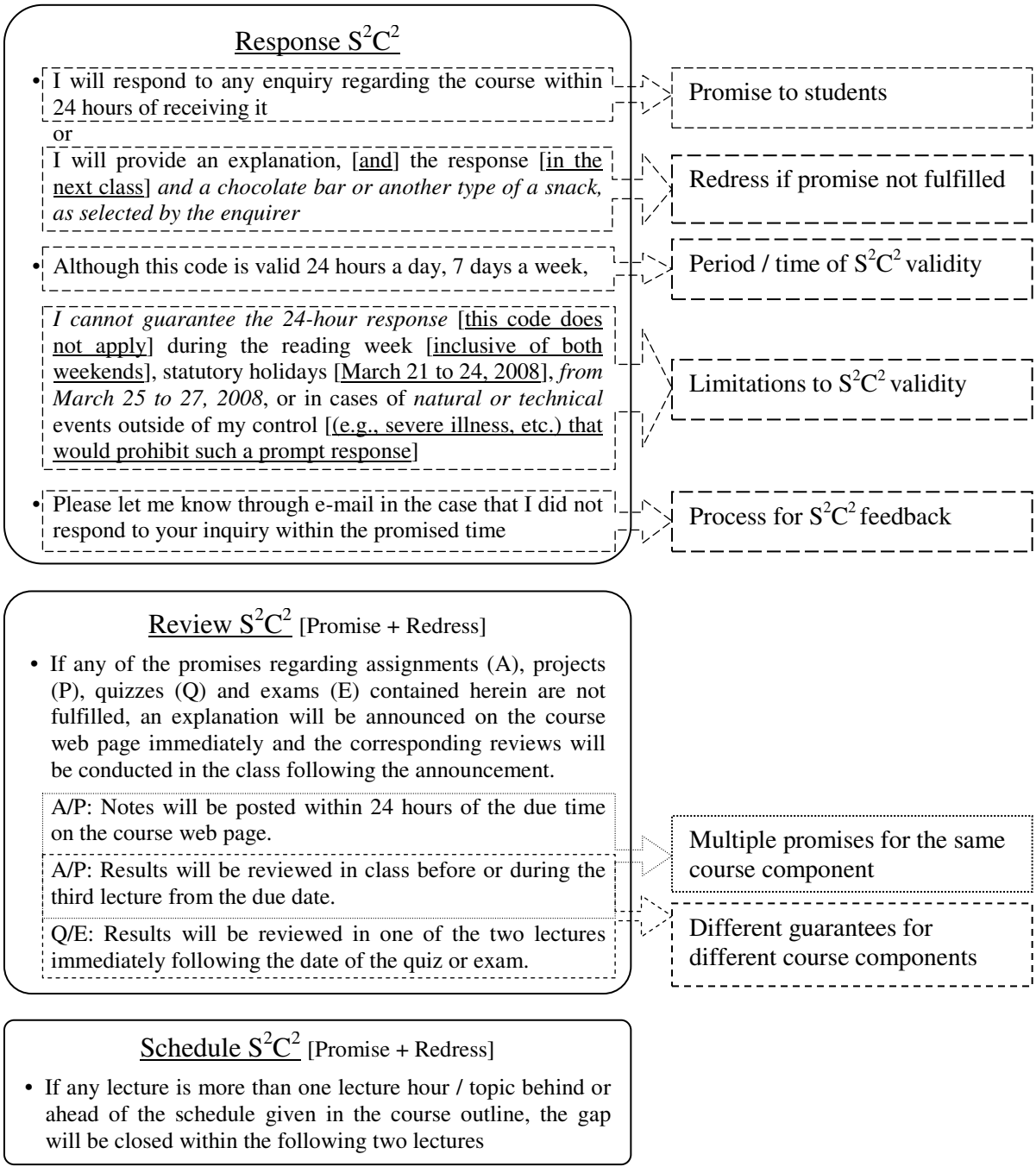

Figure 2: Examples of S^2C^2s and their components suggested by ISO 10001

Acquisition and deployment of resources for the implementation of S^2C^2s followed. The former activity included the setup of the code-supporting resources and performance measurement practices. For example, a research assistant was hired to collect data and provide summaries of the professors' response code performances, while the professors were themselves in charge of these actions for the "review" and "schedule" codes. Provision of internet access for the "response" code for all four courses, together with familiarizing the teaching assistants with the "review" code and ensuring their availability for posting solutions and marking homework in courses "A", "B" and "C", were included in the latter activity.

It is important to note that the "Guiding Principles" of ISO 10001 were taken into account throughout the development and implementation of the S^2C^2s. For instance, texts of the applicable codes were included in course outlines and discussed in the first class (principle 4.4 "*Visibility*"[6]), while the codes were also available throughout the term on course web-pages (principle 4.5 "*Accessibility*"[6]). The effectiveness of the application of some of these principles was also evaluated, for instance with "midterm surveys on the use of standards", which were conducted in the seventh week of classes in courses "A", "B" and "D". For example, awareness of the response, schedule, and review S^2C^2s was indicated by 86%, 71% and 51% of the 100, 101 and 99 students who answered the related question in course "A", taught three times a week. In the once-a-week course "B", these percentages were 82%, 88% and 63%, respectively, with 17-19 students responding. Finally, all nine students in the (also) once-a-week course "D" were aware of the response code, while the awareness of the schedule and review code was reported by seven and eight students, respectively.

These midterm surveys, executed during the implementation of the S^2C^2s in part to meet the related ISO 10001 (subsection 8.3) guidance[6], also illustrated that students generally considered these codes to be useful (e.g., at the 90%, 83% and 75% levels for the response, schedule and review S^2C^2s in course "A", respectively). In addition, students provided suggestions, at times humorous, for new codes (e.g., "*finish 5 minutes early code*"), and for the improvement of the existing codes and their implementation (e.g., "*provide better feedback on course webpage for review code*").

Professors' performance against the S^2C^2s was periodically made available to students. For example, in courses "A" and "B", performance reports were published on the course web-pages. Response code performance was provided monthly, while the schedule code performance was updated after every class. Generally following the return of assignments or tests, review code performance was posted, but only in course "A".

Figure 3 illustrates an example of a report generated from the data on response times in course "A". Please note that the reports posted on the course web-page included the monthly statistics, such as the average, maximum and minimum times, and the number of inquiries, rather than a graphical illustration.

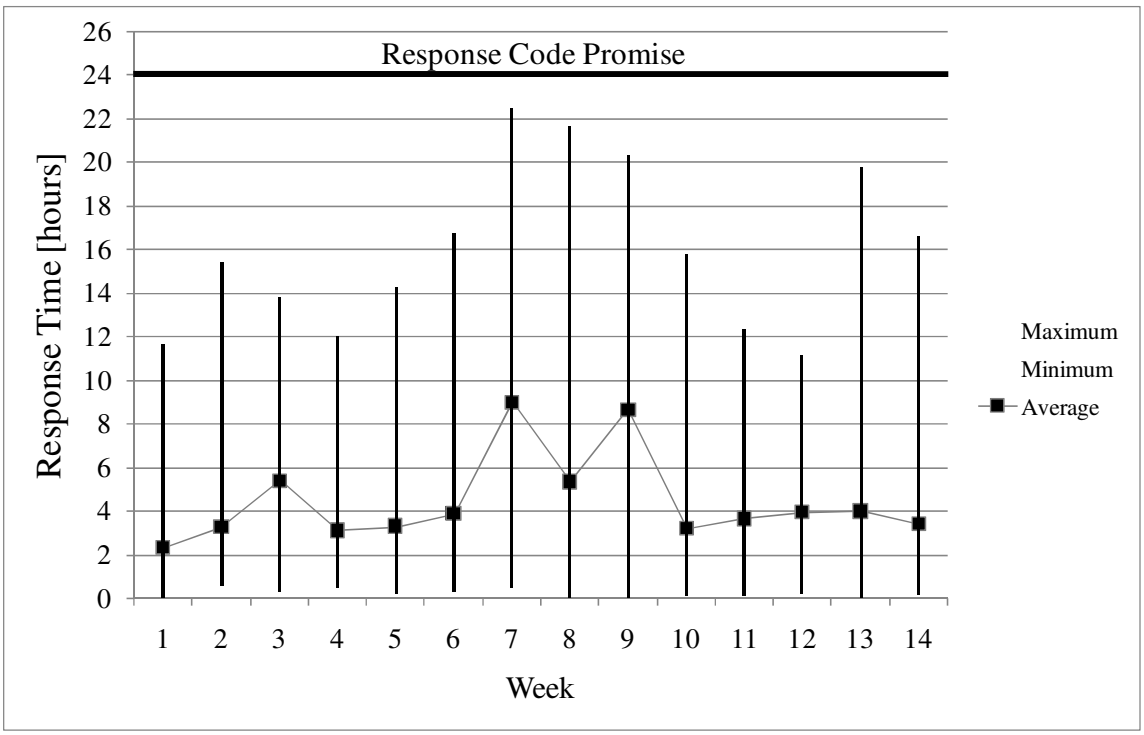

Figure 3: Response Code Performance in Course "A"

A total of 231 e-mails from 61 students (44% of the class) were received in course "A". As can be seen on Figure 3, all e-mail inquiries were responded to within the 24-hour promise, with an average of about 4.1 hours. This was also the case during the periods when the code was not valid, for example during the "reading week" (Week 6 in Figure 3). However, three out of 59 inquiries sent by 18 students (69% of the class) in course "B" were responded to in over 24 hours. The same was true in course "D" (with eight out of nine students sending e-mails), however all three responses that missed the guarantee were to inquiries sent during the "reading week", i.e., when the guarantee was not in place. Finally, course "C" had a 100% code compliance rate.

Tables 2 and 3 illustrate excerpts from the code performance reports posted on the course "A" web-page. The promise for the posting part of the review S^2C^2 was not fulfilled once in this course, seemingly due to miscommunication between the teaching assistant and the professor. The schedule S^2C^2 was met in the applicable courses.

Homework / Quiz / Exam	Due Date	Due Time	Date Notes Posted	Time Notes Posted	Code (Posting)	Code Met? (Posting)
A1	21-Jan	11:00	21-Jan	16:30	24 hours	Yes
A2	30-Jan	11:00	30-Jan	11:55	24 hours	Yes
Q1	1-Feb	N/A	N/A	N/A	N/A	N/A
A3	6-Feb	11:00	6-Feb	18:50	24 hours	Yes
P1	13-Feb	11:00	14-Feb	8:50	24 hours	Yes
A4	27-Feb	11:00	27-Feb	11:27	24 hours	Yes

Homework / Quiz / Exam	Due Date	Due Time	Date Available	Class Available	Code (Availability)	Code Met? (Availability)
A1	21-Jan	11:00	28-Jan	3rd	3rd class	Yes
A2	30-Jan	11:00	4-Feb	2nd	3rd class	Yes
Q1	1-Feb	N/A	1-Feb	1st	2nd class	Yes
A3	6-Feb	11:00	13-Feb	3rd	3rd class	Yes
P1	13-Feb	11:00	25-Feb	2nd	3rd class	Yes
A4	27-Feb	11:00	5-Mar	3rd	3rd class	Yes

Table 1: Review Code Performance in Course “A” (Excerpt)

CLASS & DATE	PLANNED TOPIC	COVERED?	GAP?
1 7-Jan	• Course overview.	✓✓	-
2 9-Jan	• Business goals and stakeholders.	✓✓	-
	• Engineering and management.	✓☒	Regulation Examples (Slide 2-5, 50%) + Summary (Slide 2-6, 100%)
		⬇	⬇
3 11-Jan		✓	Completed
	• Two aspects of money.	✓✓	-
	• Financial statements: Overview.	✓✓	-

Table 2: Schedule Code Performance in Course “A” (Excerpt)

Towards the end of courses “A”, “C” and “D”, a survey of students’ opinions on the implementation of the S^2C^2s and the standards was conducted. Questions regarding the availability, appropriateness and usefulness of S^2C^2s were asked, among others. For example, 86% and 94% of the students surveyed in courses “A” and “C”, respectively, agreed or strongly agreed with the statement that a 24-hour guarantee for the response S^2C^2 is appropriate. However, only 55% thought so for the time limits in the review code (with 35% expressing neutrality) in course “A”, while this percentage was 91% in course “C”. In addition, 78% of the responding students in course “A”, and 84% in course “C”, agreed or strongly agreed that the response code effectively met their needs for a timely response. The results of these surveys will be analyzed in more detail in order to provide opportunities for improvement, as suggested by section 8 of the standard[6]. For instance, promises made in the response and review codes may be augmented and revised, respectively, based on the results of this analysis.

ISO 10002

The focus of the use of ISO 10002 guidelines was on the process for handling unsolicited feedback from individual students (based on section 7 of the standard[7]) and the corrective / preventive actions that could be drawn from such feedback and impact the whole class (guided by section 8 of the standard[7]). Figure 4 presents a flowchart of these processes, which were applied in course "A". As with the S^2C^2 system shown in Figure 1, specific subsections relating to each activity are presented by their numbers in bottom-right corners of the activity symbol.

Student feedback from two sources, namely e-mails and in-class oral or written comments, was treated as input. In-class feedback that was received in person would be acknowledged immediately, while any written notes left for the professor and containing such feedback would be acknowledged through an announcement in a subsequent class. The acknowledgement of e-mailed feedback fell under the scope of the response code guarantee, and was therefore done within 24 hours of receipt. This is one of the examples of possible connections between the systems for S^2C^2 and student feedback handling, specifically where the outputs of the former system are used as inputs into the latter.

A "Feedback Form", based on Annex H of the standard[7], was used for recording the feedback, as well as any actions taken to resolve it and to provide overall improvement of the course delivery or the standard-based systems themselves. Five such forms were completed in course "A", due in part to the fact that only unsolicited student feedback was collected through the system, while students had additional opportunities to provide feedback through various surveys. Table 3 shows two examples of the feedback received and handled with the support of these forms.

The first example illustrates the activities performed to address a student e-mailed request to post the text of the assignment problems on the course web-page. Since the full text of the assignment problems was only available in the copyrighted textbook, and the use of the new edition of the textbook was mandatory in the course, it was determined that assignment text would not be available on the web, and that no further corrective or preventive action was necessary. As with all other completed Feedback Forms, this one was published on the course web-page to inform the students of the issue brought forward and the related activities and resolutions.

In the second example, however, such actions were identified. Namely, after an anonymous note from a student complaining about the use of unclearly-explained acronyms in a particular lecture, the corresponding analysis of the complaint revealed an opportunity for improvement of course delivery through writing of the meaning of all acronyms immediately after they are mentioned in the lecture. Consequently, correction of the issue (see the "investigation", "further action" and "further response" items corresponding to this feedback in Table 3) was performed, and the related corrective and preventive actions (also see Table 3) were planned.

As indicated on Figure 4 and as suggested by ISO 10002, student awareness of, and satisfaction with, the feedback system can be measured, through, for instance, midterm or end-of-class surveys. A midterm survey on the use of customer satisfaction standards in course "A" contained questions on the awareness and usefulness of the feedback forms. Although 77% of the 69 responding students indicated that the forms were useful, only 57% of the 98 students who

answered the awareness question noted that they were actually aware of the existence of these "customer feedback forms".

Ultimately, the results of these surveys, as well as the preventive and corrective actions, can be used not only for quality assurance and increasing student satisfaction, but also for quality improvement in the course delivery and in the implemented systems (Figure 4). Using an ISO 10002 system to process feedback on the S^2C^2s and consequently improve the ISO 10001 system and the S^2C^2s themselves on the basis of that feedback[6] is an example of such possible improvement[7] and another point of integration of the two systems[5, 6, 8].

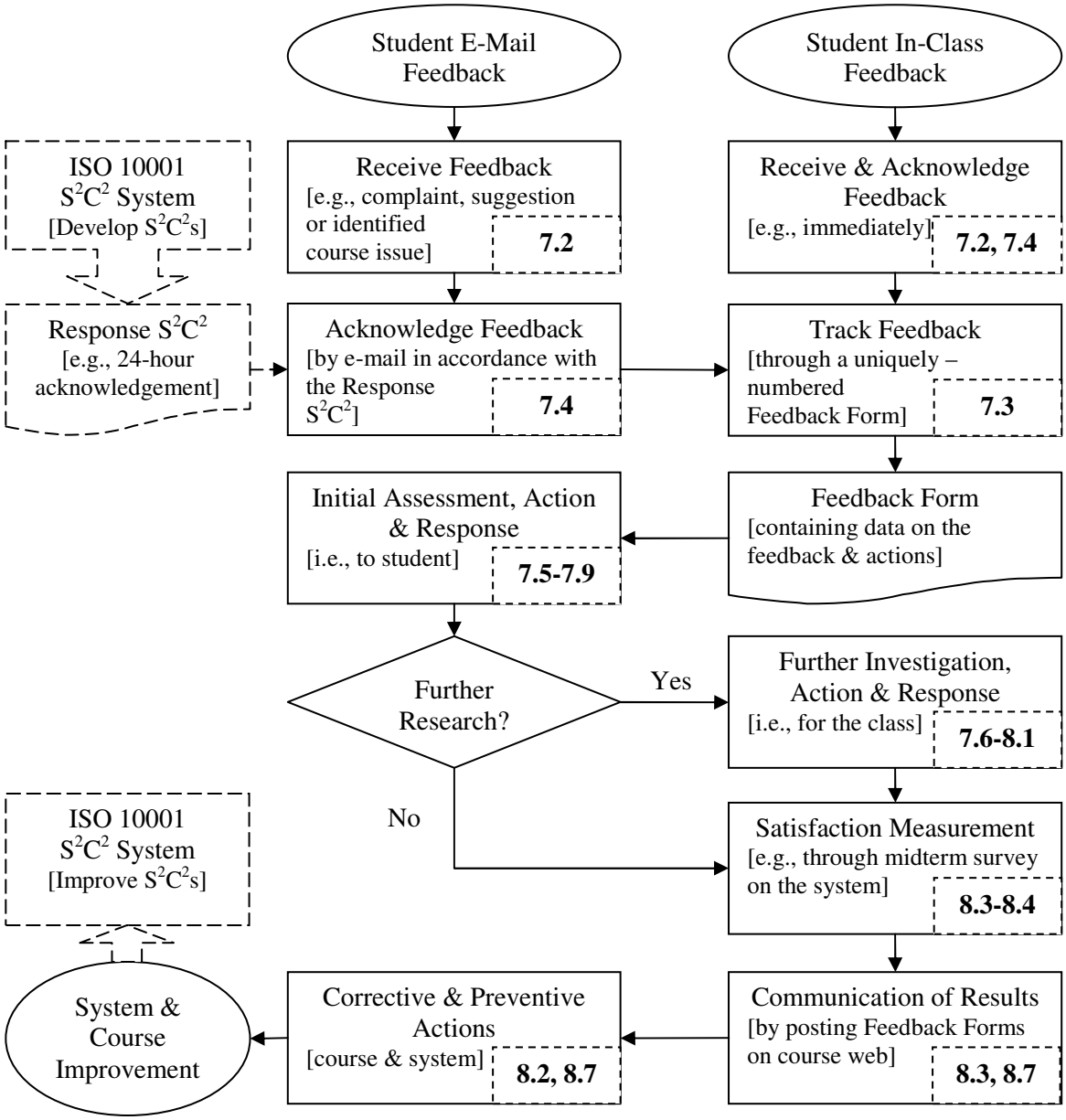

Figure 4: An Example of an ISO 10002 – Based Feedback Handling System for a Course

Feedback Form* #	#1 (Assignment Text)	#3 (Use of Acronyms)
DATE & TIME RECEIVED:	January 8, 2008; 12:59	January 30, 2008; 12:00 approx.
RECEIVED FROM:	One student	One student
RECEIVED BY:	Professor	Professor
RECEIVED THROUGH:	E-Mail	Written on the January 30 lecture questionnaire
ISSUE BROUGHT FORWARD:	Publication of assignment text on the course web page	Use of abbreviations, such as "NCF" and "DP" in today's (Jan. 30) class.
ISSUE ACKNOWLEDGED:	E-Mail response, January 8, 2008; 14:39 (EM1)	Announcement of the complaint received was made in class on February 6, 2008 (A-1).
INITIAL ASSESSMENT:	Mandatory textbook contains assignment text.	There are indeed many acronyms in the course. Familiarity with these is a part of the knowledge gained in engineering economics. A "List of Abbreviations and Glossary of Financial Terms" is available as an appendix in the textbook (p. 151-157), e.g., "Net Cash Flow" (NCF) is mentioned on this list. However, the definitions for some of the abbreviations mentioned in class were only spelled out in the lecture, but were not specifically written down (e.g., "DP").
INITIAL ACTION:	Appropriate consultations were made and resulted in the confirmation that the text of the assignments cannot be published due to the fact that it is copyrighted.	Class transparencies should be analyzed for any acronyms and abbreviations for which the definition was not written.
INITIAL RESPONSE:	In EM1, the professor informed the student that, due to copyright, assignment text will not be published on the course web-page.	Announcement of the initial action planned was made in class on February 6, 2008 (A-1).
INVESTIGATION:	As per initial assessment.	Class transparencies were analyzed as per the initial action requirement, and several such terms were found.
FURTHER ACTION:	None required.	Terms found in the investigation were defined in the "Class Discussion Follow-Up" file (F1).
FURTHER RESPONSE:	None required.	The file (F1) was posted on the course page, Feb. 6, 19:50.
RESOLUTION STATUS:	Closed.	Closed.
CORRECTIVE ACTION:	None required.	In the current class, write down the definition of any acronym or abbreviation not previously defined in lecture transparencies or slides.
PREVENTIVE ACTION:	None required.	For future classes, include a list of acronyms and abbreviations used in the previous class within the course notes.

* Modified from ISO 10002: 2004 (Annex D)

TABLE 3: Examples of Usage of the ISO 10002 – Based Student Feedback System

Conclusions

Overall, although various codes and complaints-handling procedures have been widely used in teaching, the application of the corresponding standards facilitates a structured approach to using them for quality assurance and improvement. This paper illustrated the use of ISO 10001 to establish student satisfaction codes of conduct and ISO 10002 to manage unsolicited student feedback in selected engineering management courses at a Canadian university.

After presenting examples of potential applications of the new ISO 10000 customer satisfaction standards in engineering education, the focus was turned on the adaptation of ISO 10001 guidelines for their implementation in four courses covered in this study. Three specific codes were depicted, and examples of the results of their application were illustrated. An ISO 10002-based system for student feedback, together with two particular instances of such feedback and the related processing, were demonstrated, as well.

In summary, the results of this application seem to be fairly positive, including the indications received from the related end-of-course student surveys. For instance, 79% and 94% of the students surveyed in courses "A" and "C", respectively, would recommend the use of the "24-hour Response Code" in other courses. Furthermore, although such use of standards represents a "natural fit" in engineering management and industrial engineering courses and an example of incorporating research into teaching, particularly in courses on quality and production management ("B" and "C", respectively) and on standardized systems (course "D"), the related benefits are likely independent of the actual course content.

Consequently, many possibilities exist for a further study of the use of these and other similar standards in education. Specifically, broadening of the application to other professors and courses in engineering management is currently under way, and an expansion to additional divisions and engineering departments is planned for the near future.

Acknowledgments

The authors thank Mr. Ahmad Ghazi and the McCalla Professorship fund.

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