Practicing What We Teach: Quality Management of Systems-Engineering Education

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***Abstract*—In 1992, Delft University of Technology (DUT) established a new Master degree program in the field of systems engineering, policy analysis, and management. This educational program is administered by the School of Systems Engineering, Policy Analysis, and Management (SEPA). The SEPA administration aims for high quality of all aspects of its educational program. A quality management system was put in place when classes started in 1992. This system consists of protocols and is administered by an educational advisor. The system is stakeholder-centered rather than based on didactic principles. The objectives of the system are to secure *external* and *internal consistency* of all elements of the educational program. Through a variety of assessment methods, information is collected from students, faculty, and experts from outside the university on the quality of curriculum design, teaching methods, teaching skills, and the learning environment. Assessment methods vary for the various stakeholders groups; the frequency of assessment depends on the frequency with which classes are taught and adjusted, and on the frequency of external reviews. Assessment criteria are derived from stakeholder objectives. Reports are used successfully for problem detection, diagnosis, and remediation. The system characteristics, strengths and weaknesses, may be explained in part by the fact that the system was developed to meet the needs of the SEPA administration. The set of assessment criteria and the importance of the different assessment methods would change if the system was administered by an other stakeholder in SEPA education.**

I. Introduction

In 1992, Delft University of Technology (DUT) established a new Master degree program in the field of systems engineering, policy analysis, and management. This educational program is administered by the School of Systems Engineering, Policy Analysis and Management (SEPA). The four-year curriculum is problem-oriented, and has a strong interdisciplinary character, drawing from technical, social and administrative sciences. The SEPA administration aims for high quality of all aspects of its educational program. Therefore, a quality management system was put in place when classes started in 1992. This system is instrumental in collecting information from students, faculty, and experts from outside the university on the quality of curriculum design, teaching methods, teaching skills, and the learning environment.

Characteristics of the of the SEPA program are as follows: The core curriculum is taught by SEPA faculty, whereas math and technology classes are provided by eight departments from the schools of mathematics, civil, electrical, and chemical engineering. Classes are taught to groups varying from ten–140 students. The teaching methods are diverse. About 30% of the curriculum is organized in the form of projects to challenge students to apply their skills and knowledge in the analysis and solving of real-world problems (e.g., analysis of Brent Spar incident, management of the construction of a storm-surge barrier near Rotterdam). In the past six years, each year an average of 120 freshmen enrolled in this program.

The primary objective of the SEPA administration is straight forward: "*to provide high quality education to engineering graduates in approaches to problem-solving and preparation of complex decisions at the interface of technology, policy and management*" [8]. To achieve this objective, it is not only important to maintain high educational quality standards (Do we deliver what we promise?), but also to receive recognition for the program and its graduates, both in the eyes of (international) peer institutions and society (How good is the product we promise to deliver?). The manner in which the program is delivered must also be able to motivate students to learn and complete the requirements for their degree (How did we deliver what we promised?). To enhance the educational quality of the SEPA program, monitoring of its quality is matched by continuous efforts to remediate current and potential problems. The quality monitoring is used to prioritize the aspects of the program to be improved and to allocate personnel and funds for remediation.

Other incentives for setting up and maintaining a system for monitoring educational quality are as follows. First, the overall enrollment of engineering students in Dutch universities is decreasing. Information on the quality of education can serve to raise the competitiveness of the SEPA program and to increase enrollment. Second, the academic quality of the program must be maintained despite the fact that the funding of education favors a high throughput of students. DUT funds all of its 15 educational programs according to an output principle. Funding criteria include the number of freshmen enrolled, yearly total of awarded student credit points, and Master diplomas. This emphasis on efficiency in education is reinforced by the Dutch system for the financing of student aid: fast-paced students receive grants and low-paced students must take out loans. A quality management system can take the role of watchdog, and match information on academic quality with teaching efficiency as well as identify (potential) barriers to study progress. Other reasons for the faculty-based quality monitoring system are the obligation to provide the central university administration with information on teaching efficiency and teaching quality, and the anticipation of regular, formal, external evaluations by representatives of the Dutch government's Department of Educa-

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tion. (Accreditation of educational programs common in Anglo-Saxon countries is not practiced in the Netherlands.)

In this paper, we present INTRAVIEW, the quality management system developed by SEPA and used for regular evaluation of the SEPA program. This quality management system was developed primarily to suit the needs of the SEPA administration. The major part of the paper describes the design of INTRAVIEW, which is in fact, a conceptual model relating curriculum design parameters, stakeholders and their objectives, and methods for quality assessment and reporting. Despite the fact INTRAVIEW has been used since 1992, there are no empirical data available on its costs and benefits for the SEPA administration or the educational program itself. Therefore, we are limited to presenting first-hand experience with operating the system and applying the information it generates to enhance the quality of individual courses and curriculum redesign. This lack of data on the suitability of INTRAVIEW for the SEPA administration is one of the weaknesses in its present phase of implementation. Nevertheless, the conceptual model for an educational quality management system should be of interest to professionals involved in the design and administration of engineering education programs.

II. Curriculum Design and the Role of Quality Assessment

Typically, an educational program is carefully designed, giving attention to the individual elements of the curriculum, the learning environment, and their interdependencies. A curriculum design (a specific sequence of knowledge-base and skill-building courses) specifies the criteria for course design (a specific combination of learning objectives, course materials, teaching methods, and tests), as well as the staffing of teaching faculty, course scheduling, and teaching facilities. The learning environment in which students perform is shaped by the nature of the teaching activities themselves, the schedule for courses, projects and exams, and the availability and characteristics of facilities.

In the SEPA program, the program objectives and exit qualifications qualify as design criteria for the curriculum. Changes in program objectives or exit qualifications bring about changes in the curriculum. For instance, sharpening of the exit terms for problem-solving skills in 1995 required a major overhaul of the curriculum. In the revised curriculum, which started in 1997, the development of problem-solving skills is emphasized through the explicit twinning of theoretical and practical, project-based courses.

The curriculum as a whole and individual curriculum elements are expected to be of high relevance to academics and society. To ensure this, the quality of the SEPA program must be monitored on a regular basis and improvements must be made where necessary. For this purpose, the SEPA administration initiated a quality management system: INTRAVIEW. This system is being used for monitoring all facets of the educational program, remediation of problems and regular feedback. Quality management is the responsibility of the Dean's office; a professional education advisor is full-time employed to run and further develop INTRAVIEW.

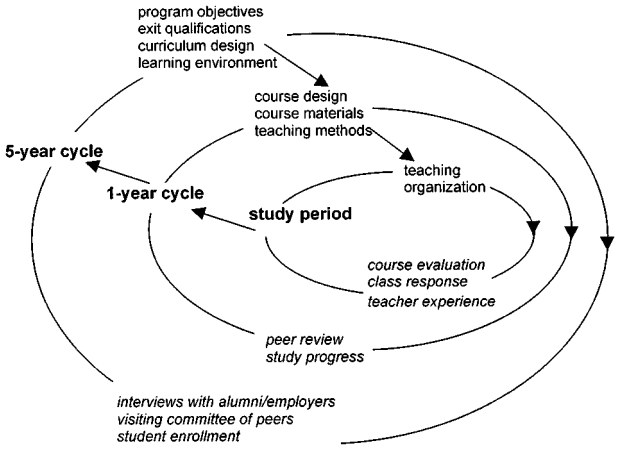

Fig. 1. INTRAVIEW is a triple-loop quality management system for education. (Elements of education are printed in regular characters; assessment methods are printed in italics.)

A. System Description of INTRAVIEW

INTRAVIEW is a triple-loop system for quality management. The system consists of protocols for both quality assessment and problem remediation. One of these protocols, for course-evaluation, has been automated and is operated on Internet. All protocols are kept and maintained by the administration and are available to the staff and students. There are two exceptions to this: the evaluation protocol used by the external visiting committee is prescribed by the Dutch Association of Universities; the Dutch law on Higher Education prescribes the roles of students and staff in advising the Dean's office on curriculum revisions. In principle, these protocols are transparent with regard to the use of monitoring tools/methods, use and definition of quality indicators, decision-making processes and responsibilities.

The protocols of INTRAVIEW stipulate three cycles of monitoring, reporting and problem remediation. These cycles concern different elements of the educational program and, accordingly, different participants and time-spans (Fig. 1). The students evaluate the quality of individual courses and teachers during and at the end of every study-period (8 weeks). Evaluation of course design takes place once a year through peer review and study progress evaluation. The results of the course evaluation do feed into this one-year cycle. The external review of the curriculum takes place once every five years; it serves as an input for decision-making with regard to program objectives and curriculum design.

The implementation of the triple-loop INTRAVIEW system was carried out in phases. The regular course evaluation during each study period (inner loop) was put in place in 1992, when the program started. Problem diagnosis and remediation took more effort in the beginning years than in subsequent years. Four years later, in 1996, the first external peer review process (outer loop) was carried out. The preparation of the external peer review (an internal review process set up along the same lines), and the results of the external review, led to sharpening of the exit qualifications for problem-solving and design skills of SEPA-graduates. To be able to achieve these new exit qualifications, a curriculum redesign process was started in 1997. The

TABLE I
HIERARCHY OF OBJECTIVES FOR THE SEPA EDUCATIONAL PROGRAM FROM THE PERSPECTIVE OF ADMINISTRATORS

	OBJECTIVE	LEVEL
1	***Academic and societal relevance***	***High external consistency***
1.1	*High academic quality*	*Intermediate level objective*
1.1.1	- Exit qualifications recognized by peer institutions	- Lower level objective
1.1.2	- Course materials include (international) standard literature	
1.1.3	- Academically proficient teaching staff	
1.1.4	- Newest didactic theory and technology applied in teaching and testing methods	
1.1.5	- Excellence in teaching	
1.2	*High societal relevance*	
1.2.1	- Program objectives concerned with and open to changes in societal needs	
1.2.2	- Knowledge and skill development (course content) vital for solving real-world problems	
1.2.3	- Didactic theory and technology applied in teaching and testing methods are appropriate	
1.2.4	- Large variety in cultural and professional backgrounds of teaching staff	
1.2.5	- Teaching schedule does not exclude non-traditional students	
2	***Congruence of curriculum elements***	***High internal consistency***
2.1	*Curriculum design appropriate for meeting exit qualifications*	*Intermediate level objective*
2.1.1	- Exit terms of courses (knowledge & skills) meet entrance terms of follow-up courses	- Lower level objective
2.1.2	- Continuous skill development in problem-solving and effective communication	
2.2	*Course design appropriate for program objectives*	
2.2.1	- Course content open to academic and societal changes	
2.2.2	- Study materials, teaching and testing methods appropriate for learning objectives	
2.3	*Effective learning process*	
2.3.1	- Effective knowledge transfer in student-instructor interactions	
2.3.2	- Fast reporting and discussion of testing results	
2.3.3	- High quality facilities (class rooms, computer lab, library etc)	
2.3.4	- Time-efficient course scheduling	
3	***Sufficient funding***	***High level objective***
3.1	*High ratio fast:low-paced students*	*Intermediate level objective*
3.2	*Low drop-out rate*	- Lower level objective
3.3	*Cost-effective teaching efforts*	

following external peer review is expected for 2001. The center loop, the regular evaluation of course materials, teaching and testing methods, has not been institutionalized yet.

III. PRINCIPLES OF QUALITY MANAGEMENT APPLIED TO EDUCATION

A. Stakeholders and Their Objectives

Quality assessment should be carried out in cooperation with all parties who have an interest in the quality enhancement of the educational program [7]. These stakeholders are: administrators, graduates and their (potential) employers, (inter)national peer institutions, teaching staff, and students. The central administration also holds a stake in the design and the implementation of this quality management system, because it must be implemented within the context of the university management system.

A hierarchy of objectives for the SEPA program is listed in Table I. This list has been drawn up from the perspective of the SEPA administrators and does not necessarily include the values of all other stakeholders. However, stakeholders appear to be able to identify themselves with these objectives at the high and intermediate levels. The differences among stakeholder values are more explicit in the operationalization of lower end-objectives, identification of assessment criteria, and preference for the means by which to reach objectives. An example: excellence in teaching is an important objective in the eye of all stakeholders but assessment criteria may differ for students, peer instructors, administrators and potential employers. These different groups may judge the quality of teaching of a math instructor by, respectively, the clarity of explanation of differential equations; the ability of a student-body to apply knowledge of solving differential equations to a dynamic modeling exercise; the degree pass rate for the math course; and the five-year retention of math knowledge of a graduate engineer.

Students are important stakeholders in educational quality assessment. Their main interest, once they are enrolled in the program, lays with the quality of the individual courses and the learning environment. Therefore, they are key stakeholders in the quality of education. Students want their own learning process to be rewarding and effective. They demand that the challenges they are asked to meet have relevance to society.

They desire freedom to set out their own learning path and they want a "do-able" study program. "*Do-ability*" is an ill-defined but important concept in the evaluation of Dutch university programs. "Do-ability" often is interpreted as the efficiency of the learning process and quantified as the extent to which regular students are able to pass a class (or degree-program) within a stipulated time frame. The "do-ability" of a study program is considered low if, for instance, the true study-load exceeds the expected study load or number of credits. Other factors which influence "do-ability" are class scheduling (and opportunities to schedule electives or a study-related experience abroad), availability of learning facilities (meeting rooms, computers, software), and the scheduling of exams.

B. Internal and External Consistency of Educational Programs

As in policy-making, stakeholders change objectives for education in response to changes in the environment in which education is embedded: society and academics [5]. A quality assessment system must be able to reflect these changes, meaning that it must be possible to adjust the choice for assessors and assessment methods according to these changes. In a stakeholder-centered approach to education, the objectives of quality management are high *internal and external consistency* among all elements of the educational program [4].

External consistency is defined as the agreement of stakeholder opinions [4], [7] concerning the academic and societal relevance of the educational program. This criterium for quality indicates not only how stakeholders appreciate the program as a whole, but also if they agree upon the academic level and value to society of program objectives, exit qualifications, course materials, teaching methods and the learning environment. *External consistency* leads to an educational program that is open to and concerned with changes in academics and society. The qualities of such a program enable students to write Master's theses of high academic level addressing practical (or real-world) problems, to acquire jobs in their field of specialization, to be productive in their first jobs early-on, and to apply productive learning skills to further their careers. *Internal consistency*, on the other hand, implies congruence of curriculum design, course design, teaching activities, and program organization. *Internal consistency* leads to a well-integrated program in which classes build on skills and knowledge acquired in preceding classes; teaching and testing methods are appropriate for learning objectives; facilities for teaching and learning are sufficient; and the class schedule allows time for self-study, interaction with teachers, and exam preparation.

C. Quality Assessment Criteria

SEPA designed a quality management system to secure *internal and external consistency* of its educational program. *External consistency* is reached when all stakeholders agree on the program's quality from their point of view. Therefore, INTRAVIEW allows stakeholders to measure the quality of education according to their own values. Thus: although the lower end-objectives in Table I can be used to derive criteria for quality assessment, this is not done in the INTRAVIEW system. Instead, INTRAVIEW focuses on the identification of discrepancies among the opinions of the different stakeholders. Identification of such discrepancies is followed up by investigation and possibly remediation. As far as criteria for *internal consistency* are concerned, the administration has not operationalized these either. Assessment of *internal consistency* takes place in open discussions by the teaching staff and administrators.

All quality assessments are made either through surveys of single stakeholder groups (students or alumni) or in single stakeholder group discussions (students, visiting peer scientists, teaching staff). The surveys make use of standard lists of quality assessment criteria and assess the opinions of large groups of stakeholders in a relatively short time-period. The protocol of the university-wide, automated course evaluation is an example of such a survey. In our experience, a lot of information about the stakeholder opinions remains undisclosed during these standardized surveys. In other words: the quality assessment criteria used in a standardized survey do not always match the criteria that the stakeholders use when they give their opinions on the courses they take. Also, the standardized surveys are administered after courses have been completed and do not support problem diagnosis during the study period.

Quality assessment in group-discussions involves smaller groups of assessors and does not rely on a standardized format. The stakeholders bring in their own points of concern and quality assessments of different program or course characteristics. The class-response group meetings are a good example of these discussions. A self-selected group of students meets once every study period to discuss their opinions on the quality of the classes they are taking at that time. Table II shows two examples of the results of such meetings. The discussions are structured around topics; assessment criteria or judgement scales are not explicit. Nevertheless, the discussions are not hindered by a lack of operationalization of assessment criteria. This is typical for single stakeholder-groups: the assessors share not only expectations but also the language, jargon and judgement-scales to give expression to their opinions.

The need for operationalization does become apparent only when the different groups of stakeholders judge quality differently. We no longer deal with a single stakeholder group when problems are identified by one party and must be solved by other parties. The first step in problem diagnosis, therefore, is explication of the quality assessment criteria which are used to identify the problem. For instance, in a dispute between teaching staff and students about the appropriate ratio of study load versus credit hours, the subjective criterium "study-load" is operationalized and estimated in a first attempt to settle the differences. The operationalization of the criterium "study-load" will depend on the nature of the student complaint and characteristics of the course. Whereas in some course the number of pages of literature may be counted to estimate study load, in other courses students time records of project work may be kept or a comparison may be made with similar type courses taught at the university.

D. Methods for Quality Assessment

INTRAVIEW is a stakeholder-centered approach to quality management rather than an approach centered on didactic principles. In other words, the stakeholder opinions are of primary importance and both the providers of education (teaching staff)

TABLE II
QUALITY ASSESSMENT BY A CLASS RESPONSE GROUP ABOUT A FRESHMEN PROJECT ON METHODS FOR POLICY ANALYSIS, AND A SENIOR-LEVEL CLASS IN WATER MANAGEMENT

Class code and name	**TB192 Mini-projects**
Content	In general students are enthusiastic
Teaching behavior	Sufficient/Good Students experience that the instructors have little discussion among themselves about the group supervision. The resulting differences in advice to project groups cause confusion among students.
Study materials	Good
Project requirements	Sufficiently communicated, even though for some students it was quite unclear what was expected in the beginning. Students indicate that review of reports takes long and they miss feedback on their work.
Teaching methods	Sufficient
Study load	Study load is experienced as high
Class organization	Sufficient

Class code and name	**TB4110 Integrated Water Management**
Content	Good
Teaching behavior	Sufficient
Study materials	Sufficient
Exam requirements	Clear
Teaching methods	Assignments take a lot of time
Study load	Students experience study load as high
Class organization	Good

and the recipients (students, employers, and government) participate. INTRAVIEW collects data from stakeholders only. The system is not concerned with collecting business administration data like student enrollment, degree pass rates, or cost-effectiveness of teaching.

Quality management depends heavily on the type of methods used for monitoring and reporting. A wide range of methods and indicators (both quantitative and qualitative) is available to evaluate quality of education [1]–[3], [6]. These methods range from written surveys to round table discussions to three-day visits by an expert-committee. Flexibility in the choice of methods is needed to be able to adjust for changes in the educational program or facilities. For instance, the addition of a part-time and/or off-campus study program may necessitate different monitoring methods. Similarly, developments in information technology may enable the introduction of an Internet-based application for course-evaluation and replace the written surveys.

To extract the opinions of the different stakeholders, INTRAVIEW uses a wide range of assessment methods and feedback methods. Some of these methods are as follows.

- *Class response groups:* Regular meetings of small groups of interested students (one for each year of study) who report their opinions on the current classes to the education advisor. These observations are used to detect immediate problems, either in teaching or in the overall planning of exams, availability of facilities. etc. The class response groups meet during the day for full-time students, and at night for the students enrolled in the part-time, evening program.
- *Course evaluation:* An Internet-based questionnaire for students, including items on quality of teaching, course materials, teaching and testing methods, experienced study load, as well as study habits of the respondent. The response rate ranges from 70–95%.
- *Review of curriculum revisions:* According to Dutch law, a committee of students and staff advises to the Dean's office on issues regarding revisions in curriculum and course design.
- *Job performance reviews:* Quality of teaching is evaluated as a separate item and may be based on course evaluation reports.
- *Assessment of employment rate and productivity in first job:* A questionnaire is sent-out on a yearly basis to graduates and their employers.

The major effort of INTRAVIEW is given to facilitating the participation of students in quality assessment of courses. Students participate in class response groups (during the teaching period) and in the standard course evaluation (when classes are finished). Student participation is very high: 70%–80% of the student body fills out automated course evaluation questionnaires. The class response groups consist of small groups of students (six to 12) and meet twice during each study period. Results of these evaluations are reported to faculty and administrators. The interests of students in the overall SEPA program (e.g., exit terms) are looked after by the students themselves, serving on committees which report to the Dean's office. Some of these committees are *ad-hoc* (e.g., committee for guidelines on supervision of writing the Master's thesis), others are established and regulated by the law on Higher Education. Consequently, INTRAVIEW does not assess student opinion on curriculum as a whole, societal relevance of program objectives or the do-ability of the overall program.

E. Reporting of Quality Assessment Results

To ensure the continuation of stakeholder participation, INTRAVIEW places emphasis on the use of reliable and fast methods for monitoring and reporting. The feedback of results also is crucial to the quality improvement processes.

TABLE III
SWOT ANALYSIS OF THE TRIPLE-LOOP QUALITY MANAGEMENT SYSTEM INTRAVIEW

Strengths	Weaknesses
• Stakeholder participation is high • Flexibility in choice of assessment methods and assessors • Assessment reports are public • Reports are being used in problem diagnosis and remediation • Results give rationale for (prioritization of) remediation efforts for all program levels	• Assessment reports are not tailor-made to reader resulting in information-overload • Peer-review of teaching methods and course materials is not implemented • Stakeholder participation and problem remediation dependent on availability and initiative of educational adviser
Opportunities	**Threats**
• Curriculum redesign is steered by stakeholder opinion • Dual aim of internal and external consistency leads to innovations in curriculum design • "Intervision"or "teaching quality circles" allowing transfer of teaching skills and experiences among staff members	• High expectations with assessors (especially students) for speed of problem remediation • No records of the benefits of INTRAVIEW in terms of quality enhancement or management • High costs: proper operation of INTRAVIEW requires 0.5-1.0 fte of educational adviser

INTRAVIEW reports results of course evaluations in written form with reference to the course number. The reports do not include the names of the responsible teaching staff but the recommendations for improvement are publicized. These reports are published at the end of each study period according to a standard format. All teaching staff and administrators receive all reports with the results on all courses. This allows comparison among courses.

Table II shows an example of how the discussions of the class response groups are reported to the teaching staff and administration. These data are considered important by all parties involved and may give cause to follow-up action. If necessary, bilateral meetings are organized with instructors to discuss the course evaluation and to find solutions for problems. Assessment results that comment on individual teaching skills are available to the teachers in question and can be used in job performance reviews. If improvements are required, the administration and/or education advisor will follow-up on these and give assistance if so needed. Quality management is not without obligations: the evaluation system is fully integrated in the administration's decision-making processes. Decisions following from quality assessment are binding as adherence to these decisions is considered a prerequisite for *internal consistency*.

F. Problem Remediation: Detection, Diagnosis, Addressing Problems

Problems reported in the course evaluation, or during class response group meetings, receive immediate attention from the education advisor. Problem-remediation follows problem-detection according to a protocol in which the education advisor works closely with the teacher. First, they discuss the opinions of both teacher and students and try to reach an agreement on the cause of a problem (diagnosis). Then possible solutions are designed and the education advisor serves as a personal coach to the teacher if actions have to be taken. This support is targeted on the use of practical teaching methods, assessment of study load, coaching by means of observations and feedback on teaching habits, organizational support etc. The teacher and educational advisor decide together on how to address the problem and on how they may assess the effectiveness of problem remediation. The educational advisor writes a report on the problem remediation process.

IV. DISCUSSION

INTRAVIEW is successful in honoring the human aspects of education and quality assessment both. This is demonstrated by the following aspects of the implemented system:

- stakeholder participation is the basis for quality assessment;
- assessment protocols are consistent with the culture of decision-making;
- assessment methods are easily accessible to the assessors (e.g., Internet-based course evaluation for students);
- feedback of monitoring results is rapid (one to four weeks);
- quality assessment results are available to all relevant stakeholders;
- professional assistance for improvement of teaching skills is available to teachers;
- teacher evaluation is anchored in job performance evaluation;
- decision-making processes with regard to educational quality improvements are transparent; The curriculum review is a continuous process.

In the following paragraphs we discuss further strengths, but also weaknesses, opportunities and threats of the INTRAVIEW quality management system (Table III).

A. Internal Consistency is a Prerequisite for External Consistency of SEPA Curriculum

Based on the results of the (preparations for the) first external review of the entire curriculum in 1997, the SEPA administration decided to overhaul the original curriculum. The curriculum redesign process was initiated to improve the academic and societal relevance of the exit qualifications (*external consistency*). In the process of this redesign, it turned out that to improve *external consistency* a higher level of curriculum integration, or *in-*

ternal consistency, is required. To achieve higher *internal consistency* in the new curriculum, knowledge and skill-building courses have been twinned. This means that the theorery taught in one study period must be applied in a group-project during a consecutive study period. Also, the objectives for the technology courses have been rewritten and are geared more specifically toward enhancing the SEPA problem-solving skills.

B. Evaluation of External and Internal Consistency Requires Teacher Participatation

According to the original design of INTRAVIEW, courses would be evaluated on a once-a-year basis with regard to course materials and teaching. This would be done through a peer review and a report of study progress. Implementation of such a peer-review process has been more difficult than expected. A formal process of peer review of teaching has not been institutionalized, neither formally nor informally. The teaching faculty is involved in the discussions and reviews of curriculum and course designs but the implementation of course design is not evaluated. The choices made with regard to course materials, teaching and testing methods, are not reviewed by peers either. This is unfortunate.

The people who deliver the educational program do not contribute now to the quality assessment. This hampers the assessment of both *external* and *internal consistency* since teachers operationalize program objectives (Table I) in different ways than students, alumni, or employers might. Consequently, a peer review would give another perspective on the contribution of individual courses to the academic quality and societal relevance of the study program. Furthermore, several aspects of *internal consistency* cannot be properly assessed without involving the teaching faculty. Teachers can give expert judgement on the matching of exit and entrance qualifications of follow-up courses, the contribution of teaching methods to developing and practicing problem-solving skills by students, the matching of learning objectives and testing methods, etc.

Another aspect of not having implemented the second loop of the quality management system is that information is not transferred from inner to outer loops (Fig. 1). Consequences are: information of successes and failures in teaching are not effectively transferred to peers; issues in implementation of course design is not communicated effectively to the curriculum designers, congruence of program elements is not discussed in a formal setting; problem diagnosis must depend on student opinion only. Since SEPA is a relatively small organization, impromptu discussions in the hallways and co-teaching activities do pick up a some of the slack in this information transfer. On the other hand, a quality management system should not depend on informal assessment or problem diagnosis. Thus: in view of the objectives for the SEPA program, the lack of peer review is a missed opportunity for quality enhancement and professional improvement.

Peer-review of teaching activities is not institutionalized in the Dutch university system. This implies that it is not part of the DUT culture to ask or give peers time and thought in reviewing the different aspects of teaching. Can this be changed? Peer review requires that there is time available for activities that may not directly benefit one's own performance. It also requires a well-developed analytical framework and skills to observe teaching activities, materials, and student response. And, last but not least, these reviews require a high degree of trust. Perhaps there are possibilities for implementing peer review with strong support of the administration. When SEPA started, there was a window-of-opportunity to implement an quality management system unlike the systems at other schools within the university. For instance, it was not necessary to break old patterns when student response groups were started and published openly. Seven years later, this is no longer the case. Therefore, to implement peer review in the current culture it will be necessary to specify the goals peer review will serve. Such goals could be

1) more information to assess external and internal consistency of the educational program;
2) higher congruence of program elements;
3) support of the introduction of new, innovative teaching methods;
4) professional improvement in teaching.

C. Problem Diagnosis and Remediation

Teachers do take the student assessments very seriously. Positive feedback is very rewarding; negative feedback often elucidates why class participation or test results did not meet teacher's expectations. Student opinion, in particular, turns out to be a key factor in creating willingness on the part of teachers to adjust and readjust course materials, teaching methods and teaching style.

Problem detection depends on the quality of the list of assessment criteria. The results from class response groups often yield more, and more timely, information on student experience than the automated standard university-wide evaluation. First, teachers are informed of the nature of negative assessments during the study period, which gives opportunities for changes during the course. Second, unlike the automated course evaluation, the class response group does not use a set of standardized criteria but chose criteria relevant to the topics of discussion. For instance, problems related to the use of the English rather than the Dutch language by teachers go undetected in the automated evaluation. During a class response group, however, students may indicate that the use of the English language posed a problem in participating in class discussions and impeded their learning process.

The percentage of students participating in the automated course evaluation in the quality management system is high (70%–90%) and underscores the importance of the data gathered in this evaluation. Once students are actively involved, they expect fast remediation of perceived problems. This poses a challenge to the administration and education advisor in finding a middle road between *ad-hoc* problem remediation and development of mid-term or long-term policies for quality improvement.

D. Time is Money: Operation of INTRAVIEW is Expensive

Two important goals for INTRAVIEW, the participation of the various stakeholders and remediation of problems, depend

in large part on the efforts of the educational advisor. If students are unsatisfied, the educational advisor alerts the teacher(s) involved. In fact, he takes on the role of watchdog rather than the INTRAVIEW system itself. His role, and the personal relationships he has built up with all faculty members, are crucial to the quality enhancement and problem remediation. Nevertheless, the efforts of the educational advisor are not secured within the system since INTRAVIEW does not have its own budget. This means that, even though the availability of the educational advisor is crucial for monitoring, diagnosis, and remediation of problems, it is not guaranteed. To ensure funding of the quality management system, it is important that its results are made visible. Yearly reports on objectives and achievements in quality enhancement, and the effectiveness of problem remediation and prevention, may be used to evaluate the budget needed for INTRAVIEW.

E. INTRAVIEW is a Tool Developed by and for Administrators

INTRAVIEW was developed at the initiative of the SEPA administration and serves foremost their needs for information. This is underscored by the SWOT-analysis. The goals of the administration in setting up and maintaining a quality management system are being met. Weaknesses in the system can be changed by the administration but the need for this has not been felt yet, apparently. In general, students and staff are satisfied with the system and want it to work. The availability of the educational advisor for reporting and consultation is considered to be crucial in that respect. Students see the advisor as an important human factor in "being heard" as they know that their opinions will be transferred anonymously to the teaching staff and administration. The staff relies on the advisor to be receive timely information on student opinion and to discuss possible solutions to problems that may occur.

What would INTRAVIEW have looked like if it had been developed from a multi-stakeholder perspective? The triple-loop system would exist and *external* and *internal consistency* would still form the objectives of quality management. The SEPA administration would be considered a stakeholder and participate in quality assessment. Consequently, the set of assessment criteria would be expanded to the efficiency of teaching effort, effectiveness of knowledge transfer and skill development in relation to teaching effort, exam and degree pass rates etc. The choice of assessment methods would shift. Reporting would still be public and accessible to all, but feedback of assessment results would be tailor-made to prevent information-overload. Publication of quality assessments would not be limited to problems experienced by students, but address all problems indicated by any of the stakeholder groups, including the administration. Peer review would become much more prominent in the system to better evaluate teaching effectiveness. Peer faculty opinion would result in transfer of successful teaching experiences and so help remedy and prevent problems related to teaching quality. Benchmarking of teaching efforts would be used to find ways to improve teaching effectiveness. The design for the INTRAVIEW system was based on the concept that an educational program serves multi- stakeholder interests. INTRAVIEW has not yet reached the full potential of this design.

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