OUTCOMES-FOCUSED EVALUATION OF ENGINEERING PROGRAMS – INHIBITOR OR STIMULANT FOR IMPROVEMENT?

Marie Arehag
Josefin Bertilsson
Åsa Ekvall
Erika Hansson
Johan Malmqvist
Lena Peterson
Ulla Rilby

Chalmers University of Technology, SE-41296 Gothenburg, Sweden

ABSTRACT

In Sweden, a new model for quality evaluation of higher education is being introduced. It is internationally unique. A very strong emphasis on assessing the quality of an entire education through its outcomes, defined by samples of final degree reports, is perhaps the most original feature of the model. This is claimed to enable a direct assessment of quality rather than the indirect assessment used in conventional models. The model has, however, been intensively debated during its development and first years of use. The aims of this paper are first to evaluate in what ways and to what extent the Swedish national model for evaluation of higher education contributes to the quality improvement of the evaluated programs, and second to describe and evaluate an approach for organizing the project to prepare the evaluation documentation for a large-scale education evaluation. The paper concludes that on an overall and averaged level, the project participants estimated that the model will contribute to positive effects. Specific areas are identified including ethics and focus of final degree reports. However, there is a strong variance in the data: There is a substantial fraction of participants who have not identified any improvements or weak spots, and who do not think that the evaluation preparation will positively affect education quality development. Chalmers University of Technology chose to approach the evaluation with a centrally managed project. The setup gave possibilities for rationalization through common training, supporting materials, a common document database and for information sharing across departmental boundaries. Nevertheless, the project was very time-consuming with an average of 540 hours spent for each program/degree.

KEYWORDS

Program evaluation, Accreditation, Education quality assurance, Sweden

INTRODUCTION

To prepare an engineering program for a national evaluation or accreditation is a very time-consuming activity regardless of the model used for the assessment. A university invests many hours on documentation of intended learning outcomes, quality assurance processes, and faculty qualifications. Arguably, such an investment in time should not only lead to a stamp that

the education meets certain criteria but also to specific improvements of the education. Nevertheless, many evaluation and accreditation models are criticized for mainly driving quality control, not improvement [1].

In this paper, we examine a new and internationally unique higher education evaluation model recently introduced in Sweden [2], with respect to its effects on the quality control vs. improvement aspects of evaluation and accreditation. A distinguishing feature of the model is its strong focus on evaluating the outcomes of the education, as specified in the national degree ordinance [3], rather than the aims, processes and capabilities that typical accreditation procedures focus on, see, for example [4]. The quality of final degrees projects is assessed and given a high weighting factor in the overall assessment. The evaluation model further features a three-level scale for rating entire programs/degrees with the levels – "insufficient quality", "high quality", and "very high quality". A program's rating will affect its governmental funding. The system has been discussed intensively during its development and first years of use, as reported later in this paper. This controversy has brought assessment of education quality to the forefront of the academic debate in Sweden. There are thus good reasons to carefully evaluate the effects of the new model.

The present study provides such an evaluation in the context of the 2012-13 Swedish national evaluation of engineering programs. This was the largest evaluation project so far, comprising about 500 programs/degrees across Sweden. We are examining Chalmers University of Technology's approach to organize the work to prepare its evaluation materials. The effort comprised 50 programs/degrees and more than 100 people were engaged. From the outset, Chalmers maintained a "triple aims" strategy to the effort. Chalmers was going (a) to convince the external evaluators that its programs are of very high quality and, (b) to identify potential areas of improvement, beyond the thresholds of the evaluation, and (c) to execute the project with limited resource consumption. The aims of this paper are to:
- Evaluate in what ways and to what extent the Swedish national model for evaluation of higher education contributes to the quality improvement of the evaluated programs.
- Describe an approach for organizing the project to prepare the evaluation documentation for a large-scale education evaluation, and to evaluate the efficiency of the approach.

In the paper, we first outline the fundamentals of the Swedish education evaluation model. We then describe how Chalmers planned and performed the "triple aims" strategy for the evaluation process. We then account for the results from a survey study directed to Chalmers' project participants. The results section first analyses the impact of the evaluation model on education quality development and then discusses the time effort spent on preparing the evaluation material, and the feasibility and effectiveness of the triple aims strategy. This paper will mainly focus on the internal effects of the preparation. Another paper will compare the internal perceptions with the external evaluators assessment.

THE SWEDISH NATIONAL MODEL FOR EVALUATION OF HIGHER EDUCATION DEGREES

The new Swedish national system for evaluation of higher education (in operational use since 2011) [2] is unique in its strong emphasis on the evaluation of the outcomes of the education. This is in contrast to other quality assurance systems, for example the EUR-ACE standards [4] or the earlier Swedish model [5] where there is a stronger emphasis on the evaluation of processes and resources (e.g. teaching staff competence, contact hours, learning infrastructure, course evaluation procedures). The argument for this new model is that a focus on outcomes is

a "direct" method for quality assurance, whereas traditional models only indirectly assess the quality of the education [6].

In the model, assessment of the quality of final degree projects is given a central role. They are claimed to give an accurate view of what graduates know upon graduation: "*The government considers the independent work (degree project) as central for confirming that the student has fulfilled the requirements for the degree. In the independent work, the student shows that he or she does not only has amassed factual knowledge, but also can apply and further develop this knowledge with the level of independence that is required to practice the profession that the education prepares for, or for entering a more advanced level of studies*" [7]. Nevertheless, the basis for the evaluation also includes more typical components and thus consists of:
• Final degree projects.
• A self-evaluation report.
• Alumni surveys.
• Student interviews.

The final degree reports are randomly selected, typically summing to 20-40 % of the reports from a program, the given year. The main purpose for the self-evaluation report is to provide evidence that the education meets those goals stated in the national degree ordinance, whose fulfillment is not demonstrated in the final degree reports. The requirements on the account for the goal fulfillment are ambitious. It is not sufficient to present intended learning outcomes. Rather, the account needs to include descriptions of learning activities, assessment tasks and right/wrong solutions to assessment tasks, in order to provide evidence for that all graduated students have reached the goal. The self-evaluation report also includes an analysis of the teacher competence and staffing in relation to the focus of the program and the number of students in the program. The alumni survey is designed by the Swedish National Agency for Higher Education and collected by Sweden Statistics (www.scb.se).

The evaluation is a three-phase project. In the first phase, review panels with academic, industrial and student members are formed. Universities, companies and student unions are invited to propose panel members. The first task of the review panel is to adapt the general evaluation model to the field (for example, "engineering"), by selecting goals to be accounted for in the self-evaluation reports, and by designing rating criteria for each of the selected goals. The selection of goals is guided by a preliminary assessment of final degree reports, which aims to identify what national goals are likely to be demonstrated in these and what are not. Typically 50-60 % of the goals should be accounted for in the self-evaluation reports. As an example, Table 1 shows the national goals for the "Civilingenjörsexamen" (MScEng degree) and indicates which goals that were selected to be accounted for in the self-evaluation reports. When the goals have been selected and criteria designed, they are announced to the universities. The universities then have eight weeks to author and deliver the self-evaluation reports. The randomly selected final degree reports are delivered to a separate deadline.

Based on the four components of evaluation documentation, the review panel then assesses each educational program and gives it a rating on a three-level scale: "insufficient quality", "high quality" or "very high quality". An "insufficient quality" rating means that the university's right to award the degree is questioned and that the university has one year to submit a plan of action in order to correct the deficiencies. At the other end of the scale, additional governmental funding, on the order of magnitude of 5 %, rewards a "very high quality" rating. It is expected that an "insufficient quality" rating will noticeably lower student recruitment to the program. The evaluation results will thus be even more important for universities than in the earlier system where only pass-fail ratings were awarded.

Table 1. Swedish national goals for "Civilingenjör" degrees vs. goals to be accounted for in self-evaluation reports.

To be awarded the "Civilingenjör" degree the student should demonstrate	Selected
Knowledge and understanding	
knowledge of the scientific foundation, and proven experience of, the chosen technology field, as well as insights into current research and development work	X
both a broad knowledge within the chosen technology field including mathematics and science, as well as significantly deepened knowledge within certain parts of the field	X
Skills and abilities	
ability to, holistically, critically, independently and creatively identify, formulate and handle complex problems, as well as participate in research and development work and thereby contribute to the knowledge development	X
ability to create, analyze, and critically evaluate different technical solutions	
ability to plan, and with suitable methods carry out, qualified tasks within given constraints	
ability to critically and systematically integrate knowledge and demonstrate ability to model, simulate, predict and evaluate events, also with limited information	
ability to design and develop products, processes and systems with consideration of human prerequisites and needs and the society's goals for economically, socially and ecologically sustainable development	X
ability to work in teams and collaborate in groups with different compositions	
ability to, in national as well as in international contexts, orally and in writing, clearly communicate and discuss their conclusions, and the knowledge and rationale underpinning these, in dialogue with different groups	X
Formulation of judgements and attitudes	
ability to formulate judgements considering relevant scientific, societal and ethical aspects, and demonstrate an awareness of ethical aspects on research and development work	
insight into the possibilities and limitations of technology, its role in society and the responsibility of humans for its use, including social, economic as well as environmental and occupational health aspects	X
ability to identify their need for more knowledge, and to continuously develop their competence	

The system has been heavily debated during its development and first years of use. Critics have maintained that it is very difficult, very costly and fundamentally unreliable to assess the quality of an education mainly based on the final degree project [8] and that it does not meet the international requirements on a quality assurance system for higher education [9]. Some have gone so far as claiming that the evaluation model risks creating total havoc in the system [10]. Nevertheless, Swedish universities have to work with the system.

CHALMERS PROCESS FOR PREPARING THE EVALUATION DOCUMENTS

In a way, it can be argued that Chalmers' work with preparing for the new evaluation started already in 2007 when a new ordinance for higher education degrees was introduced in Sweden [3]. For engineering degrees, it contained a new, larger, set of specified goals (12 as compared to 3 before), and the notion that the goals were learning outcomes that the graduate should be able to demonstrate. Chalmers and other Swedish universities spent the following years adapting to the new requirements: making them known to program directors and teachers, implementing them in program goal statements and course syllabi, accommodating the alumni surveys for following up on them. During the same time the new evaluation model evolved and it eventually became clear that the quality of final degree projects would be assessed. Thus, work was also undertaken to improve final degree project quality.

When the evaluation of engineering degrees approached in 2012, Chalmers realized that the project would be very challenging: there was no experience in the organization of documenting evidence of learning in the way required, there were no published results from earlier evaluations to learn from, the exact timetable was not known, the project would be large (50 self-evaluation reports and 700+ final degree reports to be delivered from Chalmers) and so on. Chalmers decided that a common, centrally managed project would be necessary to guarantee that all evaluation documentation delivered from Chalmers would hold a very high quality. Positive experiences from similar centrally supported and coordinated projects contributed to the choice of strategy.

The goals stated for Chalmers' project included that:
- > 75 % of Chalmers programs' would be given the "very high quality" rating.
- The project should provide a basis for the continued development of the quality of Chalmers education.
- The project should provide a professional support for the main authors including time planning, administrative and pedagogical support and project communication.

The organization structure included specific roles as project leader, communication officer, management team liaison, HSV liaison, main author, pedagogical expert, communication expert, team coordinators, directors of studies as well as student representatives. It was realized that efficient information sharing would be crucial. Chalmers e-learning management system "Pingpong" was set up to collect all information in one place accessible for all project participants. Pingpong was also used for versioning of the self-evaluation reports. Chalmers further realized that some parts of the self-evaluation reports would be rather similar and thus tasked certain participants to write templates for these elements that could be adapted for all programs. This was a measure to increase the efficiency of the project by a smart re-use of some of the documentation. Chalmers decided that the project should include an ambitious training program for the main authors (program directors) and for the pedagogical and communication experts that would provide support and feedback for the main authors, in order to develop the competence to write high quality self-evaluation reports.

This training and planning phase was thus the fundament when the project went into the implementation phase. According to the design of the evaluation model, the final self-evaluation reports should be delivered eight weeks after the final prerequisites of the evaluation are announced. Since the selection of which goals that would be assessed (six out of twelve goals for MScEng degrees) and associated rubrics are not made public until then, the main parts of the self-evaluation reports need to be written during an eight-week period. This was a very hectic phase, involving more than 100 people contributing to the 50 reports with multiple versions and iterations, but ultimately all reports were delivered on time.

During Spring 2013, the review panels will assess the self-evaluations reports and final degree project reports. Site interviews (to be carried out by videoconference) with students and university representatives take place in April. The evaluation results will be announced in September. In January-February, Chalmers carried out the internal evaluation of the project, which is reported on in this paper. For a summary of the Chalmers process, see Table 1.

Table 2. The Chalmers process

	Year / period	Activity
Strategic adaption	2007	New national degree ordinance introduced
	2007-2011	New evaluation model developed Chalmers adapts program descriptions, course syllabi and alumni surveys to align with national degree requirements Work to improve quality of final degree reports
Planning & training	2012 Jan-Feb	Project planning and staffing
	2012 Mar-Sep	Training workshops for program directors and pedagogical experts on how to understand the task, the evaluation model, and on how to author and review self-evaluation reports Set up of e-learning management system
Implement-ation	2012 Oct 15	National evaluation start-up meeting. Announcement of goals to be assessed in evaluation
	2012 Oct-Dec	Authoring of self-evaluation reports Delivery of random sample of final degree reports
	2012 Dec 18	Delivery of self-evaluation reports
Internal and external review	2013 Jan-Feb	Internal evaluation
	2013 Feb-May	Site interviews
	2013 Sep	Announcement of evaluation results

SURVEY DESIGN AND RESPONSE RATE

A survey was used to evaluate the efficiency and outcomes of Chalmers' process. The survey comprised 40 questions. 32 were quantitative, posed as questions or statements, usually with a five-level Likert or ratio scale. Eight were free text questions, allowing respondents to identify strengths and weaknesses of the process, and to elaborate on their responses to some of the quantitative questions.

The questions covered areas such as time spent, clarity of roles, quality and timing of project communication, satisfaction with support from administrators and pedagogical experts, and on the predicted effects on the future quality improvements of Chalmers' programs. Examples of questions include "*How satisfied are you with the timing of the project communication?* (*not at all satisfied*, *dissatisfied, satisfied, very satisfied, very much satisfied)"* and "*Through the work with the self evaluation report, I have identified (0, 1-2, 3-5, > 5) ideas for improvement of my program*".

The survey was sent to 110 people. 81 responded (74 %).

RESULTS

Given the considerable amount of time that the university needs to spend on preparing documentation for a quality evaluation, a good evaluation model would also lead to specific effects in education beyond securing that minimum threshold standards are met. In this section, we first present and discuss related to the quality improvement aspects of the effort, and then consider the efficiency of the project execution.

Effects on education quality improvement

Improved understanding and competence

One potential contribution from a self-evaluation endeavor is that it might improve the program director's and the teachers understanding of the program and thus improve decision-making, cooperation and communication. Another is that it could have a competence developing effect that would help program director's become better at their task. Figures 1 and 2 show how the respondents rated the evaluations contribution to their understanding of the program and their personal competence development. The average values are 3.2 (out of 5) and 2.8 (out of 5) respectively, corresponding roughly to "to some degree". One program director notes: *"Now, I have to admit that there were major values to the exercise. Today's learning outcomes for the master degree do not only focus on traditional knowledge that can be assessed through written exams, but are very modern and require a variety of teaching and assessment methods beyond the individual study for a written exam."* Working through the self-evaluation report with its requirements on documenting how student develop complex skills such as "ability to, holistically, critically, independently and creatively identify, formulate and handle complex problems" developed this program director's insight. It is also apparent from Table 2 that many of the evaluated goals do not map directly to the subject matter of a single course, and that a broader view on an engineering programme than the discipline (e.g. computer engineering) is required by the government. Programs need to demonstrate evidence for developing communication skills as well as insights into to role and impact of technology in society. The evaluation forces programs to develop an active and articulated approach to the inclusion of such skills in the program. Although Chalmers began efforts to implement the requirements of the new degree ordinance in 2007, the work with this evaluation has made it impossible for program directors and others to remain unknowing of the wordings.

It thus seems that the work with the self-evaluation has lead to a deeper understanding of the program, especially for most of the program directors. "*I got to learn the details of the courses in my program through the work*". However, some argue that the cost to reach this understanding was high: *"I have learnt a lot about the program, which is good but not particularly surprising since I have spent 237 h on the task. These 237 h could definitely have been spent in a better way."*

We also note that the values for the program directors are significantly higher, 3.7 and 3.1, than the average. The learning effect seems to be stronger amongst who have spent most time on the reports. This result is not surprising, but is a reminder that sharing the developed knowledge and understanding is a challenge, which needs attention. There is a risk that the learning effect is strongly connected to the individual, and when a program director leaves the role, the knowledge is lost.

Identification of ideas for improvement and of weak spots

On a more specific level, the work with a self-evaluation report could potentially result in identification of specific improvement opportunities and/or weak spots in the program. Figure 3 shows the results from these questions. We notice that some program directors (33 %) have identified a significant number of improvements (3 or more) and 21 % have identified 3 or more weak spots.
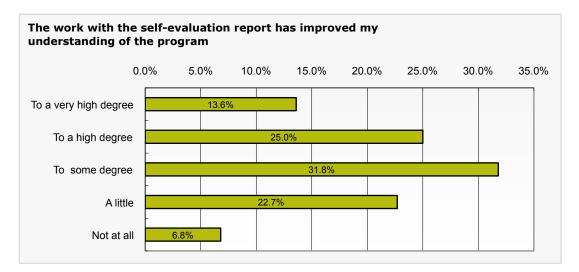
The work with the self-evaluation report has improved my understanding of the program

To a very high degree	13.6%
To a high degree	25.0%
To some degree	31.8%
A little	22.7%
Not at all	6.8%

Figure 1. Improved understanding (learning)

The work with the self-evaluation report has taught me things that have developed my competence as a program director (or similar)

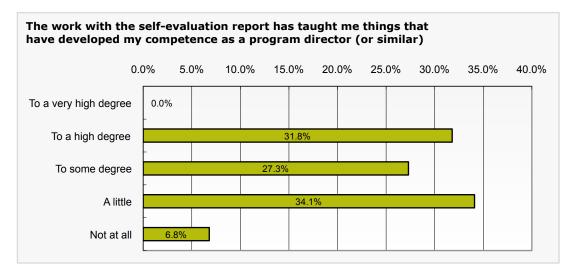|	
To a very high degree	0.0%
To a high degree	31.8%
To some degree	27.3%
A little	34.1%
Not at all	6.8%

Figure 2. Competence development

A weak spot that was identified by several programs was that of "ethics". According to the national degree ordinance for Master of Science degrees, a graduate should demonstrate "*ability to, within the main subject of the education, make assessments with consideration of relevant societal and ethical aspects*" (abbreviated goal). Another goal that recurred as a weak spot was to "*identify and formulate complex problems*". Common for these is that many programs found it challenging to contextualize the general goals. What does "ethics" mean for the main subject of chemical engineering? Following the work with the self-evaluations, several of Chalmers programs have initiated work to contextualize and include ethics into the programs. Another challenging goal to demonstrate evidence for fulfillment of was to "*independently identify and formulate problems*". Again, the difficulty was not only connected to showing evidence for the learning of the skill, but also in the interpretation. What does "independent" imply? In which of our courses do students rather than the teachers formulate the problems to be addressed? Other recurring identified weak spots were less difficult to interpret but nevertheless the self-evaluation work made it clear that there could be improvements, including oral communication skills and the ability to solve qualified problems within a given time frame.

The work with the self-evaluation report has helped me identify improvement opportunities and/or weaknesses to/in the program

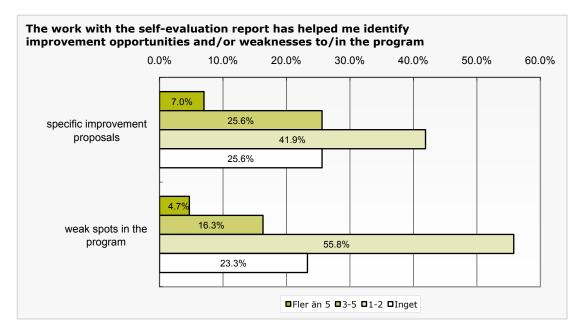|	
specific improvement proposals	7.0% / 25.6% / 41.9% / 25.6%
weak spots in the program	4.7% / 16.3% / 55.8% / 23.3%

□Fler än 5 □3-5 □1-2 □Inget

Figure 3. Identification of improvement opportunities and weaknesses.

However, we also notice that 56 % of the respondents have only identified 1-2 weak spots, and that close to 25 % have not identified any. Although a low number of identified improvement possibilities and weak spots also can be interpreted as that those programs are of very quality already or that the improvement possibilities/weak spots are already known, it seems that the Swedish evaluation model does not escape a criticism that other quality assurance models encounter, namely that they do not encourage a self-critical analysis and documentation that would include the formulation of improvement proposals.

There is a difference between different groups. Amongst the "Civilingenjör" (MScEng) program directors 58 % have identified at least three improvement possibilities and 38 % at least three weak spots. The corresponding numbers for master program directors are 5 % for both improvements and weak spots. The "Civilingenjör" program directors were the main authors of the reports and devoted most time to the task. It seems that a large investment in terms of time is needed to reach the level of understanding of the evaluation model that supports the use of it to help identify improvement possibilities and weaknesses.

A guide for future development

It could further be argued that a self-evaluation report contains a documentation that could be used to guide future development of the program. Free text responses suggest that this is possible and desirable: *"We need to use the contents of the self-evaluation reports – evolve them into living documents which are continually updated. The document (and the documentation process) is too valuable to "only" be used to report to the national agency. This is were the work really starts."* Others voices concern that the ideas may be lost in daily work: *"There is quite of lot of good material in the reports, but the question is if we have the ability to approach these issues or get stuck in the day-to-day workflow."* The answers to this question (Figure 4) are more pessimistic than the learning and understanding questions (Figure 1 and 2). The average is 2.9 with as many as 40 % answering "a little" or "not at all". Again, there is a notable difference between main authors (3.3) and other respondents (2.5), indicating that it will be very much up to the program director to drive the use of the report in the future.
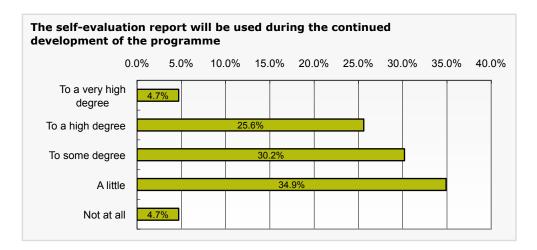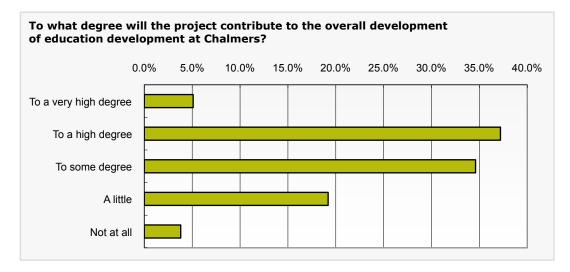
The self-evaluation report will be used during the continued development of the programme

To a very high degree	4.7%
To a high degree	25.6%
To some degree	30.2%
A little	34.9%
Not at all	4.7%

Figure 4. Continued use of the self-evaluation reports

To what degree will the project contribute to the overall development of education development at Chalmers?

Figure 5. Predicted overall effects on educational quality at Chalmers

Finally, we asked the respondents to rate to what degree the project will contribute to the overall development of education quality at Chalmers (Figure 5). Again, the average is just above "to some degree" (3.2), and there is significant variance in responses. Program directors were more positive than average (3.4) but the most positive group was the pedagogical and communication experts (3.5). The master program directors were less positive (2.8). It was earlier shown that the project communication was not as efficient in reaching these groups. It is very possible that this caused a lower sense of involvement, which in turn relates to a less positive view of the future effects of the work.

Project execution

Chalmers third goal was to provide a professional support for the main authors including time planning, administrative and pedagogical support and project communication. The main strategy for reaching this goal was to operate the project as a centrally managed project.

The total time spent as estimated by the respondents was summed to circa 15 person-years, or 0.3 person-years/540 hours per program/degree. The number clearly shows that this kind of evaluation requires a huge time commitment from universities. A very rough estimate indicates that this corresponds to between a half and two thirds of the yearly financial reward that Chalmers would obtain if it reaches its goal of 75 % programs with a "very high quality" rating. (The financial reward is granted for a four-year period, though.).

The overall satisfaction with the project was marginally positive (3.2). The involvement of pedagogical experts and communication experts was valuable (3.8). Roles were clear (3.7) and project communication efficient, although with such exceptions, notably master program directors and directors of studies, who seem to have felt less involved in the project.

The centrally managed project also produced some common texts and data, which could be used as-is or easily be adapted to a particular program's specifics. Some of these materials were used by many programs (guidelines, alumni survey, course evaluations, text on final degree reports). Some was re-used to a lesser extent (self-evaluation reports from other evaluations, a review guide). However, the lowest re-use rate was 31 %, indicating that all common materials were re-used to a substantial degree. In the final summary, it is likely that this re-use made the total effort somewhat reduced.

In many of the responses, however, there is a significant variance. Respondents are suggesting both that Chalmers project was right in starting early with the training even though the pre-requisites were not known then, while others maintain that the project should have postponed its' kick-off until more was known. Some state that it was positive that the project was centrally managed, whilst other argue that there should have been less "top down" management. Many, however, find that that approach with a common project had a symbolic effect, indicating the high priority that Chalmers as a whole placed on the evaluation. In the words of one respondent: "*The work with the HSV evaluation has further positioned undergraduate education as a central, essential element of Chalmers operations*".

CONCLUSIONS

The new Swedish higher education evaluation model brings the attention to some unique aspects not generally assessed in other evaluation models, including the quality of final degree projects and the required demonstration of evidence of learning of some new (since 2007) complex learning goals. These elements could potentially stimulate educational improvement. These benefits should be contrasted with the resource consumption. To prepare the documentation for a higher education evaluation in the new Swedish system is a substantial effort. Many others, primarily teachers, provided course material such as assessment task and statistics to the self-evaluation reports to prove that the program fulfils the goals. The massive documentation efforts risksto over-shadow the improvement stimulus.

This study has primarily investigated the participants' views on to what extent the work with preparing the evaluation materials may contribute to positive effects on education quality at Chalmers. It is difficult to provide a clear-cut answer to this question. On the one hand, the data from the survey suggests that, on an overall and averaged level, Chalmers project participants agree that the project will contribute to improved educational quality at Chalmers in the future. The data from the survey further indicated that certain specific effects may be identified, e.g. that program directors have developed a deeper understanding of the national goals and how their programs fulfil them, and that improvement possibilities and weak spots have been identified. It

is further likely that the design of the evaluation system will lead to an increased focus on final degree report quality and relevance for the subject are of the program. Finally, program directors have become aware that "ethics" has been less well integrated in many programs at Chalmers. However, there is a strong variance in the data: There is a substantial fraction of participants who have not identified any improvements or weak spots, and who do not think that the evaluation preparation will positively affect education quality development at Chalmers University of Technology.

Chalmers University of Technology (10,000 engineering students) chose to approach the evaluation with a centrally managed project. The setup gave possibilities for rationalization, e.g. through common training, supporting materials, a common document database and for information sharing across departmental boundaries. In the project, Chalmers delivered 50 self-evaluation reports and 744 theses to the National Agency for Higher Education. Nevertheless, the total time spent has been estimated to 15 person-years, or 540 h/program. 110 people were actively involved with preparing the documentation.

REFERENCES

[1]   Gray, P. J., Patil, A. S., Codner, G., "The Background of Quality Assurance in Higher Education and Engineering Education", in Engineering Quality Assurance – A Global Perspective, pp 3-25, Springer-Verlag, 2009.

[2]   Swedish National Agency for Higher Education (HSV), Högskoleverkets system för kvalitetsutvärdering 2011–2014 (HSV System for Quality Evaluation), Rapport 2010:22 R, Stockholm. Sweden, 2010. In Swedish.

[3]   Ministry of Education and Research. Higher Education Ordinance, SFS 1993:100, with amendments up to SFS 2006:1054, Stockholm, Sweden, 2006.

[4]   European Network for Accreditation of Engineering Education (ENAEE). EUR-ACE Framework Standards for the Accreditation of Engineering Programmes. Retrieved May 4, 2009 from http://www.enaee.eu/pdf/EUR-ACE_Framework_Standards_20110209.pdf, 2008.

[5]   Swedish National Agency for Higher Education (HSV), Evaluation of Civil Engineering Programs at Swedish Universities and Institutions of Higher Education, Rapport 2006:31 R, Stockholm, Sweden, 2006.

[6]   Nilsson, K.-A., Direkt kvalitetssäkring. Bedömning av utbildningens resultat och relevans (Direct Quality Assurance. Assessment of Educational Outcomes and Relevance), Lund University, Department of Evaluation, Report Nr 2009:255, Lund, Sweden, 2009. In Swedish.

[7]   Utbildningsdepartementet, Högskolepolitiska propositionen: Ny värld – ny högskola (Proposal for Higher Education Policy: New World – New Universities), Stockholm, Sweden, 2004. In Swedish.

[8]   Lindberg-Sand, Å., Koloss på lerfötter? Utveckling av metodik för resultatbaserat nationellt kvalitetssystem i svensk högre utbildning (Colossus on Clay Feet? Development of Outcomes-Based National Quality System for Swedish Higher Education), Centre for Educational Development, Lund University, Lund, Sweden, 2011. In Swedish.

[9]   Accreditation Organisation of the Netherlands and the Flanders (NVAO), Swedish National Agency for Higher Education: Review of ENQA Membership, Technical Report, 2012.

[10] Adamson, L, Flodström, A., "Political Meddling in Quality Assurance Spells Chaos", University Worlds News, 11 November 2012, http://www.universityworldnews.com/article.php?story=20121107150730970#comments, accessed on March 6, 2013.

BIOGRAPHICAL INFORMATION

Marie Arehag holds a BA degree in natural sciences and mathematics from the University of Gothenburg. She has since the mid 80-ies worked with curriculum development within Chalmers University of Technology aiming at the integration of environmental/sustainability sciences, humanities and social sciences in engineering education, and in the recent decade also with pedagogical development reform work. She acted as project manager for the central support for self-evaluation report work and coordinated the pedagogical and communication reviewers.

Josefin Bertilsson is a student in Chalmers MScEng in Mechanical Engineering program, and acted as the Student Union's representative during Chalmers evaluation project.

Åsa Ekvall holds a higher Education Diploma in Communication from Stockholm University. She works in Chalmers Student and Education Office and acted as a Communications Officer in Chalmers evaluation project.

Erika Hansson holds BA degrees in Media and Communication Science and Cultural Sciences from the University of Gothenburg. She works in Chalmers unit for Operative and Strategic Support and acted as a project manager in Chalmers evaluation project.

Johan Malmqvist is a Professor in Product Development and Dean of Education at Chalmers University of Technology, Gothenburg, Sweden. He is a co-author of *Rethinking Engineering Education: The CDIO Approach* (Springer, 2007). His current research focuses on information management in the product development process (PLM) and on curriculum development methodology.

Lena Peterson is an associate professor in Electronic Design and Dean of Education at Chalmers University of Technology. Her research interests are design methodologies for analog circuits and mixed-mode electronics systems and the learning and understanding of such methodologies.

Ulla Rilby holds a LicEng degree in Materials Science. She is a Quality Assurance Manager and acted as project leader of the Chalmers evaluation project. She has a long experience of working in different roles in Chalmers education system.

Corresponding author

Prof. Johan Malmqvist
Chalmers University of Technology
Department of Product and Production Development
SE-41296 Gothenburg, Sweden
46-31-7721382
johan.malmqvist@chalmers.se