EXPERIENCES FROM USING INTEGRATED PROGRAM DESCRIPTIONS TO SUPPORT PROGRAM DEVELOPMENT

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Abstract
Integrated program descriptions constitute a framework for the information produced during a program development process, as well as to support the development process per se. An integrated program description describes the goals, content and structure of an educational program, and how these are connected. The intent is to provide the program director and other key stakeholders involved in the program development process with a set of tools that can facilitate their development process. In this paper, we describe how the concept of integrated program descriptions was applied in a multi-program development effort, the development of 44 new master programs at Chalmers University of Technology, Göteborg, Sweden. The aims were to document and analyze experiences gained when using integrated programme description to support the development of these new programs, and to develop recommendations for future development of IPD's.

Keywords: Curriculum development, Integrated program descriptions, CDIO syllabus, Bologna process

Introduction

Integrated program descriptions [1] (IPD's) constitute a framework for the information produced during a program development process, and comprise of the program's purpose, goals, program idea, program plan and program design matrix. In the paper, we describe how this concept was used in a multi-program development effort, and relate for experiences gained.

The context is the development of 44 new master programs at Chalmers University of Technology in Göteborg, Sweden. The development of new master programs at Chalmers is an effect of the Bologna process [2], which prompted Chalmers to re-structure its existing 4 ½ year integrated "Civilingenjör" engineering degree programs into a 3+2 year format, with an initial bachelor program followed by a master program.

In the development process, the creation of comprehensive and assessable program goals was emphasized. This was motivated by several external factors. Initially, the main driver was that the 2005 evaluation of Swedish "Civilingenjör" programs pointed out that the Chalmers' program goal statements were too general, too diverse and too poorly linked to the curricula. Moreover, they were criticized for lacking goals for personal, interpersonal and professional skills [3]. In addition, the recent developments in the Bologna process have resulted in a set of learning outcomes that characterize qualifications at bachelor, master and doctoral degree levels,

known as the Dublin descriptors [4]. The Swedish Degree Ordinance has been changed to adapt to these descriptors. This change will require all Swedish universities to revise their program goal statements. The requirements for engineering degrees are now based on the Dublin descriptors, complemented with some specific requirements, applicable only to the engineering domain [5].

In order to support the master program development process including the statement of program purpose, goals and idea, and to harmonize the master program descriptions across the university, the concept of integrated program descriptions [1] was adapted. This constitutes a large-scale CDIO application with many actors with varying pre-knowledge of CDIO and with programs from different engineering and science domains.

In this paper we aim to

1. document the use of integrated program description to support the development of new master programs at Chalmers University of Technology,
2. evaluate the benefits, limitations, applicability and ease of use of integrated program descriptions in a large scale application
3. develop recommendations for future development of integrated program descriptions

The paper is structured as follows: We first briefly describe the concept of integrated program descriptions. We then account for the master program development process applied at Chalmers. We then discuss the results from a survey and an interview study directed to the program coordinators that were responsible for developing the new master programs. Quantitative data from the survey is complemented with qualitative data gained from interviews with selected program coordinators, and by a document analysis of the produced master program descriptions. In the discussion, the respondents' view of the benefits, limitations, applicability and ease of use of the integrated program descriptions are related. Finally, we state a number of recommendations for the future development of IPD's and list conclusions.

Integrated program descriptions

An integrated program description (IPD) describes the goals, content and structure of an educational program, as well as how these are connected. This section briefly describes this framework. For a more detailed description, we refer to Malmqvist *et al*. [1].

The intent of IPD's is to provide the program director and other key stakeholders involved in the program design process with a set of tools that can facilitate their design process. It also deliberately promotes a design process which emphasizes high-level considerations such as setting goals and developing the program idea. This facilitates the alignment of the goals and content of the program with actual stakeholder needs, and may point out necessary major changes which can be very difficult to motivate and implement when applying the more common practice of program (re)design to modifying an existing program plan. An integrated program description contains six basic components:

The ***program purpose*** is a high-level statement of why the program exists, which defines the overall purpose of the program, including its context and the future professional tasks and roles of its graduates. The program purpose at least defines the particular field that the program

addresses (electrical, vehicle etc engineering), the relevant lifecycle phases (conceive, design, implement …) and may imply a specific focus.

The ***program goals*** define the knowledge, skills and attributes that the graduates are expected to have developed upon graduation. The program goals can be described as a concretization of the program purpose into a set of assessable learning outcomes.

The ***program idea*** describes how the program is designed in order to meet its goals. It states the main principles and considerations that underlie the program design. Examples of (elements of) program ideas can be that the program has a stated aim to fulfil the CDIO Standards, or that it emphasizes a particular approach to mathematics, or that it is based on problem-based learning (PBL), has a high number of laboratory experiences or other some other main characteristics of the program.

The ***program plan*** is the formal specification of what courses are included in the curriculum, their credits and placement in the curriculum

The ***program design matrix*** connects the goals of the program with its courses so that it is clear in which course each learning outcome is addressed and to what degree. The program design matrix also shows the planned learning sequences (or development routes) for learning outcomes which are developed through integrated learning experiences throughout the curriculum, typically generic competences such as communication skills.

Finally, ***course plans*** define the purpose, learning outcomes and content of each of the courses in the program, and include a statement that explains the role of the course in the program, and links it to the learning outcomes of the program. The complete course plans are but included in the program description but are referenced to.

Figure 1 shows the relationships between the components. A program design process that is aligned with the contents of an integrated program description typically starts with the statement of the program purpose, followed by the development and validation of the program goals. The next step is to formulate the program idea, i.e. the fundamental principles and considerations that underlie the program design. The program plan then implements the program idea, by defining the included courses, their credits and placement in the curriculum. The role of the program design matrix is then to systematically interconnect the program goals with the courses, assuring that no program goal is neglected and that there is a thought-through learning progression in the program. Finally, the course plans are developed, by refining the program goals assigned to the course, selecting pedagogical and assessment approaches and so on. This sequence should not be enforced too strictly. In practice this process is iterative with many actors involved. It is important than the program design process allows for iterations, and makes several passes through the components. In particular, the assignment of goals for learning of generic competences needs to be done in a combined top-down and bottom-up, dialogue-rich fashion between the program director and the involved faculty, in order to achieve commitment and to transfer ownership for such goals.

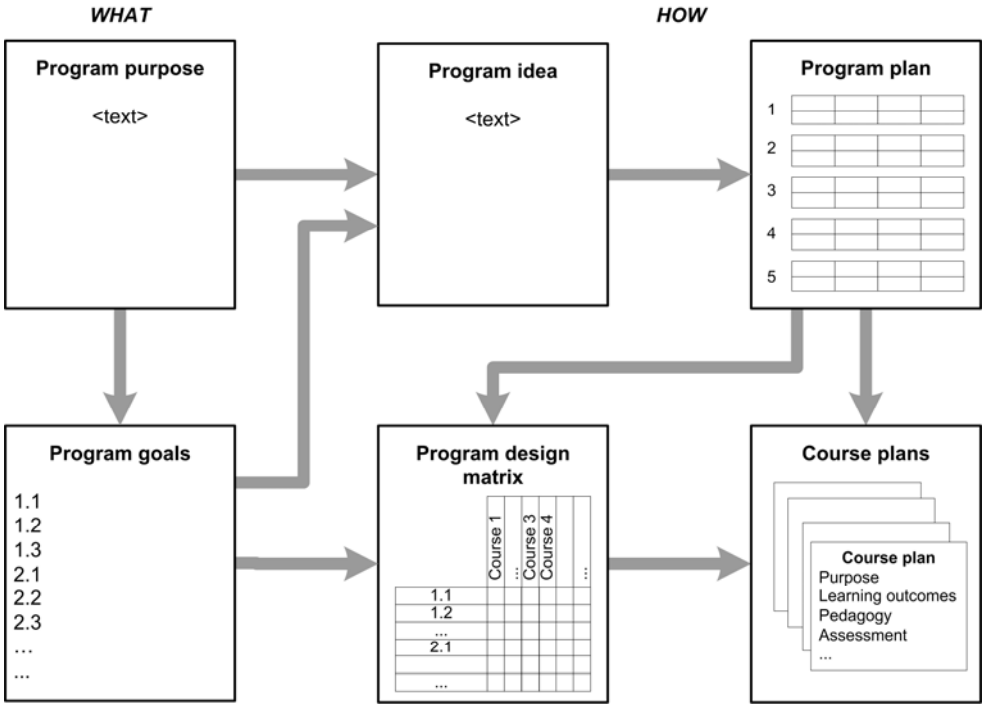

Figure 1: Integrated program description – components.

Development of new master programs at Chalmers University of Technology

The development of new master programs at Chalmers is an effect of the Bologna process, which prompted Chalmers to re-structure its existing 4 ½ year integrated "Civilingenjör" engineering degree programs into a 3+2 year format, with an initial bachelor program followed by a master program. The 3+2 format gives students (at European universities) the opportunity to switch major between the first and second cycle, within their home university or by moving to another university. This facilitates student mobility. However, the now five years of study still form a coherent whole, and the graduates are, in addition to the bachelor and master degrees, also awarded a "Civilingenjör" degree. The reform also extends Chalmers' offer of international master programs from about twenty-five to more than forty, the aim being able to attract a higher number of international students.

An overview of the activities and decisions in Chalmers' Bologna process is given in Table 1. The process of developing the new master programs can be traced back to 2001-02, when Chalmers discussed its Bologna strategy. The outcome was a November 2002 proposal [6] to adopt the 3+2 format, as well as offer all master programs in English, as a means for strengthening the internationalization of Chalmers. The proposal was accepted in March 2003 [7]. 2003 was then dominated by the development of the bachelor part of the programs, which were launched in August 2004. During the first half of 2004, Chalmers did a re-organization, which included the introduction of a buyer-supplier educational system. In this system, deans and program directors act as buyers of educational elements (courses etc), which are supplied by the departments. In the re-organization process there was a focus on making the new organization function throughout 2004. At the same time, informal discussions on the future master programs took place.

The formal part of the development process was started in April 2005, when a call for proposals for master programs was issued. In this first call, 2-page descriptions were requested [8]. The call established a number of pre-requisites for the proposed master programs, i.e., that they should

- address an identified need in industry, academia and society
- have clearly stated aims and goals
- be taught in English
- work as final parts of coherent "Civilingenjör" and architect programs
- offer broad entries (admitting students from several programs), as well as narrow, research-oriented specializations
- be connected to a strong research environment.

53 proposals were submitted from Chalmers' 16 departments. Following an evaluation by the program directors, a number of these were instructed to submit complete applications, while others were recommended to merge with other programs prior to submitting a complete application. In the complete application guidelines [9], the programs were asked to develop their ideas for program purpose, learning outcomes and program idea, i.e. the high-level parts of an IPD, but not to list courses, in order to avoid tendencies towards packaging existing courses into a new master program without consideration of new requirements and goals. The deadline for complete applications was November 1, 2005. After having evaluated these applications, Chalmers vice president for education decided to launch 44 new master programs in the Fall 2007 [10] . The range of master programs is very wide, including programs in Fundamental Physics, Automotive Engineering, and Architecture. For detailed descriptions of two of the new master programs, see Berglund and Malmqvist [11], and Knutson Wedel *et al.* [12]. For additional information, see [13].

In parallel with these developments, Chalmers "Civilingenjör" programs had been evaluated by the National Agency for Higher Education (HSV). This evaluation pointed out that Chalmers' program goal statements were too general, too diverse and too poorly linked to the curricula. Moreover, they were criticized for lacking goals for personal, interpersonal and professional skills [3]. In addition, the recent developments in the Bologna process have resulted in a set of learning outcomes that characterize qualifications at bachelor, master and doctoral degree levels, known as the Dublin descriptors [4]. The Swedish Degree Ordinance has been changed to adapt to these descriptors. This change will require all Swedish universities to revise their program goal statements. The requirements for engineering degrees are based on the Dublin descriptors, complemented with some specific requirements, applicable only to the engineering domain [5].

In the master program development process, the creation of comprehensive and assessable program goals was therefore emphasized. It was decided to use tools developed in the CDIO project to help improve the quality of program goals at Chalmers. A set of guidelines was devised [14], based on the concept of integrated program descriptions [1].

Some of Chalmers master programs have adopted a CDIO-based curriculum including design-build-test experiences etc. Other master programs have an emphasis on science, and prepare more for doctoral studies and a research career, rather than an engineering one. Thus, Chalmers' goal for the introduction of IPD's was not that all programs should be CDIO-based in the sense of adapting Standard One and having a CDIO-based curriculum. The goal was rather to use the CDIO toolbox in order to make sure that all programs have clear, comprehensive, and by the

program's stakeholders validated program goals, along with a curriculum that meets these goals, and where there for each course in the program is a clear link between the program goals and the course learning outcomes. The guidelines provide recommendations on the appropriate level of detail, how to set goals for disciplinary knowledge, how adapt parts of the CDIO syllabus to a program's specific context, for example by modifying terminology ("build" rather than "implement") or by pruning parts of the CDIO syllabus that are not considered relevant for a program (e.g. "Operate" for a master program in Fundamental Physics), and how to connect items from the CDIO syllabus with cognitive verbs in order to state proper learning outcomes.

The process of writing IPD's was started in June 2006. The process of creating the new IPD's has been led by the master program coordinators. The process has also been supported by pedagogical experts, who have offered counselling, feedback, and arranged workshops and other activities to move the process forward. Each program description has since gone through two reviews and iterations. The intent is that the program learning outcomes will now be worked into the course learning outcomes, and that the programs descriptions will be revised as part of the annual program revision. It also remains to coordinate the master program goals with those of their associating "Civilingenjör" programs in order to meet the requirements in the new Swedish Degree Ordinance [5].

Research Methodology

In order to investigate the respondents' view of the relevance, benefits, limitations and ease of use of the integrate program descriptions, and of Chalmers overall master program development process, a survey, an interview study and a documentation analysis were carried out.

The survey questionnaire was divided into three parts, see Figure 2. The first part covers background questions concerning what type of program the respondent represents and previous knowledge of the CDIO syllabus and of the new Swedish degree ordinance. In the second and third part, the respondents were asked to judge the ease of understanding, the ease of use, the relevance and the applicability of the overall CDIO standards as well as each individual CDIO Standard. The second part consisted of a number of statements to which the respondents were asked to indicate their level of agreement, from strongly disagree to strong agree. The statements were based on Norell's list of requirements on efficient product development methods [15]. In the third part of the questionnaire, the respondents were given the opportunity to give freely worded statements on the benefits and limitations of IPD's and also suggest improvements. They were also asked to reflect on their impressions of Chalmers' master program development process as a whole. The quantitative data was complemented with qualitative data obtained from interviews with selected master program coordinators, chosen to represent programs across the range of Chalmers programs, including programs within biotechnology, physics, civil, electrical, and mechanical engineering. Six semi-structured interviews were carried out by the same interviewer. The interviews were recorded and transcribed verbatim. Finally, the program descriptions of the master programs have been analyzed. The contents have been classified and compared with the responses to the survey.

Table 1. Timeline for Chalmers Bologna process

Year	Date/period	Activity/decision
2002	Jan-Nov	Discussions on new educational structure based on 3+2 format
	Nov 22	Proposal for new educational structure based on 3+2 format with master programs taught in English issued by Chalmers vice president for education [6]
2003	March 20	Declaration of intent on introduction of new educational structure published [7]. Launch planned for Fall 04 for bachelor level and Fall 07 for master level
	March-Dec	Planning for new programs, emphasis on bachelor programs. Informal planning of master programs
2004	Jan-June	Re-organization of Chalmers results in introduction of buyer-supplier organization of Chalmers educational system. New educational management team (GRUL)
	Aug 15	Start of new bachelor programs
	Sept-Dec	Start-up of new educational organization
	Sept-Dec	Planning of master program development process, criteria for selection etc
2005	April 04	Call for 2-page proposals for new master programs
	May 16	Deadline for master program proposals. 53 proposals submitted.
	May-June	Evaluation of proposals
	June 05	GRUL recommendation: some programs are encouraged to submit a complete applications as-is, others to merge with others prior to submission of complete application
	June 22	Guidelines for complete applications published. Essentially a simpler version of the future integrated program descriptions.
	Nov 01	Deadline for complete applications
	Nov	Evaluation of complete applications
	Dec 13	Decision on what master programs to launch in Fall 07. 44 programs approved
	Jan-Nov	HSV evaluation of Swedish “Civilingenjör” programs criticizes Chalmers program goal statements [3]
	Nov-Jan	Development of handbook for writing IPD’s [14]
2006	Jan 26	Decision to use IPD framework to describe Chalmers master programs
	June	Start of process of writing master program descriptions
	June-Oct	Support for master coordinators in writing process
	Oct 01	Deadline for first version of master IPD’s
	Oct-Nov	Review
	Nov 25	Feedback to master coordinators
2007	Jan 15	Deadline for revised version
	March-May	Evaluation of effectivity of IPD framework
	Sept 01	New master programs start
	Fall	IPD’s to be reviewed as part of annual program revision process

Evaluation of the use of Integrated Program Descriptions in Chalmers Master Program Development Process

Background questions

Domain of program
What roles/people participated in the development process?
Previous knowledge of the new Swedish Degree Ordinance
Previous knowledge of the CDIO Syllabus
How much time did you spend on writing the program description?

Statements <answers on a 10-level scale ranging from strongly disagree – strongly agree>

The IPD's contain the essential information for characterizing a program
The IPD's have strengthened the holistic perspective during the development process
The work with the IPD's has improved the quality of the program's purpose and intended learning outcomes
The work with the IPD's have improved the quality of the program idea
The work with the IPD's strengthened the connection between the program learning outcomes and courses
The proposed structure for the program learning outcomes facilitated writing the learning outcomes
The work with the IPD's have led to the inclusion of educational experiences that otherwise might not have been included
The use of the IPD framework has led to a more systematic development process
The degree of formalization is <too low -- too high>
The use of the IPD framework has a learning effect on the developers
The IPD's facilitate communication between actors in the development process
The IPD framework was easy to apply
The writing of an IPD requires the help of an expert

Questions requesting freely worded responses

What was positive about the IPD framework?
What can be improved?
What were the most significant effects on your program?
Do you have any other comments on the IPD framework?
Do you have any reflections on Chalmers' overall master program development process?

Figure 2: Structure of survey questionnaire.

Results

In this section, we account for the results from the survey and discuss the benefits, limitation, and development needs of the IPD framework.

Respondents' distribution across domains

23 of out 44 master programs have responded to the survey, approximately 52 %. The distribution of respondents across different science and engineering domains is shown in Table 2. Multiple classifications were allowed, so a particular program could state its affiliation in several domains. It is shown that the spread is rather even across all domains. However, there were very few answers from Chemistry and Bioengineering programs, the only response coming from a mechanical engineering program which double-classified itself.

Table 2. Distribution of respondents

Domain	Number
Mathematics and Physics	5
Chemistry and Bioengineering	1
Mechanical, Automation, and Industrial Design Engineering	6
Electrical Engineering, Computer Science and IT	5
Industrial Management and Engineering	6
Architecture and Civil Engineering	5
Environmental Science and Sustainable Development	4

Characterization of the IPD's

Table 3 provides a coarse characterization of the contents of all master program IPD's (except for two). The classification of text sentences as "program purpose" or "program idea" is crude as the relevant content may appear in other places than under the assigned headings. However, the intent is to give the reader a rough idea of the length of the documents and some of their components. For example, the table shows that the average number of stated learning outcomes is 16, but varies from 4 to 44.

Table 3. IPD document characteristics

Parameter	Average	Median	Std dev	Min	Max
Program purpose (#words)	126	124	69	15	374
Learning outcomes (#)	16	15	8	4	44
Program idea (#words)	462	369	261	155	1184
IPD size (#pages)	11	10	3	4	21

Participants involved in creating the IPD

Chalmers' educational system is operated according to a buyer-supplier model. The buyer is a "program director" who is responsible for a five-year "Civilingenjör" program. A master program coordinator is responsible for one of the master programs that are connected to each "Civilingenjör" program. A program is made up of a number of courses supplied by a department. A "director of studies" is responsible for a particular departments' supply of courses.

Thus, a program director "buys" courses with specified learning outcomes and content from the departments. The price is based on a standardized model, but is negotiable.

The respondents' answers to the question "Who participated in the development process" indicate that the process was largely executed by the master program coordinator and the teachers to be involved in the program (2 to 10, with an average of 5.7).

Contacts with other stakeholders have been occasional or even non-existent. This includes both internal stakeholders such as directors of studies and "Civilingenjör" program directors, as well as students and external stakeholder. It is striking that around 60 % of the programs did not have any student or external stakeholder participation in the process at all, and that less than 10 % had regular or frequent participation. It should be pointed out that the composition of the master programs has been communicated to students in other fora and by other stakeholders, including the program directors (responsible for the "Civilingenjör" degree programs). However, it is not evident that student input has been considered in the programs' design. A few programs mention other stakeholders such as "people involved in the innovation system" and their predecessors as master program coordinators.

The typical working process has been that the master program coordinator did the main part of writing the IPD document. Some master program coordinators have had frequent contacts with a team of colleagues and their IPD product can be viewed as a collaborative, well-anchored effort. However, other master program coordinators seem to have worked largely on their own, using their colleagues more as sounding boards on an individual basis. Some master programs consulted the authors of this paper to get feedback on draft versions.

Table 4. Participation of actors in the IPD creation. All numbers in %.

Category	Not at all	Occasionally	Regularly	Frequently
Master program coordinator	0	0	0	100
Teachers	9	13	65	13
Director of studies	17	52	17	13
Program director	39	48	9	4
Other master coordinators	43	52	4	0
Students	57	39	0	4
External stakeholders	61	30	9	0
Others	83	0	17	0

Evaluation of statements questions

Table 5 summarizes the answers to the statement questions. The results are presented in four columns, the two first showing the average and standard deviation for the entire group, and the two latter show the average for the five most positive program ("Hi 5") and the five most negative programs ("Lo 5").

Table 5. Answers to statements

Statement	Avg	Dev	Hi 5	Lo 5
Previous knowledge of the new Swedish Degree Ordinance	**3.4**	2.2	2.8	5.0
Previous knowledge of CDIO Syllabus	**3.2**	2.7	4.4	3.0
The IPD's contain the essential information for characterizing a program	**7.6**	1.8	8.0	7.0
The work with the IPD's have improved the quality of the program's purpose and learning outcomes	**6.3**	2.7	8.6	3.0
The IPD's have strengthened the holistic perspective during the development process	**6.1**	2.6	8.0	3.4
The work with the IPD's strengthened the connection between the program goals and courses	**6.1**	2.8	8.2	3.0
The IPD's facilitated communication between actors in the development process	**5.5**	2.9	8.4	1.8
The use of the IPD framework led to a more systematic development process	**5.3**	3.2	9.0	1.6
The proposed structure for the program learning outcomes facilitated writing the learning outcomes	**4.8**	2.6	8.2	3.0
The work with the IPD's have improved the quality of the program idea	**4.8**	2.5	7.2	2.8
The use of the IPD framework has a learning effect on the developers	**4.7**	2.7	7.8	1.4
The work with the IPD's have led to the inclusion of educational experiences that otherwise might not have been included	**4.6**	3.2	9.0	1.8
How much time did you spend on writing the IPD?	**81**	20	82	92
The IPD framework was easy to apply	**4.6**	2.3	6.2	3.3
The writing of an IPD requires the help of an expert	**4.5**	3.0	5.0	5.5
The degree of formalization is <too low -- too high>	**7.3**	1.9	5.6	8.3

Benefits

Table 5 shows that the strongest agreements are for the statements "contains essential information for characterizing a program", "improved the quality of the program's purpose and learning outcomes", "strengthened the holistic perspective", and "strengthened the connection between program learning outcomes and courses". These effects are strongly aligned with the intent of introducing the IPD framework. The group of most positive programs also strongly agree with the other statements, i.e., "facilitate communication", "led to the inclusion of educational experiences that otherwise might not have been included". The most positive programs came from the mechanical, electrical and IT engineering domains. It seems reasonable to conclude that the use of the framework has had a positive effect on the programs and their development process. Table 6 shows examples of positive statements.

Table 6. Positively valued statements and free text comments (examples)

Statement	**Free text comments**
The IPD's contain the essential information for characterizing a program	*"A document to start from and use as a reason when one wanted to discuss program quality, idea, purpose and learning outcomes.* *"I didn't realize the use of the entire document at first. I felt that there was too much about underlying need and career opportunities. However, that kind of thought activities created new ideas for quality assurance that we are now thinking about how to work with".*
The work with the IPD's have improved the quality of the program's purpose and learning outcomes	*"The 'learning outcomes' approach was useful and gave us a tool for coordinating the program and its courses".* *"Writing learning outcome with active verbs makes them more explicit. It gets difficult to hide weaknesses in the program or courses behind sweeping formulations".*
The IPD's have strengthened the holistic perspective during the development process	*"You are forced to think about the program more as a complete program rather than a collection of individual courses"* *"The basic CDIO philosophy (view of learning etc) felt natural for us".*
The work with the IPD's strengthened the connection between the program goals and courses	*"The program design matrix forced a useful collaboration between program and courses, and strengthened the program's continuity and 'red thread'".*
The IPD's facilitated communication between actors in the development process	*"Everyone created comparable IPD's at the same point in time. This made all master program coordinators focus on the same issues at the same moment"*
The use of the IPD framework led to a more systematic development process	*"The focus on the student perspective, and on engineering work, i.e., the ability to solve problems with a holistic perspective where balancing of stakeholder needs is crucial".* *"The most important function was catalytic: the program description served as an initiative to get the teachers at the department more involved and to discuss goals and contents for specific courses. The process also initiated new tasks such as alumni follow-up studies whose importance had been realized before but that had remained dormant"*

There are lower values for "led to the inclusion of educational experiences that otherwise might not have been included", as discussed below. However, examples exist including extra-course program activities that train 2.x and 4.x skills, inclusion of considerations of the context of technology and generic competences.

Limitations and applicability

Table 5 further shows less strong agreement for a number statements, such as "the proposed structure facilitated writing the learning outcomes", "improved the quality of the program idea", "had a learning effect on the developers", and "led to the inclusion of educational experiences that otherwise might not have been included"

The low number for "led to the inclusion of educational experiences that otherwise might not have been included", and "improved quality of program idea" indicates that few changes to the actual education experience will take place as an effect of the work with the IPD. Some of the reasons given for this were that the design of the programs was already considered as finalized, and that the master program coordinators were not willing to make changes at this stage. Some free texts quotes illustrate this attitude*: "The development had already taken place." "In short, the problem is that the reality (courses etc.) existed before the plan, and the plan's influence on reality is minimal."* (This program seems to have been designed by compiling existing 4th year courses into a master program.) In addition to the timing aspect, these attitudes also seem to reflect a resistance towards allowing external input to influence the program design. At the time of the master program development process, Chalmers had recently been criticized in the HSV evaluation for that many "Civilingenjör" programs had lacked educational experiences for and even intended learning outcomes for generic competences such as communication, teamwork and sustainable development. Moreover, such competences have a more prominent position in the new Swedish Degree Ordinance, which was published during Chalmers master development process. So there exists an external requirement that these are addressed. However, not all master programs have stated learning outcomes and educational experiences addressing generic competences. It remains a challenge for Chalmers to integrate such skills across the board.

Another reason for the lower average ratings with respect to these statements is the responses from a group of very negative programs, summarized in the "Lo 5" column. A common trait for most of the negative programs is that their domain is relatively far away from the domains of the programs that originally developed the CDIO model, and that they question the applicability of CDIO in their domain. In this group, we find programs in architecture, industrial management and engineering, and science. In addition, one strongly negative program is within the domain of electronics. More specifically, these programs do not agree that the CDIO syllabus adequately list the skills of its graduates. *"CDIO is not designed to fit an XXX education, which is not an engineering education*". *"The CDIO Syllabus does not fit our subject. The reason is that it is confusing in its classification."* However, the use of the CDIO Syllabus was not compulsory. All programs were given the alternative to using the Swedish Degree Ordinance as a starting point rather than the CDIO syllabus, but the programs in the negative group have also chosen to deviate from this regulatory baseline. They seem to prefer a short list of program learning outcomes (median 11 as compared to 15 in entire population, and 21 in the most positive group), as exemplified by a statement from the electronics programs *"You shouldn't write as detailed program learning outcomes. It is better to write a handful of program learning outcomes and*

then spend much more time on the course learning outcomes". However, the outcome may be a lack of compliance with the national degree requirements. For example, the electronics program does not list any learning outcomes for teamwork. In addition, a short list of program learning outcomes requires an external evaluator to go into details of the courses in order to assess the program.

Many respondents display an inwardly focused view of the use of the program descriptions, and of their master programs. The potential benefits of standardized program descriptions – that they should facilitate for others actors (other master program coordinators, program directors, deans, university administrators evaluators, other university representatives etc) who need to read and work with a set of program descriptions rather than a single one - are only mentioned by a few respondents. Comparability is occasionally mentioned in the responses but is not highlighted. It can also be noted that no respondent mentions that the compliance of the program learning outcomes to the Dublin Descriptors and the Degree Ordinance. The respondents do not see themselves as a part of a greater whole, but rather perceive university- and government-level policies as unwanted intrusions.

Ease of use

The data shows clearly that the average previous knowledge of both the Swedish Degree Ordinance and of the CDIO Syllabus was limited at the start of the development process. This has also been evident during the process. Many master program coordinators have struggled with the writing of the program learning outcomes.

The average time spent on writing the IPD is estimated to 81 hours. However, many respondents state that the time spent is difficult to assess, as it was intermingled with other tasks. It is notable that the negative program group claim to have spent more time than the positive group.

There are varied opinions of the ease of use and need for expert support. The value for "degree of formalization" is high (7.3), and is raised by the negative programs (the positive programs think that the level of formalization is about right, 5.6). When questioned about reasons for this valuation, it appears that especially writing program learning outcomes is perceived as difficult. There is a learning threshold before an individual is able to interpret, contextualize and gain ownership of the generalized learning outcomes of the CDIO Syllabus or the Degree Ordinance, and understands how to use them as a tool to guide the program development process in such a way that external requirements are met while also specializing them into program-specific statements that brings out the profile of the program. *"A reflection: if you don't know CDIO beforehand you need to invest some time in order to understand the model … You need to understand the whole model before you start writing"*. The low average pre-knowledge of the Degree Ordinance and CDIO Syllabus probably increase the size of this threshold. Whilst the guidelines for the process stated that the CDIO syllabus and Degree Ordinance were templates that <u>needed</u> to be customized for any particular program, some master program coordinators have interpreted them literally and, when they are not able interpret them in the context of their program, conclude that they are inflexible. This is not the intent of the guidelines. However, it seems that the double message that you should <u>both</u> use a template <u>and</u> customize it is very difficult to communicate.

Future development of IPD's

Instructional materials

A number of respondents asked for better prepared instructional materials. Such a package should include a structured set of presentations with customized variants directed to different actors such as program directors, teachers, directors of studies, and others. These different actors have different information needs and time available to spend on understanding CDIO and the IPD framework. An "IPD-light" presentation was asked for, as well as complete IPD's as examples. The first versions of the program design matrices contained many misunderstandings, for example concerning how to set the values of I, T and U, and concerning the link to the program learning outcomes. In order to facilitate the process of creating the program design matrices, respondents asked for commented examples of program design matrices. Other requests included instructions for writing program learning outcomes.

Adaptations to other domains than engineering

Respondents representing management or science programs have requested a more flexible framework. In particular, this request is directed towards the CDIO Syllabus, which was criticized by these programs for not adequately reflecting their programs' profile. Crawley *et al*. [16] suggest that such adaptations of the CDIO Syllabus might be developed by revisiting the basic principles and practices of the CDIO approach. At its most abstract level, the approach asserts the following: the education should be in the context of practice; that there is an identifiable list of knowledge, skills, and attitudes in which students should gain proficiency; that by engaging with stakeholders, the desired level of proficiency can be determined. However, worked-out examples are needed to convince these programs.

Another angle is that while these master programs may indeed be excellent educational programs, they seem to distance themselves from certain requirements on engineering knowledge and skills expressed in the CDIO syllabus and in the new "Civilingenjör" Degree Ordinance. However, they still want to award the high status "Civilingenjör" degrees, implicitly relying on that all "engineering" degree requirements are met during the first three years of study. The underlying question becomes what is an engineering education, and what is not? In this context, it should be clarified that the new Swedish Degree Ordinance is much more specific than the previous, but that that there is no accreditation system in Sweden. It remains to see how strongly the new requirements will influence the educational system. Locally, at Chalmers, there is a need to coordinate the intended learning outcomes of "Civilingenjör", bachelor and master programs, and to distribute the responsibility for attaining the learning outcomes to different actors.

Vision and development plan

One master program coordinator suggested that some kind of vision or development plan should be included in the IPD: *"Many ideas appeared during the development process than we weren't able to include now. The risk is these ideas are lost. If a vision or a development plan was included in the IPD they could have been documented."*

Conclusions

Integrated program descriptions (IPD's) have been used to support the development of 44 new master programs at Chalmers University Technology. A survey indicates that the IPD's contain the essential information for characterizing a program, have improved the quality of the program's purpose and learning outcomes, strengthened the holistic perspective in the development process and strengthened the connection between program learning outcomes and courses.

Some programs have criticized the IPD framework for not being suitable for their domain, especially programs in architecture, industrial management and engineering, and science.

Identified needs for future development include better packaged instructional materials, adaptation of the CDIO syllabus to non-engineering domains, and the inclusion of a program vision or development plan in the IPD framework.

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