Post internship student-industry collaborative projects - as vehicle for the realization of challenging parts of the CDIO syllabus

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Post internship student-industry collaborative projects, as vehicle for the realization of challenging parts of the CDIO syllabus

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ABSTRACT

A large part of the CDIO syllabus concerns skills that are difficult to address in a solely academic environment. Collaboration with industry is in reality a must in order to perform the CDIO based education.
Student internships in the industry, hence is the core of the DTU B. Eng. program. At DTU Architectural engineering the 5 month internship period is placed early in the curriculum, after 4 semesters of study.
It is obviously more challenging to find industry internships for students that are at an early stage in their studies because they need more supervision. However the investment is worth the trouble because the post internship curriculum is provided with pedagogical means to address parts of the syllabus that are on an advanced level in the learning taxonomy. The interface between the internship period and post internship student-industry collaborative projects is an important point of focus. Inquiries into this difficult transition are presented with emphasis on the parts of the CDIO syllabus addressing System Design.

KEYWORDS

Industry involvement, Design Process, Integrated learning experience, System Design, Multidisciplinary Design Project, industry collaboration, Innovation.

INTRODUCTION

For a decade the CDIO integrated learning experience of the 6th semester, at the Department of Civil engineering DTU, has addressed the syllabus 4.4., System Engineering. It seldom included industry stakeholders in the projects.
It was decided to investigate if the 5th semester internship program could be used for enhancing industry involvement in students' 6th semester projects.
At the same time it was a target that faculty researchers should have greater motivation for working with industry partners and students by transforming the 6th semester CDIO project on system design into an actual innovation project that could attract research funding.
The students are specialists on the work culture and interests of their internship companies and this proved to be an interesting vehicle for the development of a new interface between the 5th semester internship period and the 6th semester Integrated learning experience on system design.

METHOD

The process of creating a new interface between an internship program and a post internship CDIO learning experience is described. Student involvement in the design of the educational activities is presented and the results, before and after, are demonstrated.

RESULTS

Background

The 5 month internship period in the Architectural E ngineering B. eng program is placed at the 5th semester. Its purpose is to enhance professional engineering attitudes early on in the students' curriculum and by this enabling the student to choose a specialization for the remains of the post internship curriculum. The internship program was also meant to serve as a way to maintain the link between faculty and the building industry by means of mandatory visits by faculty to internship companies. During the 6th semester a mandatory CDIO Integrated Learning Experience is scheduled that leads up to the final thesis project.

However it has proved increasingly difficult over the last 5-6 years to persuade faculty to take the time to visit the internship companies. It is time demanding both in planning and execution and does not show in faculty C.V.s. The fact is that only a third of the internship students received a visit by faculty members – and this was by only a handful of the same faculty members that visited several companies. It placed the Ba. Eng. Program at risk of having future challenges with accreditation.

The CDIO integrated learning experience of the 6th semester suffered also from the disinterest by faculty in involving in industry related design- and development projects. Instead of inviting industry stakeholders, faculty members described project proposals for 6th semester students to choose from, published in a small pamphlet by the department. The majority of the project proposals derived from faculty's own research, where student in this way became an important part of the department research. This has value in itself but it alienates students and faculty from addressing the CDIO standards of personal, interpersonal and product and system building skills focusing solely on disciplinary skills.
A great chance to increase the profession related skills was hence lost. A great chance to find ideas for innovation and new development projects was also wasted. On observing this lost opportunity for contact with industry stakeholders and for developing skills in students and faculty, a plan to work more precisely with the interface between the internship period and the post internship period was launched.

For almost a decade the 6th semester integrated learning experience project, that followed the internship period, was structured as 2-3 person groups supervised by a faculty member 1 hour per Week. Due to economic constraints this could not continue. The department strategy is now that larger groups of 8-10 students should work together and profit from each other while still receiving all together 1 hour of weekly tutorials. This will run the projects more cost and time efficiently concerning faculty involvement.

So in short, the challenges were:
-Supervise larger groups of 6th semester students' advanced CDIO Integrated Learning Experience with much less costs.
- Make a better interface between the internship program and the 6th semester. That means: Create a connection between the internship companies and faculty, that will both arouse interest in faculty in order for them to pay the mandatory visits to companies, and in the

industry, so that they might want to take on collaboration with faculty and students during the 6th semester CDIO Integrated Learning Experience.
- assure that the 6th semester integrated learning experience has real industry stakeholders, allowing the project to connect to the CDIO syllabus of personal , interpersonal and product and system building skills instead of enhancing faculty research.
- Allow all students (the best and the worst) to have experienced a mandatory, real industry collaboration in relation to a design-and development project and thus making this part of the Architectural Engineering program identity.
- Influence the project topics from knowledge of what is going on in the profession and what will be a demand in society in the near future. Influence the curriculum as such from a better linkage to industry.
-Create innovation for the benefit of society.

Student interns as agents

The idea to have more out of the internship program came up during a steering committee meeting with student and faculty representatives. A discussion took place, on what could make a clearer distinction between the B.Sc. and the B. Eng. program of Architectural Engineering. The conclusion was that collaboration between students and industry about real design- and development projects should be the chief characteristic of the B. Eng. program.
A student member of the committee (Cecilie) presented her 6th semester integrated learning experience and explained how the geometrical problem of a complex façade design, that she had worked on during her internship period, developed into a 6th semester project on the same topic. (It later on developed into a 7th semester thesis that included an actual solution and mock-up façade component). Her series of projects took place with supervision from the internship company professionals.
Hence the idea came forth to make the internship program - and a succession of design- and development projects derived from the internship companies, the flagship of the B.Eng. Architectural Engineering line of study.
These meetings took place during the spring 2013 and it was decided that instead of waiting and developing the concept in detail the plan should be executed immediately. It would thus depend on the intern students to contribute actively in the development of the new interface between curriculum and internship program. The reasoning behind this decision was that the disinterest of faculty in the internship program prevented them from actually having the insight necessary to develop the new transition and it would therefore be necessary to use students as agents, because only they knew the companies and the curriculum.
Before the start of the summer vacation 2013, a meeting was called, where student Cecilie again explained about her experiences to her fellow students who were to embark on their internship just after the summer vacation. The idea of students as agents, observing for 6th semester project -topics during their stay in the company, was communicated.

The internship program before

The internship period had functioned for 11 years as a mandatory 5th semester course equivalent of 30 ects. It was assessed as passed/not passed based on 3 reports that should be made during the internship and handed in after the finalization of the internship period. The reports consisted of a logbook, an internship company report and a socalled ‘special report’ on a self-chosen technical – scientific subject.
The two first mentioned reports are rather short and matter-of- fact while the latter is 20-30 pages and includes literature survey etc. The ‘special report’ should be supervised by a

faculty member who will also pay the before mentioned mandatory visit and supervise and asses the entire internship.
During the internship the student had 2 meetings at the university: one with the intern program coordinator (administration) and with the head of study about choosing courses for the 6th semester.
Apart from this the students were supposed to meet at least once with their faculty supervisor at the mandatory company visit and preferable more times to receive supervision concerning the 'special report'. As described above these meetings with faculty supervisors almost never took place, because faculty failed to see any professional perspective in this.

The internship program after

It was decided to try using the internship company report as a tool for developing the students' understanding of business. Instead of handing in the description of the organization and main business area of the company after the internship, it was to be presented not later than one month after the start of the internship period. Instead of a self-selected topic for the 'special report' the students were to identify a topic, that would interest the company so much, that they would invest time during the 6th semester in this project. After having identified this topic, the student would then proceed to inquire in literature about the topic and write a report based on this. Finally- as a new issue - the student should write a half-page problem statement for a possible 6th semester project (for him- or herself or a fellow student to use freely) based on the 'special report' topic.
The meeting with the head of study transformed into functioning not so much as a which-courses- to-choose-session but more like a problem statement workshop for the future integrated learning experience project of the 6th semester. The topics of the 6th semester project were discussed in relation to the specialization the students were to choose for their last semesters before applying for jobs.
A first indication of the companies' interest in actively taking part in a 6th semester projects was surveyed during this workshop on a scale from 1-10.
Just after the end of the internship, and the final handing in of the 'special report' and problem statements, a second workshop was held between students and faculty. The 'harvest' of project topics derived from intern companies' real life interests were presented by each student. Students and faculty then tried to group topics in very few clusters of themes in order to create the large project groups necessary for reducing supervision costs.
The result was 2 main project topics:
-Holistic refurbishment: Urban and building transformation of 1970's housing developments viewed as a whole.
- Health care: design of the ideal hospital ward.
Under the main frame of Holistic refurbishment, were 'special report' topics such as: financial models for refurbishment, structural calculations in refurbishment projects, local drainage of rainwater, social transformation of housing developments from the 1970's, wind conditions in urban spaces, solar mapping as tool for designing urban spaces.
Health care framed topics as: façade engineering and daylight/lighting design, evidence based design theory, accessibility, infection retardant ventilation systems.
The outcome was not planned to be a multidisciplinary view on the topic. It came forth during the workshop. The anticipation had been that a narrow subject would have come up because many students would choose the same topic. It was expected that a larger number of problem statements would have been ruled out by majority. This was not what happened. Instead two highly multidisciplinary projects came forth.

Mapping of models for collaboration within the student group

One of the goals was to reduce the costs of supervising a multitude of 2 person groups 1 hour per week. Larger groups would also allow for the students to learn from each other. An equally important idea behind the larger groups was that students would be able to produce solutions of a higher quality because more work and more investigation on the same topic could be made. The semi-professional quality of the solutions is important in order to keep the interest of the industry stakeholder on the long term and make them invest time in student supervision.
The multidisciplinary character of the projects, outlined during the workshop, is a challenge to the cost-efficiency goal. On the other hand it mirrors how industry actually works.
In that sense it is of course natural that the students would point in that direction.
However there were no precedents for a multidisciplinary project like that in the department and it was again decided to use the students as agents and survey what they would point to as a valuable way to structure the work process within the student group.
4 models were outlined from which student could choose from and comment on. They were asked to choose the model that aligned with the design and development processes they had experienced in their internship companies.
The 4 Models were:

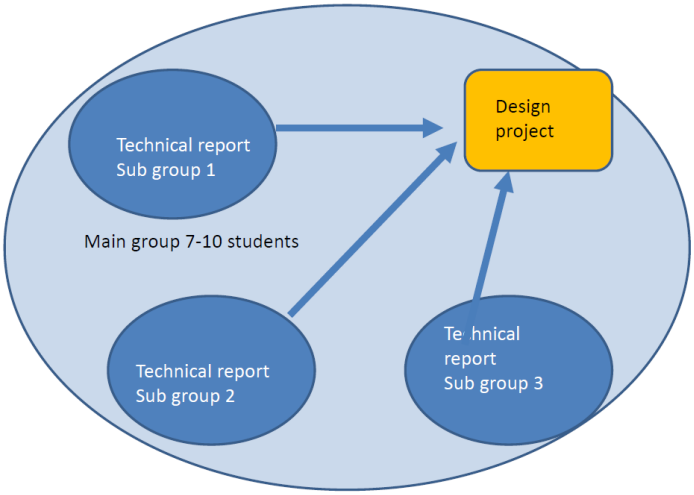

Figure 1. Model 1.
Students develop 2-3 person sub-groups that work on separate technical reports. Students participate in an ongoing design process from day 1 and work on the same design and development project all together from the start.

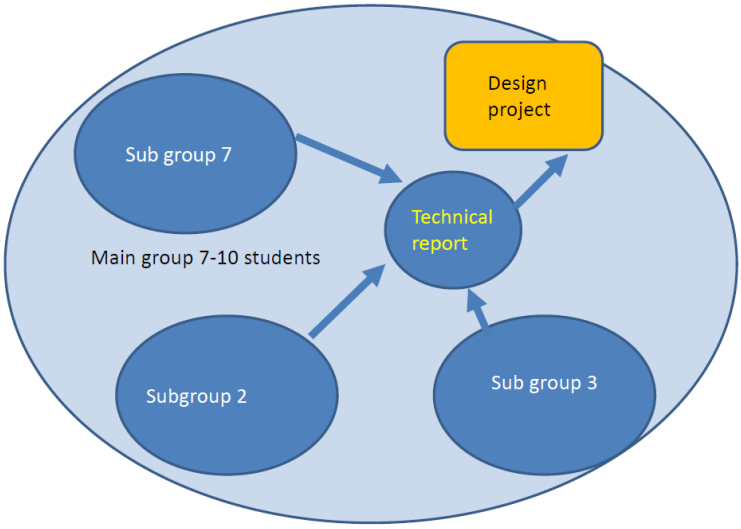

Figure 2. Model 2.

Students develop 2-3 person groups that each work on chapters in the main groups' mutual report. After the delivery of the mutual technical report the main group all work on the same design project together.

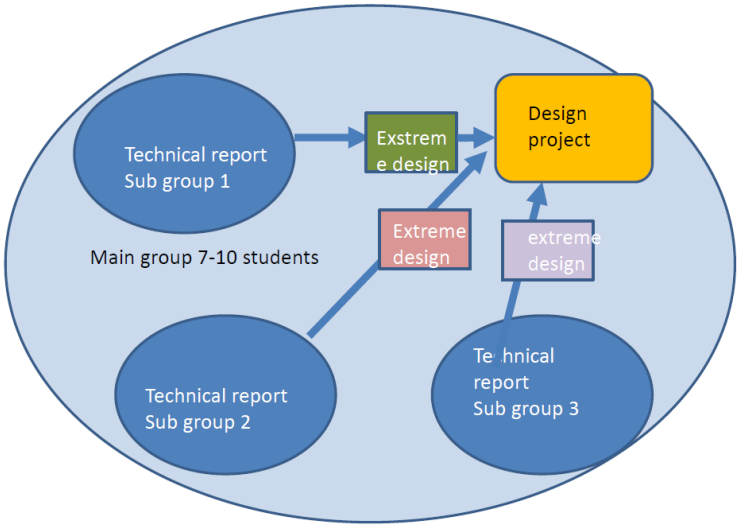

Figure 3. Model 3.

Students develop 2-3 person groups that work on the reports.

After handing in the report, students develop an extreme design proposal based on their groups' special focus on the mutual topic and present these project at the mutual interim presentation.

Finally all sup-groups develop a multidisciplinary design project, where all the extreme solutions merge into one supposedly perfect compromise.

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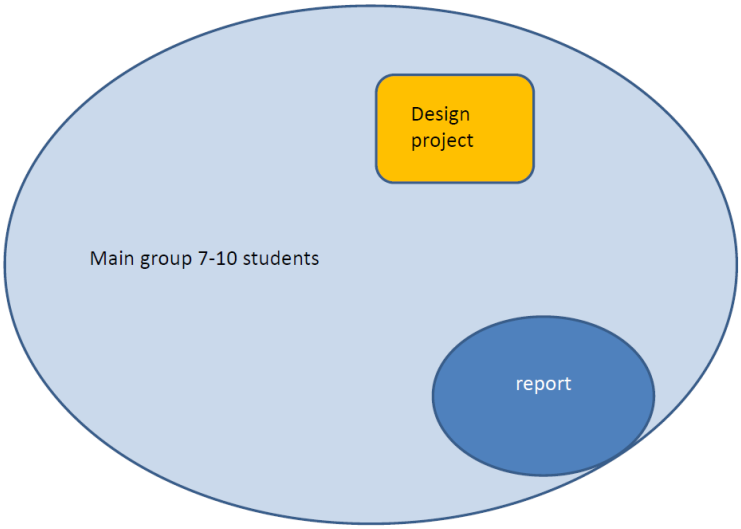

Figure 4. Model 4.
All students in the main group work on a mutual technical report and design project together.

The result of the survey was a preference for model nr. 3. It is the model with an extra 'design loop' in the process which also mirrors an industry development process. The clear ownership of specialization in this model and precise borderline between specialization and multidisciplinary design project is a choice that could also be found in real life industry.

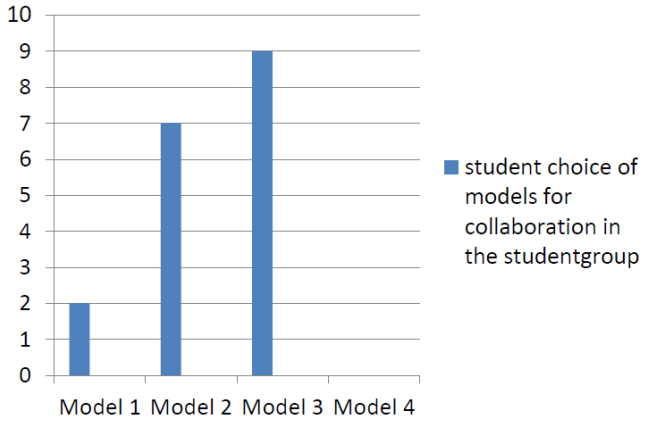

Figure 5.
Result of survey where students were asked to choose the model for collaboration that at best mimed the process in the industry.

The assessment of this preferred project-process is: 1/3 based on the report, 1/3 based on the 'extreme' design project and 1/3 on the multidisciplinary 'compromise' design proposal

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Mapping of company interest and industry /university collaboration models

At the workshop, the students also gave their impression of the intern company's interest in 6th semester collaboration on a scale from 1-10.
After the second workshop a survey among the students was made in order to identify the best model for collaboration between students, faculty and the industry partner (the intern

company). Again the students were considered to be the experts because they knew the companies very well in contrast to the university faculty. The students could choose from 4 models (that had come forth during the second workshops discussion) and were asked to choose the model that would suit their internship company best:

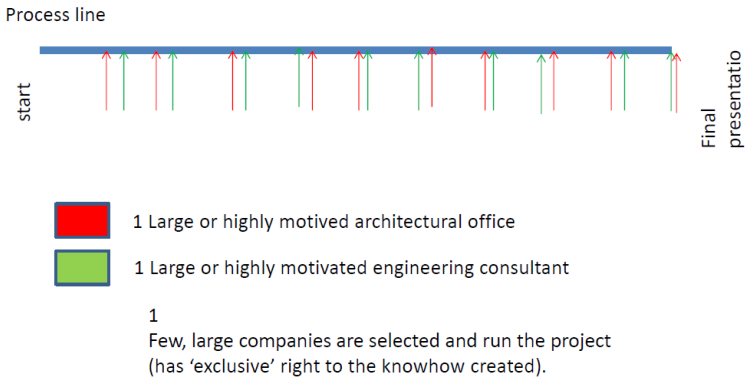

Figure 6. Model 1
Supervision meeting every second week, interim critique every 6 weeks, company participates in final presentation.

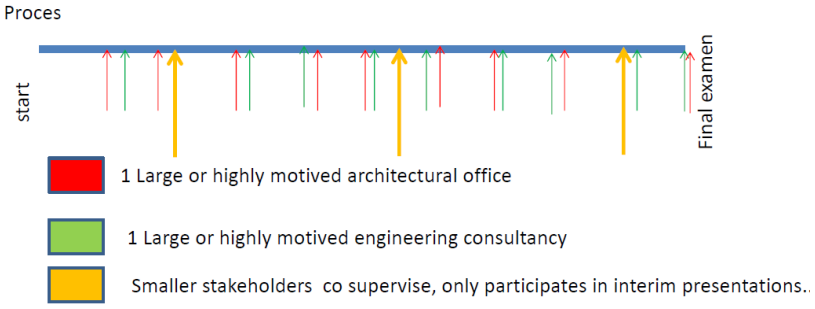

Figure 7. Model 2
Few large companies are principal but smaller companies or individuals can be invited to interim presentations to supplement with special focus or because students want them as supervisors.

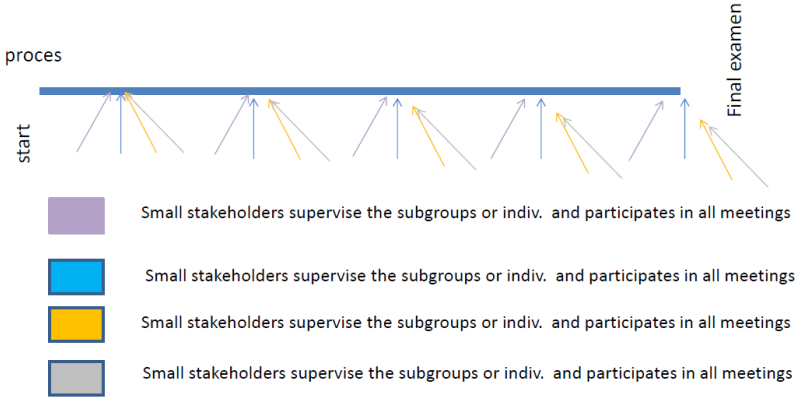

Figure 8. Model 3

All subgroups in the main group have their own company supervisors from many different companies, which all participate in all meetings and interim presentations as well as the final examination.

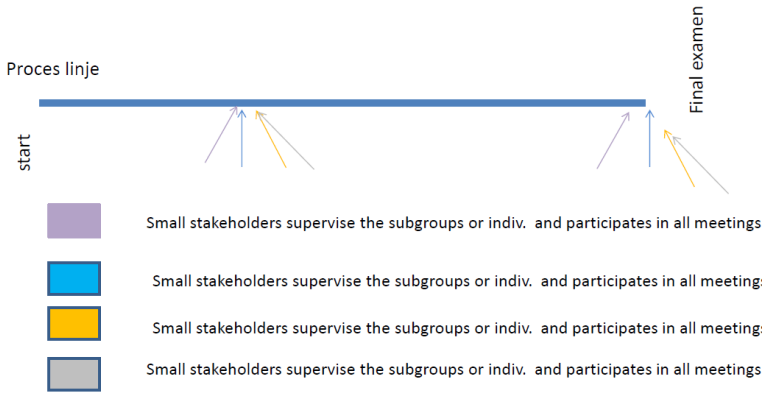

Figure 9. Model 4
Faculty supervisors run the process, companies are invited for interim presentations and final examination.

The result of the survey was a clear preference for model number 2. This model both allowed for the simplicity of collaborating with few large stakeholders that, because of their size held different specialist knowledge within them, but at the same time a door was kept ajar if a student had an industry contact from the internship company that he or she really wanted to be part of the project.

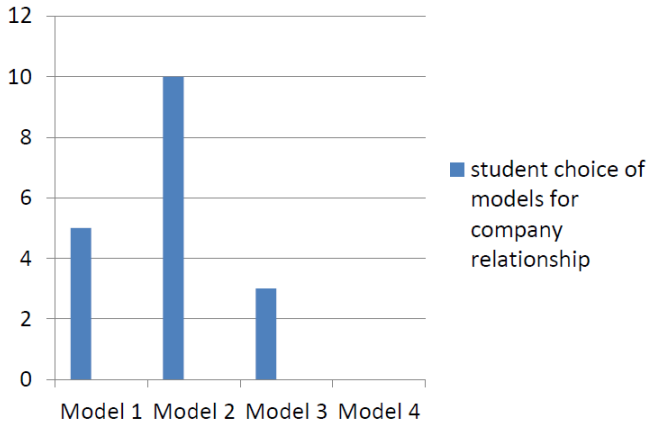

Figure 10.
Result from student survey.

Matchmaking between students, faculty supervisors and companies

From the surveys a priority list of internship companies was made linked to each of the two topics. At the same time a priority list of faculty supervisors was attached.
Concerning Health Care, there was a very positive response form the first-priority industry stakeholder who immediately started working with the outline of a synthesis.
Concerning the second theme, Holistic Refurbishment it proved to be more of a challenge. Destiny wanted that in that particular moment of time two large architectural competitions

were launched concerning refurbishment of large 1970's housing developments. Difficult questions came up: can a state financed university contribute to an ongoing competition involving many companies and thus creating possible imbalance? Obviously not. Finally an agreement with a company that had already won an entry for a competition that none of the other stakeholders had interest in was chosen. The broad perspective of the topic demanded that both housing and urban specialist were involved and a process of finding a second partner that the company could accept turned out to be very complicated, but finally an agreement with 2 collaboration partners was settled.
Concerning faculty supervisors, at least 3 different is needed in order to facilitate the broad multidisciplinary perspective, challenging the cost-effectiveness goal of the matter.
The 2 topics that were chosen were not in the faculty made pamphlet of suggestions for projects. There was a refurbishment project proposal but not with the multidisciplinary urban approach attached.
The Health Care topic was new to faculty.

CONCLUSION

The strategy of letting students perform the role as agents for both coming up with relevant new project topics for the CDIO Integrated learning experience and for developing a project process proved to work.
Topics of highly relevance for the industry had completely been overlooked by faculty researchers. The multidisciplinary character of the topics was also aligned with the demands in the industry and new to faculty.
The costs for supervision will probably not be reduced because a number of supervisors are needed to cover the topic. Interestingly, the supervisors have to be called in not only from the Department of Civil Engineering but from other departments on campus. However it might turn out that the supervisors are needed for a shorter time and the students can profit from each other and work more independently or can make use of industry supervisors.
The 2 project topics developed in the process met the target of system design (CDIO syllabus 4.4.).
It was possible to create industry partners for students', 6th semester projects by making use of the knowledge student gain of the present interests of industry, during their internship period.
Concerning the target of creating more interest amongst faculty for dealing with the internship program and making the mandatory visits, it failed so far. Hopefully, the view to real innovation and development projects might create interest in the future amongst faculty.

DISCUSSION

The motivation of university researchers to work with the practical realm of internship programs is a challenge. However, there are new winds blowing in terms of research funding programs that demand close collaboration with industry and favor multidisciplinary approaches. This is for instance the case with the EU horizon 2020 program.
Viewed in this perspective internship visits might be an eye opener to faculty and help them create the necessary industry contacts in order to apply for horizon 2020 etc.
Most national policies tend to focus on innovation as a central platform for future societal development in Europe, and this might also motivate researches. The linkage between internship companies by means of the 6th semester CDIO integrated learning experience might be a hub for real innovation projects and thus attract the attention of faculty researchers.

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BIOGRAPHICAL INFORMATION

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