Students as agents – connecting faculty with industry and creating collaborative projects

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Students as agents – connecting faculty with industry and creating collaborative projects

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ABSTRACT
Collaborative projects between partners in the building industry and students constitute important means for addressing more advanced parts of the CDIO Syllabus 4. In this paper an existing internship program is revised in order to enhance collaboration between industry and faculty/students and perform as vehicle for addressing challenging parts of the CDIO syllabus.

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

INTRODUCTION
The technical University of Denmark embraced the CDIO program as one of the first Universities. It was a top down management decision to choose the CDIO syllabus as backbone for developing the engineering curriculum. The initial years concerned implementing the basics;
- Developing learning objectives that match the syllabus and work within the 12 CDIO standards
-mapping the progression in competence matrices.
-Developing Design-build projects

After the initial years, attention was given to the more complex parts of the CDIO program such as Syllabus 4.1.-4.4 Conceiving, designing, implementing and operating systems in the enterprise and societal context. Syllabus 4.1-4.4 is closely connected to a long line of other CDIO syllabus focus points concerning professional, communication, personal skills - and of course with technical knowledge as starting point.
Working explicitly with the enterprise and societal context of the engineering program thus came in late. In the following the process of developing a model for direct student-industry collaborative design and development projects in the framework of CDIO is presented.

METHOD

Student involvement in the design of the industry related educational activities is demonstrated and the results are presented.

RESULTS

BACKGROUND

A 5 month internship period in the Architectural Engineering B. Eng. program was for a decade placed in the 5th semester. Its purpose was to enhance professional engineering attitudes early on in the students' curriculum and by this enable the student to choose a specialization for the remains of the curriculum and aid the transition to an actual job after the 7th semester.

Implicit was also that the internship program was 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. However these visits were too rare.

Having the CDIO syllabus in mind, an inquiry to see if more could be gained from the internship period was set forth. Could the internship period be made to add to a controlled progression in CDIO skills, instead of being viewed as a kind of 5 month break during studies? Could the internship period be a starting point for innovation projects between industry, faculty and students?

ENTERPRISE AND BUSINESS CONTEXT 4.2

The assessment of the internship period was always based on three assignments: a 'logbook' (a record of daily events), an 'internship-company-report' and a so called 'special report' on a self-chosen technical – scientific subject.

The internship company report was changed into having objectives addressing syllabus 4.2:

4.2.1. Appreciating Different Enterprise Cultures
4.2.2. Enterprise Strategy, Goals and Planning
4.2.3. Technical Entrepreneurship
4.2.4. Working Successfully in Organizations .(1)

The new approach prescribes that after just 2 weeks in the company the students describe the organizational structure in the company and from what the company earns a profit. This is described in the 'internship company report'.

The sharper focus and the early deadline for this report has changed the report into a kind of tool for meeting the objectives of syllabus 4.2 instead of a dreary obligation handed in by the end of the internship period, which was the order during the previous decade.

The 'special-report' was also altered in order to address the CDIO syllabus 4.2 An idea to make the students agents for finding out the innovation potentials and development interests of the internship enterprises came forth. This demanded that the students should understand 'their' enterprise and the market quit deeply and extensively.
The newly developed approach involves a meeting before starting the internship period and one during the period, where students are presented with the task of looking for design- and development projects within 'their' internship enterprise. These company preferences – as perceived by the students - are now what determine the choice of subject for the 'special report'.
The criteria for the choice of subject:
The internship company should find this particular subject so interesting that they would be willing to invest a minimum of, monthly, a one hour meeting with the students after ending the intern period. This means that the company should be willing to continue developing and designing together with the students after ending the internship period within the framework of the subject.

DESIGNING 4.4
The largest step in making better use of the internship period in the curriculum is concerning design processes. These are placed high on Blooms Taxonomy(2) and when adding industry collaboration it is a great challenge. Getting ideas for projects from industry is not extraordinary, but explicitly aiming at creating real design- and development projects between industry and students is a completely different matter.
It was also decided that this 'active integrated learning experience' with industry should be for all the students in the program, the best and the worst. It could thus be a mandatory feature. Spring 2014 the first round of these new design and development projects took place.

During the previous decade, 6th semester mandatory CDIO Integrated Learning Experience projects existed in the program. It was scheduled to lead up to the final thesis project and the topics of the projects were outlined by faculty. In reality that meant that the topics for the 6th semester project were derived from

the realm of research with a tendency to repeat the same projects year after year. The topics chosen by faculty were presented in a project pamphlet, for students to choose from.
It was thus interesting to observe if the new projects topics 'harvested' from the internship companies would be a lot different from the ones faculty provided.

The actual 'harvesting' of innovative, industry collaborative project ideas were organized as follows:
-After having pinpointed a project or topic within the internship company, the student will write a report with a literature survey or 'state of the art' survey.
This replaced the report where the topic was chosen by the student.
-During a workshop just before the start of the 6th semester and just after the end of the intern period, the students present the harvest of ideas via power point shows to faculty and each other. They range the level of company interest (meaning how many hours the company will invest in meetings and supervision). At the same time faculty present at the event try to compose groups of potential faculty supervisors for each design project ideas.
The task is made even more complex because the students should have their specialization in mind: the project should also serve the further development of individual disciplinary core engineering competences.

The result Spring 2014, was two 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 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, simulation of indoor climate and energy consumption.
'Health Care' framed topics as: façade engineering and daylight/lighting design, evidence based design theory, accessibility, infection retardant ventilation systems.
The setup was initially not planned to be interdisciplinary. Fortunately it ended up being it, and thus addressed the syllabus 4.4. precisely.

MAPPING OF MODELS FOR COLLABORATION WITHIN THE STUDENT GROUP

The interdisciplinary character of the projects 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 students 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:

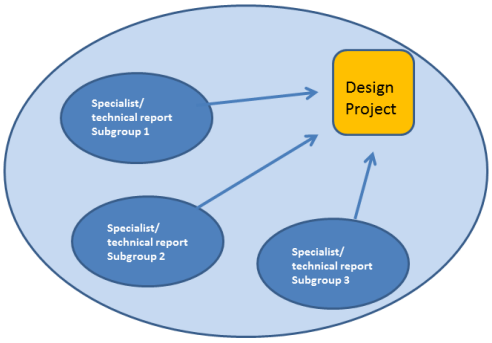


Figure 1. Model 1.

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.

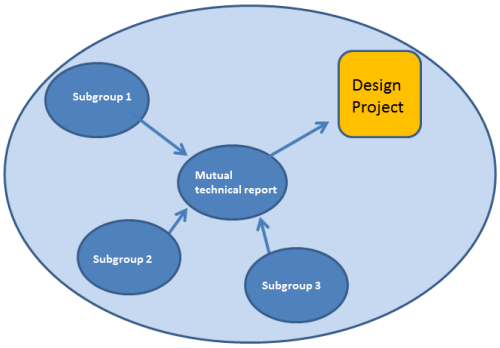


Figure 2. Model 2.

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.

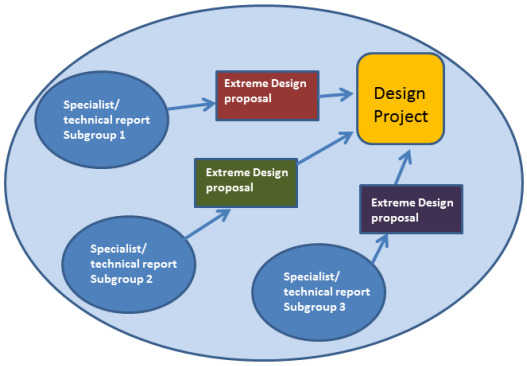


Figure 3. Model 3.

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 projects 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.

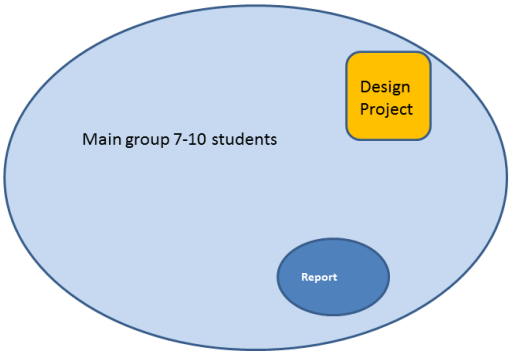


Figure 4. Model 4.
All students in the main group work on a mutual technical report and design project together.

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.

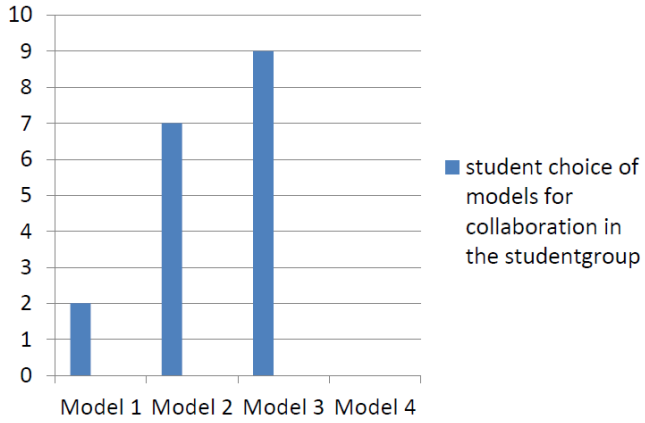


Figure 5.
Result of survey where students were asked to choose the model for collaboration that at best mimed the process in the industry.

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

MAPPING OF INDUSTRY/UNIVERSITY COLLABORATION MODELS

a survey among the students was made in order to identify the best model for collaboration between students, faculty and the industry partner. Again the students were considered to be the experts because they knew the companies 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:

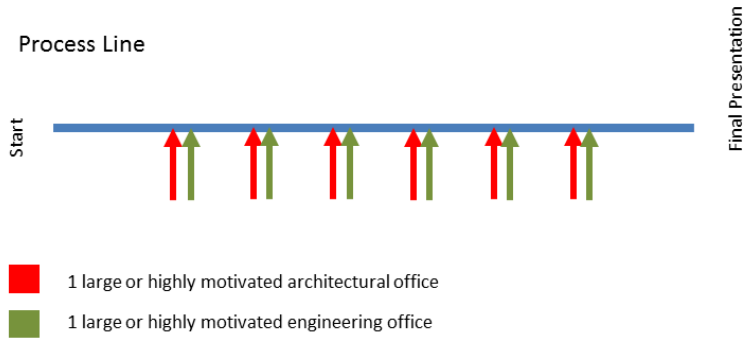


Figure 6. Model 1

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

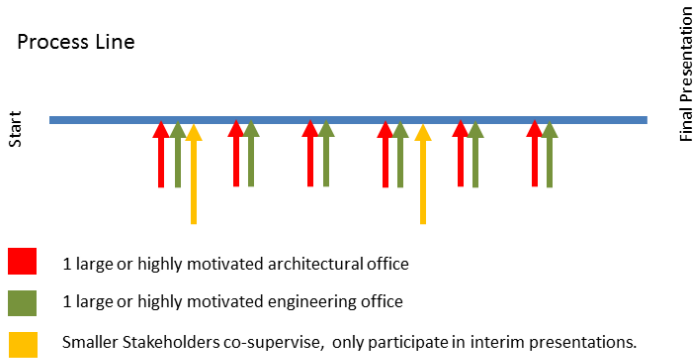


Figure 7. Model 2

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.

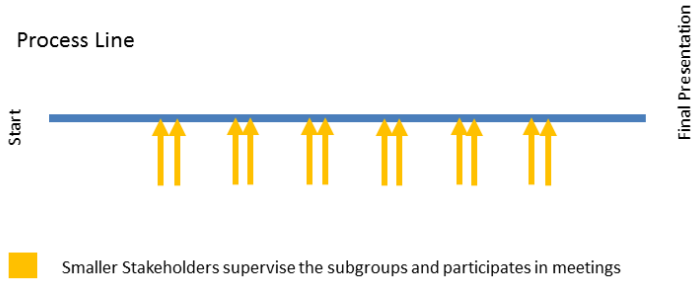


Figure 8. Model 3

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.

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.

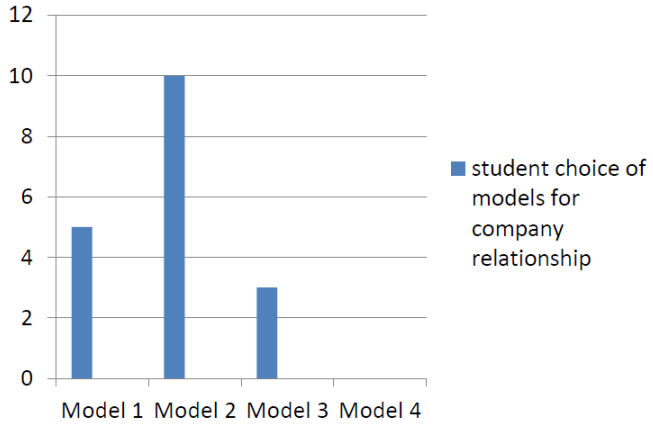


Figure 9.
Result from student survey.

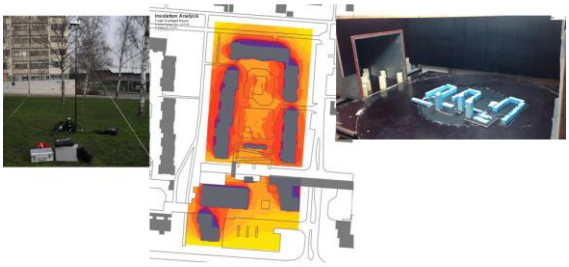
MATCHMAKING BETWEEN STUDENTS, FACULTY AND INDUSTRY

From the survey, a prioritized list of internship companies was made, linked to each of the two topics. At the same time a 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 on outlining the project.

Concerning the second theme, ‘Holistic Refurbishment’ it proved to be more of a challenge. 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.

Concerning faculty supervisors, at least 3 different were needed in order to facilitate the broad, interdisciplinary perspective, challenging the cost-effectiveness of the supervision.



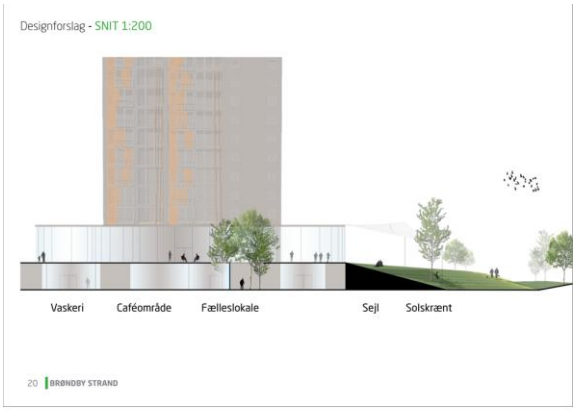


Figure 10.
'Holistic Refurbishment'. From top: Example of Technical Report on wind measurement, wind tunnel and solar simulation. Then 'Extreme Design' viewed from only the point of wind specialists. Below; final proposal with solutions from both indoor climate specialist (solar shading), structural engineers (the

structure of the lower floors are altered to allow more transparency and public facilities) and the wind specialists have added a glass pavilion and a solar sail where the turbulence is most severe.

CONCLUSION

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.
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 increase 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' post internship, real design and development projects by making use of the knowledge student gain of the potential of the enterprises, during their internship period.

DISCUSSION

Hopefully, the view to real innovation and development projects might create interest amongst faculty for engaging directly in the internship program in terms for visits to the companies. 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. (3)
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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