Bringing Practitioners (and Practice) into the Curriculum

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Abstract

Many of the Delft University of Technology curricula have a rich history of bringing practice into the classroom. The most common and most obvious way that this is done in Delft is to seek candidates for full professorships almost universally from industry as opposed to having them progress ‘up through the ranks’ as is most common in US universities.

Realizing that most US universities will not change their ways so drastically, the paper describes and analyzes experiences with several other and less far-reaching ways in which industrial guests has been brought into Delft University of Technology curricula:
1. Provide a single lecture period as part of a course.
2. Provide specific expertise for a course exercise.
3. Teach an entire course.
4. Coach a thesis - along with university staff.
5. Participate - as quasi-student - in university-taught classes.

Experiences with each of these will be described, but more importantly, lessons learned from the experiences and the methodology for improvement of the utilization of industrial practitioners with students will also be highlighted. All of this work has taken place over the last quarter century with a significant increase in this activity in the most recent decade.

Introduction

The Delft University of Technology as well as most other Dutch universities, by the way, generally award full professorships to persons who have already earned significant recognition in a non-academic position outside the university. It is only occasionally that truly exceptional university staff progress upward through the ranks to this supreme level.

US universities, on the other hand, use full professorships more as a reward for their own staff; they progress to the top from within the academic environment. These two approaches are so different and so entrenched that it would serve no purpose to discuss their relative merits; neither side is expected to change their position.
Most curricula in Delft use persons from outside the academic environment to enhance their programs on a (formal) part-time or even a more ad-hoc basis. The offshore engineering curriculum does this more than others, however. This has been motivated partially by the need to provide optimum coverage of a variety of topics with only a small core team of university staff dedicated fully to offshore engineering.

Two companion papers - one by Lange\textsuperscript{1} and one by Massie\textsuperscript{2} - have addressed the motivations for industry-university cooperation; this paper concentrates primarily on the operational aspects of such cooperation.

Background for Industrial Curriculum Teaching

There are several reasons why industrial staff have are used for teaching in Delft:
1. The most direct reason can be that the university simply lacks the expertise to teach the material itself.
2. Industrial teachers convey an aura of 'this is the way it is actually done'. This is especially true when they are used for design-oriented courses.
3. Industrial theses allow students to work on 'real' problems. This motivates them.
4. An industrial thesis eases the student's transition from the academic to the industrial environment.
5. Industrial theses are usually carried out in industry. They provide the primary support so that the curriculum can accommodate more students with fewer university resources.

The university must remain primarily responsible for its curriculum, even when an entire course is provided by industry - as is sometimes the case within the offshore engineering curriculum in Delft. The ultimate responsibility for content of every course as well as its participant's grades remains in the hands of university staff.

Details and lessons from various forms of industry-university cooperation are described below.

Single Class Guest Lecture

An excellent example of the context of such a lecture is the input from roughly 20 persons within a Survey of Offshore Engineering course that exposes course participants to a myriad of disciplines behind the development of an offshore oil and gas field.

It is pleasantly surprising how willingly industrial guest lectures participate at this level. They consider it an honor, apparently, to do this and there is nothing wrong with the university taking advantage of this feeling. The guest's work is limited in such a case to providing the lecture; they are not involved with the course examination, etc. Generally, it is not necessary to pay these guests for this effort.
Since guests, especially, can also have a role model function for the course participants, they are encouraged to tell a bit about themselves and their career at the beginning of their lecture. They are also generally allowed to tell a bit about the company for which they work as well.

Problems and Solutions
1. The guest tries to cover too much; as a result, their content often overlaps with that handled by others within that same course.
   The best preventative measure is to make sure that the guest lecturer is fully aware of the entire course structure and the topics that have already been discussed as well as those that are to follow. This implies that the course leader must make up the entire course outline and make it well known to all of the teachers involved. Usually a short phone conversation to discuss what each person is planning to present is also valuable for focusing the guest on his or her part of the total course.

2. The guest wants to discuss a spectacular and recent special case instead of covering the basics.
   It is indeed human for industrial persons to want to talk about their most recent successes; it is sometimes easier for them as well - especially if they have recently prepared a talk on this for other purposes.
   So far, the best solution found for this is a sort of compromise. One approach is to make it clear to the guest that some basics are important to the context of the course and encourage the guest to present information on the new project via a video, for example.

3. The guest fails to show up - the nightmare of every course organizer.
   This provides an excellent opportunity for the course leader to demonstrate creativity. On the very few occasions on which this has occurred, the course leader has to fill in things in one way or another:
   • If this is the last class for the session, the subject may simply be dropped for the day and possibly re-scheduled for a later session.
   • In one case the course leader has filled the hour himself. This involves first admitting that the topic is not really his expertise, but that he has heard this lecture before. He then continues to fill in the material - sometimes more in the form of a discussion than a formal lecture - with the class. Indeed, he will generally not have a prepared presentation handy for such a circumstance.

4. The guest does not provide notes.
   Modern technology is making this a smaller problem than in the past. Nearly all lecturers today have some form of (electronically) prepared talk such as a powerpoint presentation. In such cases it is relatively easy for them to provide this presentation to the students as printed notes sheets and possibly as a CD as well.

5. The guest does not get the message across effectively.
   In all such cases, the guest should be given feedback on this - preferably rather quickly. There are two further action alternatives:
   • If the underlying cause of this is considered to be the content (too much, too deep, too superficial), then the guest can be given a new chance to do better when the course it taught again. Without improvement, the guest should be replaced.
   • Unfortunately, some otherwise brilliant persons simply cannot effectively get the point across to a group of course participants. If this is the root of the problem, then the only
solution is to replace the guest speaker with someone else in the coming year. This has been done a few times.

6. An excellent guest has been moved to a foreign location since last year. The international character of the offshore industry makes this an especially relevant problem.

- The approach most commonly used has been to contact that guest at their foreign location - e-mail is excellent for this - and ask them to recommend a local replacement. He or she may or may not be able to do this.
- In one case, such a speaker arranged a vacation back in The Netherlands so that he could still give our guest lecture.
- When these steps don't work, the approach has been to ask an engineering leader - probably from another relevant company - to suggest a good speaker on the topic. This person may or may not be one on his or her own staff.

Provide Expertise for an Exercise

Three quite different forms of this are being used in Delft. None have had really significant problems. In the first case, a retired oil company engineer - with a broad experience - provided a series of lectures to help teams of participants carry out the conceptual design of an offshore oil and gas field development. His primary task is to provide a generic working path for the participants based upon his own similar past experiences. He provides no notes to accompany his lectures. This is done partly with an educational objective; it forces listeners to make their own notes for a change. He also reviews and comments on the work done by project teams. This involves attending team oral presentations as well as a review - at home - of their written reports.

In the second case, an outside person provides expert guidance for a computational exercise in a design course. He is only occasionally in the classroom; he does most of his work at home and converses with teams of participants by e-mail or snail-mail depending upon the type of question asked. He comments on all facets of the exercise: The computational model chosen, the selected input and - of course - the quality of the output.

In the third case, a trainer comes from London and spends one full day making participants familiar with special software for estimating costs of an offshore field development.

These people are paid for this work. Fees are negotiated, but are generally well below commercial rates; part of their remuneration is the satisfaction of seeing the participants grow and knowing that they are (still) helping to improve the quality of new emerging offshore engineering professionals.

Problems and Solutions

So far, there has been but one problem with working with retired persons: Sometimes they have quite different activities - such as a visit to children in a foreign country - at the same time that they would be most desired in the classroom. A bit of scheduling flexibility - possibly involving other teachers in the team to 'cover for him' along with early planning are the only real remedies for this - unless, of course, one wishes to risk trying to find an equally competent replacement.
Teach a Major Segment of a Course

Two of the offshore courses, marine pipeline design and subsea engineering, are taught entirely by persons from outside the university. Subsea engineering is taught by one person who is responsible for a total of six full days of class. A larger team - split into three sub-teams, each from a different organization - each fill the equivalent of two full days of class. Since most of these persons come to Delft from a foreign country (The United States or England) their classes are scheduled to fill a full day on a Friday and the following Monday. The subsea engineering teacher therefore makes three trips to Delft from London - usually with a two-week interval. Other foreign teachers generally come once per course.

Problems and Solutions
1. The first two subsea engineering teachers were failures.
   The first two subsea engineering teachers had given general awareness courses for colleagues, but their presentations lacked the depth expected by university students. Neither was invited for a second time. Luckily our third teacher is very good.
   One of the advantages of using industrial - rather than university - teachers is that they can be replaced relatively easily if they fail to meet expectations.
2. Scheduling of the Fridays and Mondays.
   Reserving two full days in a week for a single course imposes a significant restriction on the scheduling of other courses. This inconvenience has been minimized by scheduling all such courses in a single academic quarter in which all other offshore engineering courses could be scheduled during the remaining three days. Since students can also be participating in a myriad of elective courses, not all scheduling conflicts can be avoided; some participants will occasionally have to choose which course to attend. By scheduling the subsea engineering course every two weeks, students were at least not required to miss a contiguous segment of another course.
3. Efficient use of the Fridays and Mondays.
   Two design courses plus an all-day training session for a third course along with one or two half-day activities were all dovetailed into the available Mondays and Fridays in the quarter. Success of this depends upon the availability of and cooperation by the industrial teachers involved.
   In one case it has indeed been necessary to move two days of class to another term. In order to fit this in, the teacher came to Delft twice for individual Tuesdays instead of a single Friday - Monday combination.
4. Examinations.
   Written exams are given twice per year for each of these courses. Of course the industrial teachers now participate in this as well by composing the questions and grading the answers. The logistics of this are significant. Appropriate examination answer sheets are copied and sent to the relevant teacher; the original is kept in Delft and is graded independently by the university's coordinating teacher. After grades have been received from the industrial teachers and processed by the offshore staff, they are compared to those assigned by the university's teacher. Any glaring discrepancies lead to discussion, and so far at least, to final agreement on grades submitted by the university staff member.
Thesis Coaching

Thesis coaching is the oldest and most widespread use of industrial teachers within the Delft University of Technology. Roughly 70% of the offshore engineering theses are carried out with some form of industrial assistance. An offshore thesis last nominally 6 months and in the majority of cases is carried out within industry using their facilities. Industrial theses give the industry access to the latest information from university courses (via the student) as well as a relatively inexpensive worker with a relatively innovative approach to problems.

The thesis is coached from the start by a team of up to six persons including at least three from the university. This team meets with the student at a frequency of once per four to six weeks. Committee meetings take place by e-mail if these projects are taking place in foreign countries.

Problems and Solutions
1. Balancing university and industrial needs.
   Many uninitiated persons expect this to be a problem. It is generally a non-problem however. This stems in part from selecting the bulk of the thesis coaching committee at the start of the project. Their first task is to review the student's proposal and agree to its scope and method of approach. While there may be a bit of discussion at this meeting, these generally lead to consensus.
   Unfortunately, not everyone who comes to the university with a thesis idea fully realizes that a thesis involves more than just processing a pile of data. One such case of this type of thesis is known: The university committee members recognized their error too late, but did not punish the student; they did resolve never to place another thesis student with that company however.
2. Committee meeting scheduling.
   It is often an interesting lesson in logistics for a thesis student to schedule a meeting for his or her committee meeting; many busy schedules have to be combined. The most common solution to this is to make an appointment for the following meeting at the end of the previous one. This puts pressure on the student as well to produce a tangible result in time for it to be reviewed for discussion at that meeting.
   In a few cases, students suggest dates for committee meetings in their proposals. Such dates usually correspond more or less to the particular project's milestones.
3. Industrial coach gets moved.
   Occasionally the primary industrial coach is sent off on a foreign assignment for several months part way through the thesis project. If he or she has no colleague that can take over the coaching, then only a bit of improvisation can help the student involved. He or she then must fall back more on the university members of the thesis committee.
4. Domineering industrial coach.
   At least one case is known in which a (good) student's industrial coach had already formed a good idea of what had to be done and how it should be approached before the student even completed his own survey of the problem. Since the student's review yielded other information, he (in this case) was kept rather 'under the thumb' by his industrial coach. As luck would have it, the student actually delivered a very valuable report - after his
domineering coach was sent to a foreign country midway through the project. That person will not be allowed to coach new student theses.

University committee members should be attentive to this problem. A common sign is that the coach - rather than the student - plays an important part in progress meetings.

5. Industry expects too much.

Students - and European students in particular - are not highly ranked when it comes to the tempo of their study; assigning a task that is on an industrial project's critical path to a student generally involves too much risk of delay. Instead, thesis topics which:

- May be an alternative for a method or solution already used, or
- Relate to a problem that has never (yet) been solved.

are usually the most satisfying and rewarding for everyone.

6. I need thesis students to work in my (university) lab.

This is one common (real - if not expressed this bluntly) argument against industrial theses. In most cases is comes from one who has both a lab and relatively few students; apparently their activities are not that attractive to students. A discussion of the reasons for this is beyond the scope of this paper, however.

While the author has no lab of his own, occasionally one of his 'pet' projects has had to wait a while until a student was motivated to pick it up. Usually, the wait was amply compensated by the student's motivation.

Industrial Participation in University Classes

A new activity - started this past Fall - allows a few participants from selected (see financing below) industries to sit in on offshore engineering courses; they do not take part in exams or lab exercises. Their status is much like that of course auditor at some US universities.

Problem without a solution

Industrial participants are no better at attending class than are (European) university students. While on the one hand, it is in no way critical to the university that the industrial persons attend class, on the other hand, those attending only a single class certainly miss the course context. No real remedy for this has yet been found.

Financing

Obviously all of the above activities cost money and most all of them cost the industry money. Since industrial thesis students often must be on the payroll for insurance purposes, these represent a direct cost to the industry in addition to the time used by their regular staff for coaching.

At the other end of the scale, even companies that do charge for teaching a course, do so for such an attractive price that there is probably little if any direct financial profit involved.

From the university side, real money has to be available to pay the additional cash expenses charged to the university by some of the industrial teachers. The source of this funding is perhaps unique in Delft: A few companies provide annual grants to the university that are earmarked for
offshore engineering education. It goes beyond the scope of this paper to explain how these industrial grants all came about. In one exceptional case, a company that provides more than 12 hours of class for no charge is also included in this support category. Staff from these supporting companies may sit in on offshore courses as outlined above.

Reflections and Conclusions

It is perhaps surprising, but students tend to pay more attention when - for example - an engineer from an installation contractor comes to Delft to explain how offshore structures are installed. Students leave such classes with two new feelings: First that they are getting relevant and up-to-date practical information, and secondly that if someone from industry is coming to talk just to them, then they and the curriculum must be important.

Feedback to the industrial teachers and coaches is important to everyone. Results of course evaluations as well as of annual curriculum evaluations are routinely solicited from course participants and provided to relevant teachers.

Curriculum cooperation is a win situation for the industries involved for the following reasons:

• It brings them in closer contact with the relevant university staff and on-going developments.
• The closer contact makes it easier to judge the quality of curriculum as a whole and to form a better opinion about its quality.
• It makes students aware of the company and can motivate some to want to join that industry's team upon graduation.
• More generically, it can improve the general quality of graduates; this benefits everyone.

Bringing the industry into the curriculum is a win situation for the university for the following reasons:

• The resulting close contact with industrial staff keeps the university teachers up-to-date on industrial needs and developments. This can stimulate gradual but continuous curriculum improvement.
• Industry can provide expertise that would be underutilized (and possibly too costly) if provided by the university. As a result, the university can do more with less.
• Industrial thesis projects - especially - demonstrate that the university's curriculum supports the solution of real-life problems. It must therefore be relevant.
• Industrial teachers with a 'can do' attitude can be excellent when it comes to conveying design and other practice-oriented courses to students. Students are assured that their teachers are talking about real-world problems and solutions.
• Industrial teachers tend to have a user-oriented vision of theory. They can remain more focused on the desired result than some of their university colleagues.

Students win from industrial participation in the following ways:

• They gain exposure to successful role models.
• Industrial thesis work - especially - helps to ease a person's transition from a 'free-and-easy' student life to the more regimented industrial society in which they will be making their career.
Students are more easily motivated to study a problem that is obviously realistic.

Potential conflicts of interest - so often feared from industrially-sponsored research - have not been experienced with their educational involvement. The nature of education is less prone to this anyway, but keeping the final responsibility for course content within the university helps further to prevent this.

Industry - university cooperation can increase the value of a curriculum to society in an efficient and cost-effective way.

References


Biographical Information

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Walt has a primarily US background in Civil as well as Mechanical Engineering. He first went to The Netherlands as a Fulbright Scholar in 1968 and has been on the faculty of the Delft University of Technology since 1970. He has filled various functions within the university - primarily within Civil Engineering - and is currently the Offshore Engineering MSc Degree Curriculum Leader.