

INDUSTRIAL INTERNSHIPS AS INTEGRATED LEARNING EXPERIENCES WITH RICH LEARNING OUTCOMES AND SPIN-OFFS

Aldert Kamp, Femke Verdegaal

Delft University of Technology, Faculty of Aerospace Engineering, Delft, the Netherlands

ABSTRACT

At graduation engineering students should be able to use the engineering skills they learnt in advanced industrial applications with preferably little additional training. Authentic design and innovative engineering problems and questions in the life of an engineer should therefore be identifiable subjects in engineering curricula. An important contribution to the attainment of these targets can be obtained by a compulsory internship in the Master programme. Internships can be transformed from a period of work off campus into effective integrated learning experiences with rich learning outcomes. Many of the outcomes relate to key capabilities that each engineering student should have at graduation, to be prepared for the world of work and create the best chances for a successful career, such as employability, organisational sensitivity, intercultural communication, ethical accountability, professional responsibility and lifelong learning. This paper describes how TU Delft Faculty of Aerospace Engineering has implemented the internship in its programme, including its assignments and assessments with feedback from and to the students, with the aim to have real impact on student development. It describes how company feedback is provided to the students and how this is also fed into the education quality assurance cycle, and in what respect the internship can stimulate the collaboration with industry to achieve a win-win situation. An excellent and professional organisation is a critical success factor. The logistic challenge to coordinate the planning, organisation and assessment of more than 300 - 400 Master students per year, who take an internship all over the globe, is big and demanding. Securing a sound account management with the more than 600 industrial companies, who provide the opportunities for our engineering students, is a condition to achieve sustainable internship opportunities of high quality.

KEYWORDS

Internship, industrial placement, engineering education, professional orientation, employability, industrial feedback to curriculum, CDIO Standards 1,2,3,7,8,11,12.

INTRODUCTION

In order to prepare engineering students for their future world of work it is a must that they experience the real world of engineering and get a taste of genuine research and design by learning-by-doing and getting lectures and coaching by engineers and experts who have experience in engineering practice (CDIO Standard 1: Context) (Crawley, E.; Malmqvist, J. (2007)). Experimentation in labs, hands-on design projects on authentic problems, and internships in industry or institutes enhance the engagement of students. Students grapple with the uncertainties of evidence, the communication of arguments, and the societal and ethical context of the latest developments in science, engineering and technology. Internships make it more likely that young engineers come to understand the big picture and the need to learn: how

context shapes the tasks and how business thinking and contingency factors have to be integrated into technical performance. Interacting with modern engineering professionals is key to providing students with the role models for their future and exposes them to real-world professionals and the problems engineers face every day (Kamp, 2014).

The above vision has been the main driver for having a compulsory three-month industrial internship in the curriculum of the second year of the Master in Aerospace Engineering at TU Delft. Having a vision is one, but implementing an internship as an effective and integrated learning experience (CDIO Standard 7: Integrated Learning Experiences) in an international environment, with well-defined intended learning outcomes and a sound assessment approach, for more than 300-400 engineering students per year, requires a solid educational concept, a smooth and transparent organisation and an intensive account management with the more than 600 industrial partners.

THE TOUCHSTONES OF OUR MASTER'S

The T-shaped professional

The complex multidisciplinary problems and challenges in our society require deep problem solvers who are capable of interacting with and understanding specialists from other disciplines. Industry refers to these people as T-shaped professionals: deep problem solvers in science and engineering who are capable of interacting with and understanding specialists from a wide range of disciplines and functional areas (Kamp, 2011). The Bachelor's provides the broad academic background with consolidated knowledge of aerospace engineering and development of engineering and academic intellectual skills, personal and interpersonal skills, representing the bar of the T. The Master's represents the stem of the T. It develops the student's in-depth working knowledge by providing a specialised course and research programme, and a professional orientation. Specialisation, research, and employability are the key words for this programme.

Programme philosophy

It is our aim to educate all-round professionals who are able to use their engineering capabilities in advanced industrial applications with little additional training. In the Master's the students develop the basic capabilities acquired in their Bachelor's study to a higher level. Central to this philosophy is the view that specialisation is mandatory to achieve the higher attainment levels in capabilities like independent thinking, professional orientation, innovation and research.

The programme has therefore five salient features.

1. **Specialisation and depth of study**: the students develop a thorough and detailed knowledge of one identifiable field of expertise in Aerospace Engineering.
2. **Academic skills**: the students conduct a comprehensive research project. In the internship they develop and apply many personal and interpersonal skills, such as ethical accountability, intercultural communication, technical writing, lifelong learning and risk taking.
3. **Autonomy**: the students are given flexibility in compiling and planning their individual study programme (self-directed learning), including the choice of the company for the internship and the planning.
4. **Professional orientation**: the student acquires employability skills during a three-month internship that is preceded by employability trainings. They experience and explore the professional environment, develop organisational sensitivity.

5. International orientation: the students gain an international focus by working with foreign fellow students in the classroom on the campus, by studying abroad and by doing an internship in industries in the Netherlands or abroad.

INTERNSHIP

Intended Learning Outcomes

Having an internship as an obligatory integrated part of the Master's (CDIO Standard 3: Integrated Curriculum) requires well-defined intended learning outcomes (CDIO Standard 2: Learning Outcomes), deliverables and set standards with regard to the assessment of the internship (CDIO Standard 11: Learning Assessment), and its continuous evaluation for improvement (CDIO Standard 12: Programme Evaluation).

The intended learning outcomes of the internship have been flowed down from the programme's final qualifications and are well aligned with CDIO Standards:

1. Industrial orientation/societal context (CDIO Standard 1: Context):

- To increase your understanding of employment options after graduation
- To get a good perception of your tasks and responsibilities within a professional environment
- To create an understanding of the context in which aerospace engineering and utilization is practiced by industry, institutes and organizations.

2. Socio-psychological (CDIO Standard 7: Integrated Learning Experiences)

- To learn a different way of behaviour, suitable for a professional social work environment
 - To be able to communicate and cooperate with colleagues and non-colleagues
 - To obtain a better view of the position of a company compared to other companies (business thinking, competition, achievement)

3. Intellectual skills (CDIO Standard 7, 8: Integrated Learning Experience, resp. Active Learning):

- To use acquired knowledge and skills in an environment different from that of the home university
- To obtain, rapidly and effectively, new skills that are necessary to successfully accomplish a project
- To be competent in reasoning, reflecting and forming judgments.

In practice we experience that the above intended learning outcomes are difficult to assess and quantify. They are not yet formulated in a smart way (see also section "Challenges for the future").

**Testimonial Tom Burbage,
Lockheed Martin**

"We have had a superb experience with the students who have come through the program. Every class has had a unique personality and all have been a true pleasure to have on de F-35 team. The students come to us very knowledgeable of the F-35 product areas they will be working on as well and are well educated about the military aerospace industry in general. More importantly, the students are tremendous ambassadors for the Netherlands and for Delft University. They are highly motivated, do an excellent job and are very well regarded by all of their work teams. One of my favourite comments I have heard is one of the 2010 supervisors described his intern as "scary smart" which means he is very impressed with the level of knowledge the possess."

By Tom Burbage, Former Executive Vice President & General Manager Lockheed Martin, F-35 Program Integration, Fort Worth, Texas, USA.

Implementation

Integrated learning experience

The three-month internship, equivalent to 18 European Credits (EC), enables the student to acquire professional skills different from those taught in the classroom. Besides the (technical) assignment set by the host company, the student also has to complete a dedicated individual assignment about the engineering *profession* and make a personal assessment of his or her performance during the internship. This makes the internship an integrated learning experience (CDIO Standard 7). The professional assignment involves an exploration of how the host company meets professional standards in such areas as sustainable development, project or risk management, value management or health and safety management. The personal assessment is about asking oneself – for example – “What did I learn about myself in the professional environment?” “Did I discover unexpected talents?” “What points for personal improvement remain?”

Timeframe

The internship is scheduled in the second year of the Master's. This gives the student in the first year the time to start orientating, preparing a Curriculum Vitae, thinking about a motivational letter, following informative workshops about job interviews and application letter writing, and most important of all, making choices as to where he or she would like to go. Already on the first day of their study the students are informed about the steps to be taken to successfully organise the internship and their urgency. Students are made aware that *they* are in the lead and personally responsible for success, while the internship office is available for consultancy on demand. Since most students have the wish to take the internship abroad, long-term planning is essential: the students are stimulated to start their preparation and orientation already nine months before the planned date of departure.

Deliverables

To make sure that the intended learning outcomes are achieved, the student has to submit three deliverables:

1. No later than four weeks before departure the students have to submit a completed “final approval form” to the internship office. We want the students to leave well prepared, and assure they are well informed about the expectations and the professional role in the

Student experience Thomas Slijpen, Netherlands Office for Science & Technology

“My internship at the Netherlands Office for Science & Technology in the Dutch Embassy in Washington DC was a fantastic experience. Together with a fellow intern in San Francisco (it was a job share internship) I worked on an assignment to increase the innovation power of the Netherlands. I explored trends in the High Tech Systems & Materials Top Sector in the Netherlands and the opportunities for (R&D) collaboration with US partners. Establishing projects in the areas of 3D printing, photonics and flexible electronics was particularly interesting and challenging. The combination of having direct contact with companies and dealing with innovation, strategy and international cooperation taught me a lot. In addition: working in the embassy and living in the Capital of the World was very special. Nearby cities such as New York and Chicago were perfect for weekend trips.”

*By Thomas L.F.P Slijpen, Innovatie Attaché
Netwerk (Netherlands Office for Science &
Technology) Nederlandse Ambassade
Washington DC*

internship. There has to be a clear project description and dates, and the names of the company supervisors have to be known. Besides the project description, the student is asked to hand in a self-assessment. This includes a reflection on each of the core capabilities a graduate of the Master in Aerospace Engineering is expected to have, identifying what is going well and what capabilities should be strengthened or developed. The same questionnaire will be submitted as part of the mid-term and final evaluation, but then filled in by the company supervisor, as described in the next paragraph. The students are also asked to choose one aspect of the engineering profession that he or she would like to reflect upon on site. This is the more creative chapter of the internship report. Having to write a chapter on a non-engineering, more socio-economic topic, such as human resource management, financial reporting, design-for-value, management skills, forces the student to look beyond his engineering work and meet with colleagues of other, non-engineering departments.

2. Half way the internship the student needs to mail a mid-term evaluation that is filled in by the company supervisor. The assessment includes the same competencies and questions as the student filled in on the self-assessment before departure. Having a mid-term assessment enforces the student to plan a meeting with the supervisor to reflect. This gives the student the opportunity to provide feedback and discuss issues with regard to the internship. Having the same questionnaire first filled in by the student (before departure) and by the supervisor half way the internship, gives the student insight in his performance, attitude and behaviour: is the way the supervisor assesses him the same as the way he sees himself? What are the points of improvement to work on?
3. After completion of the internship the student has to submit a report within two weeks. The report has to include the technical chapter, the reflection on the engineering profession, a self-assessment, tips and tricks for future students, and the final assessment form filled in by the company supervisor.

Assessment

Halfway through an internship, the supervisor completes an assessment form (Table 1) addressing the student's knowledge and academic and engineering capabilities such as analytical ability, initiative, interpersonal skills and diligence, and submits it to the internship office. If this reveals significant deficiencies, the Internship Coordinator contacts the student as well as the supervisor so that corrective action can be taken.

Testimonial Rik-Jan Lemmen, Airbus Hamburg

As former student from Aerospace Engineering (AE) I know the value of the students in AE in Delft. Therefore, we are always interested in having students within our departments at Airbus. We have several teams working on the design and engineering of the composite Vertical Tail Plane. It is typical that all teams that have experience with students from AE are highly enthusiast about the high level of these students. Students from AE are able to work within a short time independently on complex projects in multi-functional teams. Therefore, managers who have had experience with a student from AE once are standing in line to take the next student. To all students who want to make an internship at Airbus I want to say: you are a product of your own advertisement!

*By Dr. Rik-Jan Lemmen, Fatigue Engineer,
Centre of Excellence Empennage/Aft
Fuselage-ESTL2, Airbus Hamburg*

Table 1. Assessment Form Internship MSc Aerospace Engineering

Work Result	
<i>Overall performance during the internship</i>	Score:
<i>Competent in doing research/ Competent in designing</i>	Score:
<i>For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.</i>	
<ul style="list-style-type: none"> ▪ What is particularly good? ▪ What can be improved? 	
<i>Problem Analysis/Analytical Ability</i>	Score:
<i>Identify problems and important information; connect data. Find out possible problem causes; Searching for relevant data.</i>	
<i>Initiative and willingness to learn</i>	Score:
<i>This is about being keen and enthusiastic, taking responsibility for own learning and development and being hungry to succeed and learn.</i>	
<i>Interpersonal Skills</i>	Score:
<i>Works harmoniously and effectively with subordinates, peers, supervisors? Team player? Shares information with others? Resolves conflicts? Welcomes and seeks constructive feedback on own performance? Cooperative?</i>	
<i>Diligence and resilience</i>	Score:
<i>This is about being determined, hardworking, and results focused and being able to work effectively under pressure. Target driven.</i>	
<i>Flexibility</i>	Score:
<i>Ability to change behaviour if problems or chances arise in order to reach the specified aim. Competent in reasoning, reflecting, and forming a judgment.</i>	
General Remarks	
To what extent did the student meet the expectations?	
Do you have recommendations for the student concerning his/her personal and professional development?	
Can you imagine the student as a future colleague?	
Overall performance of the student; Please indicate the category:	
<input type="checkbox"/> outstanding performance (top 5%) <input type="checkbox"/> excellent student <input type="checkbox"/> good student <input type="checkbox"/> average student <input type="checkbox"/> this student does not fulfill the minimum requirements	

The student learning gains are assessed (CDIO Standard 11) on the basis of the deliverables as outlined in the previous section: the different chapters of the internship report (technical report, engineering profession, self-assessment, tips and tricks) and the assessment form by the company supervisor. The internship report is evaluated by the internship office as well as by a senior member of the faculty teaching staff. Since comparing different internships is not doable with so many sectors, countries, cultures and people involved, we have chosen to evaluate the report with a pass or a fail criterion. Every student receives written feedback on the report.

ORGANISING AN INTERNSHIP AS A COMPULSORY CURRICULAR ELEMENT

The organisation behind a compulsory internship depends on three key elements: the students, the companies or institutes, and the educational programme. The tasks of the internship office are quite multidisciplinary and require a vast amount of organisation and coordination, since internships have to be arranged for 300-400 students per year, most of them for a placement abroad. In our faculty we have two staff members (0.6 full-time equivalent (fte) each) and one student assistant (0.3 fte) working at the internship office. In the following sections we discuss the organisational aspects with respect to students and companies or institutes.

The students

To make sure that the internship yields a maximum learning gain for the student, the guidance and feedback given by the faculty is absolutely important. The message that is given to the students on the first day they inquire about their internship is that “*they* are in the hot seat”. For some students this is a difficult step. They get confused and sometimes panic by the many options and different places to go to – this is neither fixed nor constrained. Learning how to manage so much liberty in choosing where to apply is an important learning process for the student; making choices! The internship office gives guidance in the orientation phase, during selection and application, and the making of practical arrangements.

Orientation

Online there is a “Steps to be taken”, posted on the university intranet which gives the student insight and structure into how to best start the orientation for the internship. There are many choices to be made for the internship: Abroad or in the Netherlands? In a company or in a research institute? A big or a small company? What field of expertise? In order to help the students with these choices the faculty organises lunch lectures throughout the year about topics, varying from “How do I organise an internship?” to “How was my internship at Qantas?” presented by one of their fellow students. Our experience learns that such peer instruction by fellow students who give information about their selection process and applications, their successes and failures, and the actual internship is very effective.

On the intranet the actual open positions are posted that are collected from companies and institutes by the internship office. Most positions can be acquired through an open application. It is therefore also recommended to look beyond the options that are available on the intranet. The intranet also provides tips and tricks and other experiences from fellow students. This is sorted by country and company. These tips and tricks and experiences from fellow students appear very useful in the decision making process. Some students need more guidance than others. If the information sessions and the intranet do not give enough information or guidance for the student, he or she can make an appointment for a one-on-one meeting with the internship

coordinator. During such a meeting the coordinator supports the decision making process, thus helping the student formulate the options and the choices that need to be made.

Selection and application

At the end of the orientation phase the student is supposed to have a top-10 list of companies of interest for the internship. It is then important to trade and rank the options and find out how and when to best approach them. Are direct contacts available? Does the student have contacts in his own network? Do specific deadlines apply? How do companies recruit the interns? What do we know about the companies based on earlier interns? Does faculty staff have a network contact with the company?

In order to prepare the students on the application process, the internship office provides on-line information about the writing of a CV and a motivational letter on the university intranet. The office also organises workshops on CV writing, LinkedIn and recruitment interviews, in collaboration with the university Career Centre. Social media like LinkedIn become more and more important. LinkedIn is often used to find the best point of contact, while companies and institutes use LinkedIn to evaluate the applicants. Once selected for a position the student must request a formal approval by the university. The internship office provides the template. This is the moment that important questions have to be answered as to what tasks he or she will get, what the plan of action is, what type of constraints may apply on confidentiality, who will be supervising, at what department will the student be employed, and what the required entry capabilities are to make the internship a success. Once the approval is given, the practical arrangement can start.

Practical arrangements

Since 80% of our students go abroad often housing, health insurance, vaccinations, visa, funding and flight tickets have to be arranged. TU Delft offers insurance for all students travelling abroad: the students register on-line, which gives the university full traceability of all students abroad. It makes it possible to take action in case of emergency; there is a 24/7-alarm number. All students are advised to have an internship contract signed by the company/institute before departure. In the contract the start and end date of the internship, the remuneration, the parties involved, confidentiality and possible patents are formalised. The internship office provides a format but often companies have their own format. In case the format of the company is used, the student can get legal advice through the internship office.

After completing the internship

Within two weeks after completion of the internship the students have to hand in the report. Then the internship office arranges a one-on-one meeting with the student to exchange first-hand feedback to both parties, and discuss what went well and what are the lessons learnt. While the report is being evaluated the students receive a last questionnaire from the internship office. This is more from an educational quality perspective (CDIO Standard 12: Programme Evaluation), addressing questions about the added value of an internship for the curriculum, the usefulness of the intended learning outcomes, and any tips for the internship office to improve the value or organisation of the internship in the curriculum. This feedback aims to sharpen the office.

The institutes and companies

Win-win

The Faculty of Aerospace Engineering heavily relies on the companies and institutes to employ their graduates. Without a good market for our graduates the study programme would soon be unpopular! Also a compulsory internship in the Master's relies heavily on the companies to employ our students as an intern. It is therefore very important to identify how an internship can be turned into a win – win situation for both parties:

- i. An internship enables the university to include authentic practical experience (CDIO Standard 1: Context) and make the curriculum an integrated curriculum (CDIO Standard 3) with an intensive integrated learning experience (CDIO Standard 7). The intern is able to experience how it is to work as an engineer in the industry and develops a good sense of ethical accountability and social responsibility.
- ii. The company or institute gets into contact with potential employees who master the latest knowledge and engineering capabilities. Scheduling the internship in the second year of the Master's makes it possible for students to be of great added value and fully perform as a professional engineer. In the course of the internship the company has sufficient time to evaluate the performance of the student and think about possible employment. The ERASMUS impact study "Effects of Mobility on the Skills and Employability of Students and the Internationalisation of Higher Education Institutions" (European Union, 2014) shows that one out of three students who has taken an internship, are offered a job by their host company, and one out of 10 of them start their own company. So industrial internships have not only a more positive impact on the development of professional and personal skills, they also create better employment and career prospects. In our case, 88% of our company supervisors answer the question if they would consider the intern as a future employee with a full "yes".
- iii. Good contact with the companies and institutes is essential. The feedback given by the company supervisors about our interns is worthwhile and helps the educational management to sharpen the curriculum including its internship, and keeps them up-to-date. (CDIO Standard 12: Programme Evaluation). The feedback from the supervisors provides the programme with valuable information about the students' attainment of the MSc final qualifications.

Account management

At the internship office of the Faculty of Aerospace Engineering we have a database containing more than 600 companies and institutes around the world. It is a database that has grown over the last decade. To acquire internship positions and strengthen the network, staff members of the internship office visit conferences like the Paris Air Show, Farnborough Air Show, EAIE, Berlin Air Show on a regular basis. This is an efficient way of contacting a large number of potential employers in a short timeframe. On these occasions we distribute a dedicated flyer "Intern Recruitment at the Faculty of Aerospace Engineering" (available on www.lr.tudelft.nl/internship). The website is also an important way for companies/institutes to get in contact with the internship office at our faculty. Good account management is a key success factor. The students are the ambassadors of the educational programme and of the Faculty of Aerospace Engineering, even the whole university. It is our experience that excellent internship preparation and job performance by the students make the acquisition and marketing relatively easy and sustainable once there has been a successful intern. Every time a student has completed his internship the office contacts the company to learn about the experience and

explores how the collaboration can be continued. In a small number of cases we help companies to make a pre-selection for prestigious positions: they appeal the interest of a great number of students and thus lead to a lot of applications. This extra service by the internship office has been a strategic decision made by faculty management.

Efficient account management for the large number of companies and relations requires a CRM (Customer Relationship Management) programme or other database, containing the information about the relations, sorted per country, sector, industry, department etc. This is not only a useful and valuable resource for advising students about internship opportunities and experiences, but also for the faculty establishing internationalisation strategies and preferred partner institutes, universities or companies.

Establishing and maintaining long-term relationships is the fundament for successful account management. It requires regular contact with the company supervisors, jointly reflecting on the success of particular interns, and when necessary “damage control” in case the experience of an intern does not meet the expectations. It is crucial to stay in contact with the supervisors and to evaluate on a regular basis. Providing the information to the supervisors as to what can be expected and what the requirements are on quality, level and coaching of an internship, helps the management of expectations. The basis for success is established when both parties have the same expectations. We have constructed a website that includes information about the intended learning outcomes as well as about the Master programme and the disciplinary specialisations. It gives the company supervisors insight in the subject matter and courses that have been taught and the level of disciplinary knowledge and capabilities that may be expected from the students. It also includes testimonials from students and supervisors from all over the world (www.lr.tudelft.nl/internship).

CHALLENGES FOR THE FUTURE

The success and quality of a compulsory internship depends on the companies, the students, the educational framework of the programme, and last but not least on the organisation. Since each of these stakeholders has its own goal, priority and responsibility there are several challenges for now, and for the future.

Industrial demands vs University needs

The industrial companies and institutes would love to have our interns for six months or more, whilst three months is reserved for a fulltime internship in the two-years Master in Aerospace Engineering. The wish of industry for longer lasting internships has a big influence on the choices made by the students and their study planning. The average time a student presently spends on the internship is about four months. From university point of view, a duration of three months would be enough, since the steep learning occurs in the first months. Obviously longer lasting internships are more beneficial and productive for the companies. Long lasting internships however result in a study delay with financial penalties for the student and adverse effects on the reputation and attractiveness of the educational programme (“apparently this programme is not doable within the nominal duration”). Students are very creative though, they may use their summer holidays in order to spend more time on the internship or, when feasible and compatible with academic standards, combine their internship with a master thesis.

Ethics

The internship in industries is an optimal way for students to come in close contact with senior engineering professionals with whom they can identify and try to emulate. It enables them to develop a good sense of ethical accountability and social responsibility in the real world or work. This encounter with ethics on the shop floor may be confronting and difficult. It is important that students are guided and well prepared for this. Questions could arise: I was working in the factory where the aero engines were integrated and tested, and I saw that certain safety checks were not taken seriously, what should I do? What should we do as a university? These are unexpected circumstances for which a clear answer needs to be formulated when a student encounters the issue.

Assessment and personal feedback

The current intended learning outcomes are not yet formulated in a smart way. This makes the assessment of the internship somewhat ambiguous and defines a need for a reformulation of the learning outcomes. Furthermore, from an educational point of view it is a challenge how to best give feedback on the internship. The big numbers (300-400 students per year) and the limited faculty resources, have led us to the approach to only give written feedback on the report. A more in-depth feedback by a face-to-face meeting with the student would be much more appropriate Especially when the effort and time spent by the student (at least 500 hours), and the great learning gains of the internship, are taken into consideration.

RICH LEARNING OUTCOMES AND CONCLUSIONS

The main learning outcomes of the internship as listed by the students are related to personal and interpersonal skills and engineering capabilities, such as employability, preparing for job interviews and writing application letters, giving tools how to approach and apply, making self-assessments. Other learning outcomes students often mention are autonomy, organisational sensitivity, international mind-set, intercultural communication, appreciation of the need for lifelong learning, risk taking, professional responsibility, and innovation. The development of these competencies are all stimulated by the “immigrant mind-set”, that is experienced when students study abroad or take an internship in industries or institutes in different business, cultures or environments (Kamp, 2014).

The industrial internship is highly appreciated by the students. Our students gave it a score of 4.6 on 5-point Likert scale (based on an online questionnaire (EvaSys) filled in after the internship 2014 n=169). In the i-graduate survey 2013 the Faculty of Aerospace Engineering scored 85% satisfaction on employability. The average score for the TU Delft (all eight faculties) was 70.64% (the lowest score being 61%). This can at least partly be explained by the fact that most other Master programmes offer no internships, or provide some light support to students who want to undertake an internship on a voluntary basis, as an extracurricular component of their study.

In a recent survey, alumni were asked to list three parts of their degree programme from which they still benefit in their current job. Based on the parts that have been mentioned, the following ranking was found: 1) Master thesis research project; 2) Internship; 3) Design Synthesis Exercise (the 10-week fulltime Bachelor thesis project in a collaborating team of 10 students) and other Design Projects in the Bachelor's.

Having an industrial internship as a compulsory element in the curriculum has, however, much more impact on the programme and the university, than just the rich learning outcomes described above:

- The internship is an important reason for many foreign students to come to the TU Delft for the Master in Aerospace Engineering. At the moment 54% of the Master students come from abroad.
- The students doing an internship abroad are the best ambassadors for our Master programme. Eighty per cent of our students go abroad. They bring the Faculty of Aerospace Engineering a great exposure and visibility all over the globe.
- Good employability: the alumni survey 2013 indicates that two third of the respondents indicate to have found a job on an appropriate level, within one month after graduation. 93% of the respondents found a job within 3 months after graduation.
- The internships provide a worldwide network for the faculty, that often lead to long-term contacts between the faculty and industry and institutes. This network stimulates collaboration on research.
- The feedback from the students who experienced real world of work during their internship as well as the assessments of the students knowledge level, professional responsibility and working ethics that are made by the company supervisors provide a constant feedback on the learning outcomes of our educational programme. This feedback is incorporated in the quality control cycle (CDIO Standard 12).

REFERENCES

- [1] Crawley, E.; Malmqvist, J. (2007), "Rethinking Engineering Education", Springer Science and Business Media.
- [2] Kamp, A. (2011), Delft Integrated Engineering Curriculum. Proceedings of the 7th International CDIO Conference 2011. Technical University of Denmark, Copenhagen, Denmark, June 20-23, 2011.
- [3] Kamp, A (2014), Engineering Education in the Rapidly Changing World, Rethinking the Mission and Vision on Engineering Education at TU Delft, Delft: TU Delft, Faculty of Aerospace Engineering.
- [4] European Union; The Erasmus Impact Study; Effects of mobility on the skills and employability of students and the internationalisation of higher education institutions; Publications Office of the European Union, Luxembourg, 2014; retrieved 13 October 2014 from http://ec.europa.eu/education/library/study/2014/erasmus-impact_en.pdf.

Biographical information

Aldert Kamp is the Director of Education for the Faculty of Aerospace Engineering at TU Delft, the Netherlands. He has over 20 years of industrial experience in space systems engineering management and lecturing space engineering & technology. Since 2002 he has been involved in university education policy development, quality assurance in higher education, reconstructing engineering curricula, and vision development for Delft's engineering education of the future. Since 2006 he has been the instigator and leader of the innovation of the Bachelor, Master and Excellence programmes in Aerospace Engineering that are highly CDIO compatible. Since 2013 he has been an active member of the CDIO Council, a board member of the 3TU Centre for Engineering Education and board member and trainer of the Leiden-Delft-Erasmus Educational Leadership course for young directors and coordinators of educational programmes.

Femke Verdegaal is the Coordinator External Affairs, Faculty of Aerospace Engineering at TU Delft, The Netherlands. As Coordinator External Affairs, she is responsible for the Master internship as well as the student exchange at the faculty. After obtaining her Master's Degree in Business Economics at the Erasmus University in Rotterdam she started working at Randstad, the world's second largest provider of HR services. In 2006, after 10 years' experience at Randstad, she became responsible for the Master Course Internship (www.lr.tudelft.nl/internship). The variety in companies and institutes, in locations, and in students is what Femke enjoys most in her job. Recently Femke became responsible for the Bilateral Agreements with partner Universities, establishing opportunities for students to experience a semester abroad at a different University.

Authors

Ir. Aldert Kamp
Delft University of Technology
Faculty of Aerospace Engineering
Kluyverweg 1
2629 HS Delft, the Netherlands
Tel: (+31) 15 278 5172
E-mail: a.kamp@tudelft.nl
Website: www.lr.tudelft.nl

Drs. Femke Verdegaal
Delft University of Technology
Faculty of Aerospace Engineering
Kluyverweg 1
2629 HS Delft, the Netherlands
Tel: (+31) 15 278 9562
E-mail: f.m.verdegaal@tudelft.nl
Website: www.lr.tudelft.nl/internship



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License](https://creativecommons.org/licenses/by-nc-nd/3.0/).

This paper is also presented at the Global Internship Conference, University College Dublin, Dublin, Ireland, June 9-12, 2015