

ENGINEER PROFESSIONAL IDENTITY: FOR AN EARLY CLARIFICATION OF STUDENT'S PERCEPTIONS

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ABSTRACT

Engineer diplomas greatly facilitate first job offers. However, uncertainty and indecision often result from freshmen appraisal of the career kaleidoscope. Some students struggle to identify career directions and therefore need some time before feeling committed and being operational within their curriculum. In light of this, it is advisable to disclose to students their career perspectives from the early stages of their curriculum, in order to give some meaning to their studies and learning. It is also essential to provide them with means which will enable them to participate actively in their own learning path, to build their future professional identity, and to plan proactively their future career.

In order to initiate student's self-efficacy, our engineering school recently reformed its career preparation program over the three years of the curriculum. In particular, it now integrates some workshops and active sessions which are listed in this paper and linked with the most recent CDIO syllabus. These new sessions were inspired, among other things, by the analysis of an activity deployed for students several years ago, for purposes of collaboratively surveying career directions. This previous activity is more specifically presented and discussed in this paper. Limits regarding its usability for freshmen are addressed herein.

As prestigious as it may be, the engineer diploma is a complement for practical internships. The professional path of an engineer is often closely related to the early professional experiences of his/her career, but it also depends on his/her education. The traditional French higher education system with its *Grande Ecole* model provides an interesting study sample with its outstanding freshmen whose career choice is often still undecided.

KEYWORDS

Engineering education, careers, personal and professional project, professional identity, self-efficacy.

INTRODUCTION

Engineer diplomas greatly facilitate first job offers and open up on broad career possibilities in many economic fields where engineers may often exercise their potential as leaders. However, this large number of professional opportunities makes it difficult for many engineering students to determine which career path to favor. As a matter of fact, each incoming student does not necessarily have a professional ideal. Moreover, many freshmen have a limited knowledge of the working world as well as false ideas thereon. Consequently, uncertainty and indecision often result from their appraisal of the career kaleidoscope, possibly causing a decrease in their

engagement and motivation level. It is therefore critical to reinforce these students' self confidence, especially when considering that the recruitment market is becoming more and more demanding and competitive for newly graduated engineers.

In order to achieve this goal, we believe that students must initiate, by themselves, the necessary transition from the position of a learner to that of a practitioner of engineering. Traditionally, educational institutions design career preparation programs which focus on making their students more attractive to potential employers. We recognize that students should learn how to enhance their job applications. But it is also essential, at the early stages of their engineering studies, to give them the means which will enable them to build their own future professional identity, to become active players in their own learning path, and to plan proactively their own improvement and future career. In order to expose students to career directions as soon as possible, we first decided, in 2005, to introduce a half-day active session on career directions at the very beginning of the first year. Such experience comforted us, in 2007, as to the need to redesign the career preparation program with a competency continuum over the three years of the curriculum.

This paper is structured as follows. First, some elements of freshmen's perceptions of their future career are discussed in the context of the original French higher education system with its *Grande Ecole* model. The following section presents the active session formerly used for freshmen to survey career directions which is still successfully used for sophomores in a part-time apprenticeship curriculum. After several years of application, some limits of this session for our freshmen are addressed. Together with other signs, they conducted us to reform our career preparation program which is briefly presented and aligned with the most recent CDIO™ syllabus [1]. Finally, the last section concludes this paper.

ON FRESHMEN'S PERCEPTIONS OF THEIR FUTURE CAREER

Many engineering schools find it difficult to prompt an evolution of their students' self perception from mere engineering learners to future professional engineers [2], especially as regards freshmen whose career choice is often still undecided.

The Specificity of French Grande Ecole Freshmen

In its classical curriculum, Telecom Bretagne engineering school admits two types of freshmen: (i) foreign students (in 2009, approximately 10 % of the 157 incoming students), often with multicultural expectations whose decision to study in France was generally carefully pondered [3], and (ii) French and North African students (approximately 90 %) who attended French preparatory classes with a view to entering into a *Grande Ecole* [4] after a highly competitive exam (i.e. *concours*). In these classes, many students are under considerable pressure to succeed, sometimes for family reasons. Moreover, a rather digestive approach of teaching, aiming at forging analytical thinking and potentials, leaves limited room for personal development and practical professional experiences. Nevertheless, these students are generally motivated and eager to practice once admitted into an engineering school, even though they often slacken their study efforts as their diploma is more or less secured once the *concours* is passed.

For most students entering our school, the first year is a delicate period when they open up to their own desire [3], first from a personal perspective and quite rapidly from a professional one (i.e. our generalist sophomores can integrate a one-year internship in companies and senior

students must validate their curriculum with a six-month internship). Roughly, during the very first semester, the classical question is “What do I do?” especially because curriculum choices are to be made. Before that, they rarely had to make any such important decisions and, often, they are still looking for the “perfect secured itinerary”. Due to their need for success, some of them are scared to make mistakes. This period corresponds with a change of references. During the second semester, uncertainty begins to grow (“What will I do?”). Often, they would like other people to show them the golden way (e.g. seniors, parents, teachers, mentors), to be told what must be done... The school, and its campus favouring autonomy with peers, is the place where the question of the professional meaning arises. It should also be the place where students are progressively led to identify their own wishes in order to find who they actually are.

The 2009 Telecom Bretagne Job Kaleidoscope as First Profession

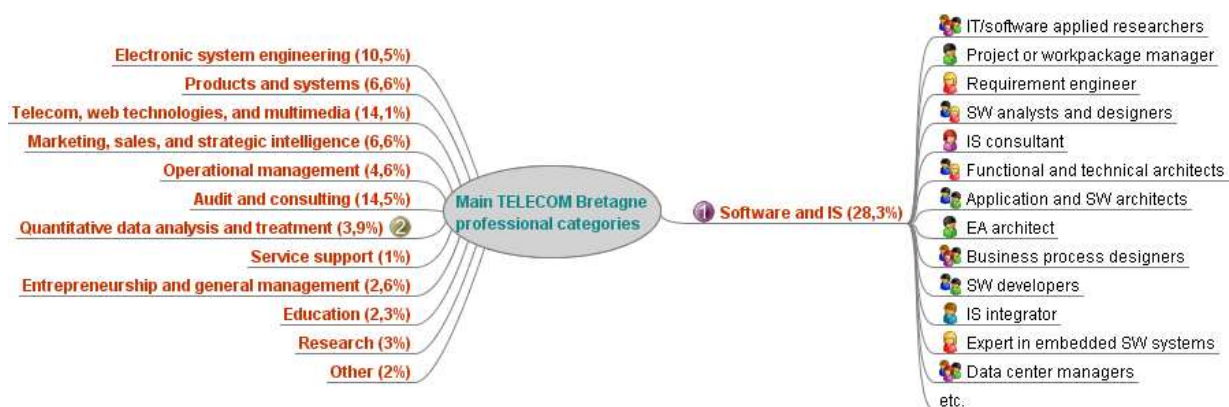


Figure 1. Main Telecom Bretagne graduate job categories as first professions

Telecom Bretagne is a generalist engineering school, with a focus on ICT. Many professional sectors and domains are accessible to its graduates which may generate confusion and indecision for some newcomer students. Figure 1 categorizes an example of the main professional activities available to them on the basis of the most recent junior professional integration surveys. Category 1 (Software and Information Systems¹) is detailed on the right side of the Figure while the other categories, on the left side, are not, for concision concerns (for example quantitative data analysis and treatment, category 2, may be refined, inter alia, with the following positions: risk manager, trader, financial product designer and auditor, actuary, credit manager, middle back office manager, debit and equity capital marketers). Percentages appearing in the Figure represent the survey results for the 2009 class. Note that 40% of the replying students chose their profession (exclusive choice) in adequacy with their professional project, and 37% of them retained it for its interest. Other criteria such as compensation, company reputation or good financial health, human resource policy or geographical location are less significant.

¹ This category is mainly constituted of technical executives who define scientific orientations and technological fields. Specialists and SW, IS, and EA architecture designers define and analyze product contents, equipments and systems. Scientifics and experts conduct upstream studies, carry out technological intelligence, and transfer knowledge. These teams are responsible for SW development, whose place is now preponderant. They also design and build flexible IS and enterprise architectures, to manage information necessary to client business process activities.

Career Attitudes and Indecisions

Among freshmen, many different profiles may be observed. These profiles and related behaviours will evolve as time passes and maturity grows, depending on each individual's personality [6]. We can, for example, identify the "targeted" student (with an ideal), the "autonomous" student (who refuses any advice or standardized method), the "curious" student (who experiences everything, shows interest and confidence), the "not ready" student (who focuses on formal issues to avoid troubles), the "hidden" student (who constantly avoids challenges), the "lost" student (who tries to find himself, lacks of self-confidence, needs references), or the "dreamer" student (who primarily wishes to indulge himself). In 2007, we had requested more than 200 of our sophomore students to draft a three-page written document describing their middle-term professional project. Such paper, which also invited to propose three career opportunities and companies as examples, corroborated many profiles and our previous feeling as to student indecision in front of the career kaleidoscope.

More recently, the CDIO initiative [1] launched a study on career attitudes (cf. CDIO-Gordon MIT study) so as to identify how desirable engineering students find different career opportunities (e.g., designing financial products, directing a high technology group, consulting, managing engineering projects). At the end of 2009, the use by our institution of the related questionnaire confirmed that, for many of our freshmen, professional intentions are extremely diverse and sometimes hard to face and define. The questionnaire was submitted to our students at the end of the first semester on an anonymous and voluntary basis and provided 46 answers (retrieved via the Moodle learning management system), representing 29 % of our freshmen cohort. In particular, one section of the questionnaire was drafted as follows: "If the following opportunities appeared in your career, how desirable would they be?". No clear aspirations could be observed as to the average desirability of pure engineering, of a broader use of technology, or of a technology based entrepreneurship, and only two items - "Using your analytic and math skills to design new financial products" and "Managing a group responsible for setting the business strategy for a well-known company" - prompted clear extreme answers.

Before their first job or contact with industry, many students do not clearly envision their professional future and are not really able to foresee the economic, technological and, most of all, managerial changes affecting their future profession [5]. We certainly must rely upon our students to finally find their own way, but we must also give them a sense of responsibility so as to enable them to take care of their career, as soon as possible and at best, in accordance with their genuine wishes. Moreover, young engineers often have a hard time categorizing and identifying objectively their skills. Following this baseline, we proposed in 2005 an initial half day group session for surveying career directions. This activity is more specifically presented and analysed hereafter.

SURVEYING CAREER DIRECTIONS: LIMITS OF AN ACTIVITY TO INITIATE SELF-EFFICACY ON FRESHMEN

In consistence with a problem-based learning style [7], the group session for surveying career directions requires the presence of a tutor whose task is to prompt students to list and understand, by themselves, career opportunities. It consists in the definition by the students of a group of competencies associated with their perception of the engineer profession, as derived from their own knowledge and experience [8]. We designed it for use in two different contexts: (i) for newcomers issued from preparatory schools, most often without previous job experiences, and (ii) for sophomore students engaged in an apprenticeship engineering curriculum.

Implementation

During this three-hour session, a class of approx. 35 students is divided in small teams of five individuals which are asked to collaboratively give their respective definition of a generalist engineer in five lines maximum. After ten minutes of preparation, the tutor invites simultaneously one student per group to the blackboard so as to write his group definition. For each definition, the tutor [9] underlines action verbs, scientific and technological domains, as well as management or international related terms. Based on these highlights, a common short definition is then collaboratively established and written on the blackboard. Two well-recognized definitions are then disclosed to each group, to be compared with their own results: a first one, from a recognized French dictionary and a second short one from the Wikipedia site.

Thereafter, each team must make an exhaustive list of typical job profiles (offers from job boards may sometimes be provided for groups still facing difficulties after 10 minutes). Once done, the tutor surveys their results on the blackboard and asks the students to associate job profiles which may fall into one single main category. Job categories may thus be addressed and conceptualized through a map [10]. With a view to discussing completeness as well as medium and long term career perspectives, the tutor favours, whenever possible, reflectivity among students [11] based on this map.

Before the break, a general definition of competency is presented to students and discussed, based on the example of the knowledge, skills and attitudes required to obtain a driving licence (i.e. behaviour aspects, associated conditions, and related criteria). Finally, for some of the jobs listed, the student teams are requested to describe some concrete work situations and then to establish a list of ten pondered core competencies for their selected job. Each team presents its conclusions to the others on a slide. The tutor captures the key elements thereof on the blackboard.

Results

For freshmen without previous work experience, as regards the “What’s an engineer?” question, group answers very often emphasize on scientific fundamental knowledge and ability to work within an international environment. By contrast, many groups fail to address the following points: (i) mastering the engineer methods and tools (e.g. analyzing and conceiving complex systems, experimentation), (ii) ability to adjust to, participate in and favor the evolution of a business organization, (iii) considering the industrial, economic and professional stakes, (iv) complying with social values (e.g. ethics, social relations, environment), or (v) business culture. Note that, quite systematically, students, as stimulated by the tutor, are able to derive, collaboratively, from the definitions proposed by each team a final short definition which is close enough to the classical ones. The corresponding list of jobs rarely exceeds ten to fifteen items per groups, sometimes including unexpected jobs which shed some light on their quest for sense and identity. For those students, competencies are very hard to identify, understand and ponder.

In contrast to our freshmen, the students concerned by the apprenticeship engineering three-year curriculum did not attend preparatory schools and more than half of them already performed training sessions in companies, prior to joining the school. In addition, their program requests them to work approximately three months per semester in a company. Consequently, these sophomores are already familiar with the business world, even though it is limited to the actual company which welcomed them and to the engineers employed therein [12]. In such a case, team based learning greatly favours knowledge sharing. For these students, the initial

question raised in the activity (i.e. the general definition of an engineer) is harder and controversial, due to the limited time devoted thereto (very often, debates are emerging on the essential elements of the definition). For the job list, Figure 2 presents a job conceptual map which was elaborated by sophomores in 2007 (blackboard in French). At the center of the Figure appears their “professions of engineers” (cf. *Métiers de l'Ingénieur*). Competency lists are more easily synthesized by students even if technical skills are often strongly pondered. Since 2008, at the end of the activity, each sophomore is asked to individually list and detail ten core competencies required in his specific apprenticeship and to elaborate a first action plan for skill enhancement. In a hypothetical perfect world, each student must ultimately carry out the same exercise with respect to a strongly appealing job for him.



Figure 2. A job conceptual map elaborated by sophomores in 2007 (blackboard in French)

Limits of the Career Directions Activity for Freshmen

Based on various feedbacks from students and tutors, we note that the activity is clearly more valuable for and appreciated by sophomores after an internship or professional experience than by freshmen who did not benefit from previous contacts with professional activities, especially regarding the competency pondered listing associated with some concrete work examples. In practice, this activity was used for freshmen from 2005 to 2007 (during a first semester compulsory computer science course). From a practical standpoint, it highlighted that, due to really poor experiences and knowledge in computer science careers, many students found it hard to propose a list of computer science and software engineering jobs, within a short time, without relying on a set of documents exemplifying competencies requested for typical work situations. Probably as a consequence, the activity was very often poorly rated by students, even though it was a seed to initiate awareness and perception requirements.

From a more general perspective, we identified additional flaws resulting from the fact that the session was a brief, punctual experience. First, the potential benefits derived from the session depended on the profile and maturity level of each student at that time: the activity was only profitable for students whose maturity and/or profile was “compatible” therewith, on the day it was organized. Moreover, when they enter engineering schools, many students are still looking for a personal as well as professional project, i.e. they still do not consciously want to become engineers. Second, such experience was too isolated in the first year to provide students with

genuine tools to analyze and evaluate, from a personal standpoint, the various careers available to them. Overall, for some students, the activity amounted to an incidental thinking on their distant future and a mere booklet on career-based learning outcomes soon forgotten.

Also, this experience taught us that students enjoyed concrete experiences and practical cases which, in turn, enhanced their abstraction and conceptualization skills [8]. Consequently, we decided to reform our approach of the career preparation program with a view, at the early steps of their engineering studies, to helping students better understanding, creating, analysing, and then evaluating more securely their own learning and career path. In accordance with the most recent syllabuses suggesting to address career knowledge, skills, and attitudes, e.g. CDIO [1] or EUR-ACE [13], a competency continuum over the three years of the curriculum has been established.

REFORMING THE CAREER PREPARATION PROGRAM FOR GENERALIST FRESHMEN

In 2003, our institution reorganized its global curriculum by systematically incorporating large semester project-based learning experiences [14]. In our new integrated curriculum, professional skills are viewed as essential aspects of engineering education. However, soon after this reorganization, we have been faced with a problem about personal vision for student's future: freshmen struggled to identify career directions and therefore needed some time before feeling committed and being operational in their studies. Considering this, we determined that it was advisable to disclose to students, from the early stages of the curriculum, their career perspectives in order to give some meaning to their studies and learning. As a matter of fact, we believe that our students should be able to enhance their professional potential and to have future expectations as well as a vision and intention in life. Following a more active approach for and by students, several new activities, such as workshops, portfolios, career games, company visits, peer review, etc. were appealing.

In 2007, in light of the limits identified with respect to freshmen during the half-day active sessions and in connection with this first exposure of our students to career directions, we decided also to redesign the career preparation program. Before this reform, the career preparation program merely offered (a) the three-hour group session on career directions presented above at the beginning of the first year and (b) seminars, testimonies and recruitment-oriented communication tools, only during the last year of studies (seniors). The purposes of the latter were to identify a potential first job, enhance job applications, and obtain interviews. It mostly relied on presentations by professionals and recruiters in order for the senior students to be more familiar with communication methods and tools and prompts a recruitment simulation.

The New 2007 Progressive Program to Favour Students Own Career Shaping

Many career-oriented activities, now representing 63 hours per students, have been introduced all along the curriculum in order to improve students' ability to actively participate in the construction of a realistic and secured personal and professional project. Each year, a specific theme is investigated with a view to increasing their self-efficacy: (year 1) identification of one's personality and competencies, (year 2) career orientation, and (year 3) itinerary.

Our approach is mostly based on skill management (in the human resources meaning) as Le Boterf defends it [15] through the following definition "A skill is only effective once it has been tested and validated thanks to its confrontation to reality", where a skill corresponds to the

“know-how-to-act”. It is also inspired from methods proposed by Levy-Leboyer [16]. Continuously over the curriculum, we mostly deploy our activities with dedicated outcomes:

1. to be able to define a set of skills and to know oneself in order to better recognize and define one’s choices;
2. to be able to propose a coherent professional project and career orientation;
3. to be able to define career paths, to evaluate them, and to combine personal development therewith.

The first year phase allows the student to identify his strengths and formalize his current set of skills. Depending on his personal projects and maturity, as well as personal experiences, it helps to choose his core courses and electives, thanks to active team workshops supervised by human resource experts or tutors.

The second year phase consists in discovering the realm of career possibilities and making choices over the next years. The student assesses his skills through internships, projects, meetings, workshops. He can optionally enrich his portfolio while being “actor of his own skills” with the help of a tutor through the end of his studies. MBTI (Myers-Briggs Type Indicator [17]) formative and debriefed tests are also introduced, with a view to demystifying these tools which are often used by recruiters and head hunters, but principally to identifying or discussing one’s strengths and potentials.

The third year phase is personalized through a face-to-face option with coaching instructors, optional stress management courses and tests on managing and entrepreneurial qualities. Interaction with former students presenting their own experience is also encouraged in order to build a reference social network. The student has then to evaluate and justify his orientation choices in front of a professional jury composed of a human resource manager and a real domain manager from the industry.

As a first attempt, principal activities of this new career program are categorized in Table 1 (inserted after the conclusion), in correspondence with the most recent CDIO Syllabus [1] items addressing career and professional behavior. Our progressive approach (activities deployed on specific semesters) helps the student to anticipate and test his choices and reassures him. He learns how to identify his needs for new skills and to adapt to career evolutions. Thereby, he gains maturity and self-confidence and can reuse, on his own, at major stages of his development, the methods and tools proposed, in accordance with his profile evolution. Now, a more in-depth analysis of the Table is however necessary to address coherency and completeness of our activities regarding the syllabus, and perhaps to refine items.

CONCLUSION

“Never ask your way to the one who knows, you may never lose yourself” (translated)

“Ne demande jamais ton chemin à celui qui sait, tu pourrais ne pas te perdre”

by Simone Bernard-Dupré [18]

Students construct their professional identity as students and as graduate engineers, at the beginning of their studies, at different stages of their studies, and after graduation [19]. One of the main problems to be faced by universities or engineering schools is that some of their graduate students are not adequately prepared for the professional world they are supposed to join. This situation may be attributed to students themselves who are not committed enough or simply skipped the related career classes or sessions, or to the educational institution which

does not sufficiently insist on this objective and consequently limits its intervention to a few seminars or classes about how to draft a resume or behave during an interview [5]. Moreover, some students do not actually wish to become engineers and are more interest-driven than career-driven.

As prestigious as it may be, the engineer diploma is a complement of internships. The professional path of a junior engineer is often closely related to the early professional experiences of his studies, but it also depends on his education. An educational institution should not only try to ensure homogeneous graduate profiles on core competencies, but also allow its students to fully express their potential. It should help to achieve this objective each time a student makes choices possibly impacting future career. When conceiving or reforming their educational programs, institutions should keep this in mind so as to adequately anticipate students' professional stakes. Even if career opportunities are still thriving for engineers, they were not spared by the 2008 crisis. Today, for ensuring a secured career development process, the objective is not only to apply to a job as an engineer, but also to do it in a professional manner vis-à-vis the market.

Many freshmen inherited a quest for perfection and fear the little-known employment market. It is therefore advisable to help students evolving from exemplary learners to fulfilled professionals in promoting their active participation in their own choices, possibly by learning in groups [20]. This paper addresses a specific aspect of student development, i.e. the evolution of their self-perception from mere engineering students to future engineers. In particular, it describes a specific group-based activity on surveying career directions whose purpose was to initiate self-efficacy and favour the commitment of students. Such activity was deployed from 2005 through 2007 for freshmen and is still a part of the curriculum applying to part-time apprenticeship students. Based on several years of experiences and in light of its limits for freshmen, we now promote the use of learning activities to facilitate and continuously support the student development process, from the early beginning of the curriculum. Thus, a reform was conducted resulting in a new career preparation program which permitted to integrate several new complementary activities into the curriculum over its three consecutive years. Even though it is too early to derive therefrom a rigorous analysis of the impact of the program on the career of our junior alumni, many signs seem to show that students who attended these activities better negotiate their personal and professional projects in making choices which are closer to their present or future aspirations.

Since that reform, many other courses of the curriculum have started addressing this career issue in providing insights into their professional applications. For example, in addition to a booklet listing the intended learning outcomes [21] of a specific course or project, several course descriptions now include associated job profiles and, sometimes, middle-term market trends. Recently, "Inter-semesters" (sandwich courses) were also organized so as to extend the scope of the career investigation to other fields of activity (e.g., theater, music, political sciences, design, astrophysics, or photography).

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CDIO ITEMS	SUB-ITEMS	ACTIVITIES
2.4 Creative and critical thinking, educating and aesthetics	2.4.5. self-awareness and meta-cognition; 2.4.6. lifelong learning and educating.	- MBTI formative test with a tutor debriefing; - resume workshop and analysis with HR students; - feedbacks of an HR expert and a manager about what they expect from a junior; etc.
2.5.2 Professional behavior	- a professional bearing; - professional courtesy.	- recruitment interview: assessment centre with operational managers to develop self-confidence; - specific course : "How to control stress and emotion before interview?"; - specific course : communication, negotiation; etc.
2.5.3 Proactively planning for one's career	- a personal vision for one's future; - networks with professionals; - one's portfolio of professional skills.	- specific course: how to build his/her professional projection; - one to one interview with career consultant to refine personal and professional project; - team work on professions and sectors; - meeting with the career manager of Telecom Bretagne (individual plan); - testimonies of operational managers who have done their studies at Telecom Bretagne (first social networking and feed back of experiences); - seminar advices of HR managers; - competency portfolio (optional); - one year internship in a company after the second year (optional); - how to make his/her strategy of internship; etc.
3.2 Structured communications	3.2.1 communications strategy; 3.2.2 communications structure; 3.2.3 written communication; 3.2.6 oral presentation.	- oral presentation and written argumentation of his/her life project, his/her values; - conference: "how to negotiate his/her first job?"; - conference: diversity of people behaviours (Jung and Enneagram); etc.
2.6 Leadership: character and core personal values	2.6.1 initiative; 2.6.2 decision making in the face of uncertainty; 2.6.3 responsibility, urgency and will to deliver; 2.6.4 resourcefulness and flexibility; 2.6.7 vision and intention in life.	- activities on management and leadership in a team; - team work on career paths and mobility; - conference: "expert or manager: how to choose my own way?"; - conference on MBA and Ph.D.; etc.
3.4 Leadership: relating to others	3.4.4 grouping and diverse connections (ensembling).	- course on team management with different cultures and generation; - conference on international careers; - working with an international management context; - career meetings with operational managers around position and exchange of visit cards; - seminar: the importance of the relationship in the company; etc.
4.1 External, societal and natural context and environment	4.1.1 Roles and responsibility of engineers.	- companies visits in different sectors (4 visits/year); - round tables (e.g. the financial functions, working in the sector of Energy); - forums, etc.

Table 1. Telecom Bretagne new career preparation program aligned with the CDIO Syllabus in its 2.5 version

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Biographical Information

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Nathalie Chelin is responsible of student internships, of the new career preparation program presented in this paper, and of relationship with companies in Telecom Bretagne. Before, she was Human Resources Manager in Thales Group (technology leader for the aerospace). She is specialized in human resources, more specifically in skills management, career mobility, and job cartography.

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