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Politecnico di Milano and Politecnico di Torino, the top technical universities in Italy, united their efforts in 2004 by launching a unique excellence programme called Alta Scuola Politecnica (ASP). The ASP programme is devoted to 150 students, selected each year from among the top 5–10% of those enrolled in the Engineering, Architecture and Design MSc programmes at each institution. This paper reports on the original motivation, evolution, lessons learned, present status, results, challenges and perspectives of ASP. In particular, the issues related to the selection of the ASP class and to its multidisciplinary nature, the cultural track of ASP and also its sustainability in connection with its location inside the Milano-Torino framework will be highlighted.

Keywords: excellence; innovation; multi-disciplinarity; talent

1. Introduction

Alta Scuola Politecnica (ASP; see www.asp-poli.it) was founded in 2004 as a joint initiative of the two top technical universities in Italy, Politecnico di Milano (PoliMi) and Politecnico di Torino (PoliTo).

The main original motivation was to provide the top students enrolled in the 2-year 120-credits MSc programmes at the two institutions with an additional multidisciplinary (horizontal) education, which should complement the disciplinary contents of their MSc tracks orienting them towards sustainable innovation (see Figure 1). The programme is designed so as to minimally interfere with the normal activities and calendars of the MSc studies. At the end of their ASP

Figure 1. Education paths at PoliMi and PoliTo. In Italy, the BSc track lasts 3 years, the MSc (or MEng) 2 years (resulting in the so-called 3 + 2), the PhD another 3 years.

studies, the students who complete the programme receive a double degree from PoliMi and PoliTo, as well as the ASP diploma ('with merit' in 10–15% of cases).

While several excellent education initiatives are present in Italy, both in the basic science/humanities field (e.g. Scuola Normale Superiore) and in the applied science/technical field (e.g. Scuola Superiore Sant'Anna), the issue of interdisciplinary studies in technical domains is receiving attention in many higher education institutions worldwide (the interested reader can refer to Purdue University 2010, University of California, Berkeley 2010, Bronet *et al.* 2003, Ollis 2004, Harrison *et al.* 2007, Yablokow 2008, Richter and Parett 2009 to explore some alternative approaches). To the best of the present authors' knowledge, the ASP experiment is unique at the national and also, possibly, European level.

For many years, in the USA, ABET, Inc. (the former Accreditation Board for Engineering and Technology) has published criteria for accrediting engineering programmes. It should be noted that in the 2009–2010 criteria (ABET 2010), engineering programmes should demonstrate that their students attain a series of outcomes, a subset of which are very closely related to the ASP core business; namely, an ability to function on multidisciplinary teams, an understanding of professional and ethical responsibility, an ability to communicate effectively, the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context and a knowledge of contemporary issues. Analogous European documents, such as the British UK-SPEC, the French CTI References et Orientations, the German ASIIN Requirements and Procedural Principles, the international EUR-ACE Framework Standards (all available online) contain requirements similar to the quoted ones by ABET. The Italian situation is rather different, since no independent accreditation body still exists and all courses are accredited by the minister, provided that some very mild criteria are satisfied, mostly of a quantitative nature. These include the range of disciplines taught and the ratio between courses offered and teaching staff of the university, but no detailed criteria concerning the expected learning outcomes are yet defined. In the Italian context, therefore, the inclusion of such skills in the ASP programme definition and requirements is somehow filling a gap that is present in the normal syllabi.

The uniqueness of ASP is related to several aspects, including:

- The broad spectrum of the MSc programmes in which the ASP students are involved at PoliMi and PoliTo, including all branches of the Engineering, Architecture and Design Schools.
- The multi-centric (Torino and Milano) character of ASP.
- The collocation at the MSc level and the additional workload with regard to a regular MSc course.

These unique aspects of ASP carry with them specific opportunities and challenges:

- ASP courses/projects (see section 4) have to be addressed/be carried out by a group with very different disciplinary competences, including the specific and indeed quite unique challenges of simultaneously addressing engineering and architecture or design students.

- The so-called Milano-Torino (Mi-To) axis, i.e. a strong relationship between the two cities, which are about 150 km apart but now connected in less than 1 hour by high speed train, provides an ideal framework for the ASP programme, which could, in turn, also constitute a sort of laboratory for other more comprehensive possible future joint ventures between PoliMi and PoliTo. This connection has already found further practical realisations in the merging of two of the major Italian banks, located in Milan and Turin, into Intesa Sanpaolo, at present the leading Italian bank, as well as in the joint organisation of a prestigious international music festival.
- The multi-cultural nature of the ASP environment is strengthened by the very different origin of ASP students (e.g., the ones who come in the fifth cycle were from 20 different countries).

The original motivation of ASP as outlined above is now evolving into the rather ambitious goal of providing a not insignificant contribution to the education of future leadership. The aim of ASP for this future leadership is to be not only capable of effectively addressing multidisciplinary tasks that are characteristic of today's companies and/or public institutions, but also, and more generally, to be aware of and strongly proactive in the field of innovation. Furthermore, the breadth of ASP-related education is a vehicle to open the mind and to create an awareness of both the opportunities and the responsibilities of such a selected and trained class of students. The social interconnection of former students then becomes an important tool to create and nurture such awareness.

It should be noted that, while 150 years ago talent was considered as a feature that democracies do not trust[1] and meritocracy was originally portrayed some 50 years ago as a dystopian political system (Young 2008), the situation in Italy, in this respect, recently reviewed in Abravanel (2008), is, in the present authors' opinion, such that a serious effort (including, it is hoped, that of ASP) in the promotion of talent and meritocracy could contribute to its progress along the same direction taken by others, in particular in the Anglo-Saxon world, several decades ago.

ASP is governed by a Board (the co-authors of the present paper), as heterogeneous as the ASP cultural programme requires, composed of four professors from each institution and chaired by the ASP Director. Periodically, the Board is advised by an international scientific committee, which includes, for the 2009–2011 term, Professors R. C. Armstrong, (Cambridge, USA), M. Ferrari, (Houston, USA), E. Goles, (Santiago, Chile), K. Osterwalder, (Tokyo, Japan), and L. Yongqi (Shanghai, China).

2. The roots of ASP inside PoliMi and PoliTo

As opposed to other initiatives of 'Alta Formazione', born in the same period in Italy, e.g. the Institution Markets Technologies Institute for Advanced Studies, it was decided from the very beginning that ASP should remain part of the two founding institutions—a decision that, of course, has some major implications.

The first problem that ASP had to face was to make both the students and the faculty of PoliMi and PoliTo aware of its existence, aims and scope. As to the students, the absence of its roots at the BSc level required direct advertising actions in selected BSc classes. It was also suggested that an initiative called ASP Competition[2] should be launched for the first time in 2008 and confirmed in the following years, in view of its success. It is interesting to note that several of the students applying to the ASP Competition pointed out in their motivation letters, and/or in the ensuing interview, that for the first time the university was explicitly appreciating and, so to speak, rewarding their excellence.[3]

As to the PoliMi and PoliTo faculty, in the beginning ASP had to face a bit of scepticism from those who considered such a broad-spectrum initiative as being inevitably superficial, as well

as the risk of being confused with a business school. This situation has significantly improved over the years, thanks to the increasing involvement of the PoliMi and PoliTo faculty in both the ASP courses and the ASP multidisciplinary projects (so far about 50 PoliMi or PoliTo faculty per cycle[4] were involved as tutors in the ASP multidisciplinary projects, a similar number as the teachers or tutors in the ASP courses). By adopting this strategy, ASP can also make the best use of the spectrum of disciplinary competences present in the two universities.

The rooting of ASP inside PoliMi and PoliTo brings, as an additional benefit, the fact that one can take advantage of the know-how present in administration departments such as, e.g. career, communication, internationalisation and recruitment services, among others. The financial implications of the rooting of ASP inside PoliMi/PoliTo will be addressed in section 6.

3.   Selection of the ASP class

Since the key to the success of any educational initiative lies in the selection of the most suitable students for that particular initiative, the ASP Board devotes significant time and attention to this process. Every year, ASP selects up to 150 students among those enrolled in the MSc programmes at PoliMi or PoliTo. The main channels for the selection are shown in Figure 2.

There are three main channels for recruitment, namely, students with a BSc from: 1) PoliMi or PoliTo; 2) abroad (approximately 25% of the total as target); 3) the rest of Italy. While a separate call was originally launched for each of these channels, the ASP enrolment process has undergone significant evolution during 2008 and 2009 (see below). Independently of the channel through which the students are applying to ASP, they are asked to submit their academic CV and a motivation letter at the time of their application. If their credentials are considered interesting, they are then invited for an interview, which, in some cases, may also be done remotely. This interview is considered to be the key point of the entire selection process and its focus is on assessing four major points: 1) the actual interest of the student in the ASP programme and its keywords (multidisciplinarity, teamwork, etc); 2) the relational skills of the student, including her/his knowledge of the English language (in particular speaking skills); 3) the capability of the student to make elaborated connections between relatively different items; 4) the passion of the student for what she or he has been doing so far.
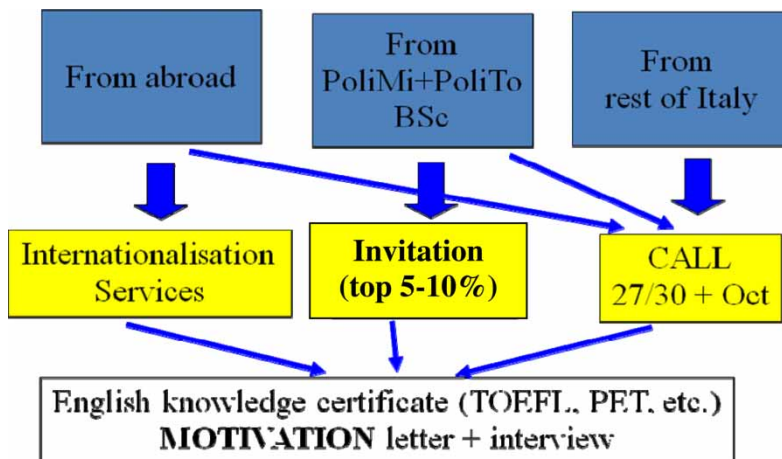

Figure 2.   Channels for the selection of the ASP class. Oct = these candidates must have obtained the BSc degree (general prerequisite for ASP enrollment) by October of the third BSc year.
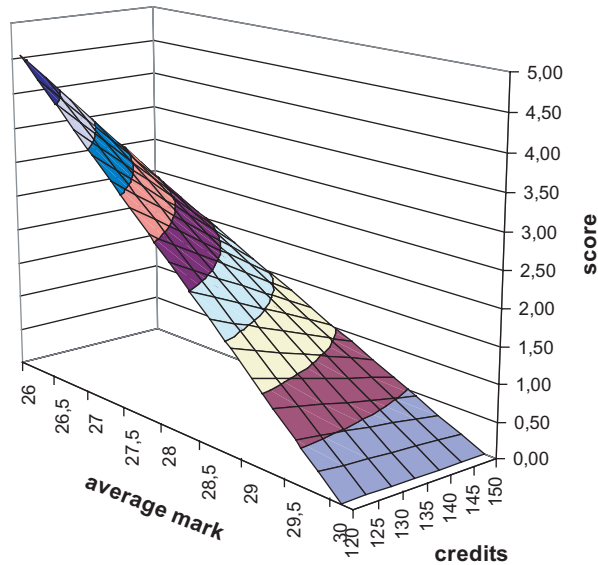
Figure 3. Score function of average mark (*30) in the BSc single exams and credits achieved, both by the end of the fifth semester, used as ranking parameter of PoliMi and PoliTo students academic performances at the time of their application to ASP.

Students enrolled in the BSc programmes at either PoliMi or PoliTo have their career constantly monitored and at the end of the fifth semester they are ranked, inside each BSc programme separately, according to a certain function $B(A,C)$ (shown in Figure 3). This is a suitably weighted product of the average mark A and of the number of credits C achieved at that time, trying to balance the 'speed' of credit acquisition and the marks achieved. Taking the target domain for potential ASP students as a reference point, namely, an average mark greater than 26/30 and a number of credits greater than 120 after five semesters, 10 additional credits are equivalent to 0.5/30 extra average mark. It should be noted that a mere product of average mark and credits would create a rather different picture, with 10 additional credits equivalent to 2/30 extra average mark. As this was considered to be inadequately balanced, a normalised product was preferred.

It is important to emphasise that this fine-grain procedure turned out to be needed when it was realised that the satisfaction of the original criteria for the admission to ASP, namely, a final average mark of at least 27/30 and graduation by October of the third and last BSc year, showed a high degree of variability across the different BSc programmes at the two universities; in principle, causing a significant penalty to some of them (see Figure 4). At present, the students ranking in the top 5–10% of each BSc programme at PoliMi or PoliTo are invited to apply to ASP[5]. If their motivation letter is considered interesting, the student is interviewed, after which admission is decided.

At the beginning of each year, PoliMi and PoliTo open their websites for the application of foreign students. From the Internationalisation Services of the two universities, lists of students are received. Their careers have been evaluated by admission officers and they are considered potentially good candidates for ASP. The students in these lists are invited to submit their application to ASP by sending a motivation letter. If this letter and the previous career of the student are considered suitable for ASP, the student is interviewed. As soon as this process is completed, there is a primary list of admitted students from abroad. The selection of foreign students is particularly critical as, eventually, a significant fraction of the ASP drop-outs (see below) are in this category. Preliminary data from PoliTo indeed show that, for the years corresponding to the first three ASP
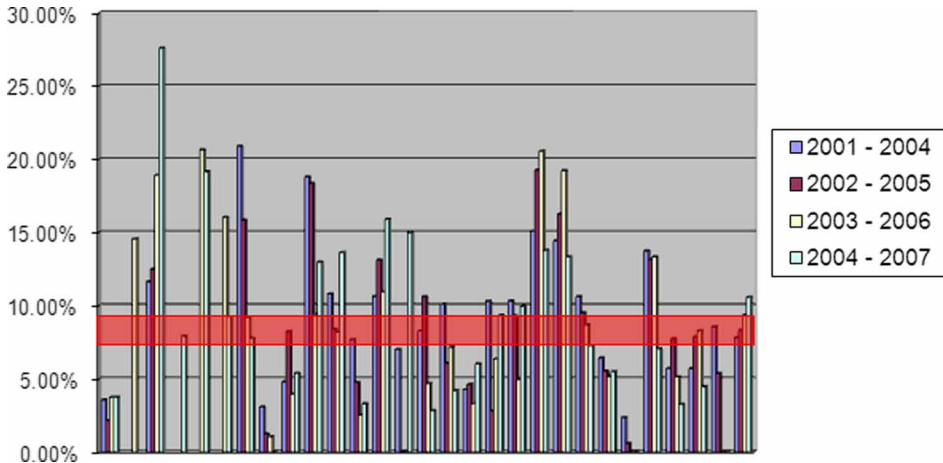
Figure 4.   Distribution of the proportion of BSc students, across the different BSc programmes at PoliMi, which would satisfy the cold criteria previously used for admission to ASP. The red horizontal bar indicates the university average for the (first four) ASP cycles included in this database.

cycles, only the top 10% of the foreign students enrolled in the PoliTo MSc programmes (to be compared with the corresponding fraction of Italian students, amounting to 24%) would satisfy the requirements for remaining in the ASP programme related to the MSc career.[6] This means that foreign drop-outs will continue to exist unless only those foreign students are selected, based only on their previous career abroad plus motivation letter and interview. They will then make it to the very top 10% of their peers. It is easily understood that this is a rather challenging task, due to the extreme difficulty in comparing the very diverse educational systems worldwide, as well as in predicting how foreign students will adapt to the Italian higher education system.

The third and last batch of students is admitted following a general call, addressed in particular to the students who obtained their BSc from universities in the rest of Italy. Also included are interested students from both PoliMi/PoliTo and from abroad, who did not access the first two recruiting channels. Here it is perhaps worthwhile mentioning that the weakest response at present in the ASP recruitment process, is that from the rest of Italy (students from this group never progressed above 10% of the total ASP population). Obviously some issues concerning inter-university relations also come up, making for example direct advertising of the ASP initiative in other universities, with the exception of PoliMi and PoliTo, quite delicate. While the only channels for ASP promotion at the national level were so far based on road shows and the AlmaLaurea, a new initiative was experimentally launched in 2009 at PoliTo, by realising a completely web-based application procedure for Italian MSc candidates (see http://apply.polito.it/indexp.html), which automatically includes a section that explains what ASP is and offers interested students the opportunity to easily apply.

For the latest two ASP classes, selected in 2008 and in 2009, ASP received more than four applications per position available, almost all of which were already highly qualified. As an example of the multidisciplinarity of the ASP classes, Figure 5 shows the distribution of students of the first five ASP cycles across the different MSC programmes. It can be seen that the distribution is quite uniform, as desired. About one-third of the ASP students are females.

As a measure of the excellence of the students admitted to ASP, Figure 6 shows the average BSc mark for the different cycles. Figure 7 shows the fraction achieving the BSc degree with a mark of 110/110 or above (*cum laude*). It can be seen that the average mark is well above the typical nominal threshold of 27/30 (average 28.5/30) and that, on average, almost 90% of the ASP students achieved their degree with at least 110/110.
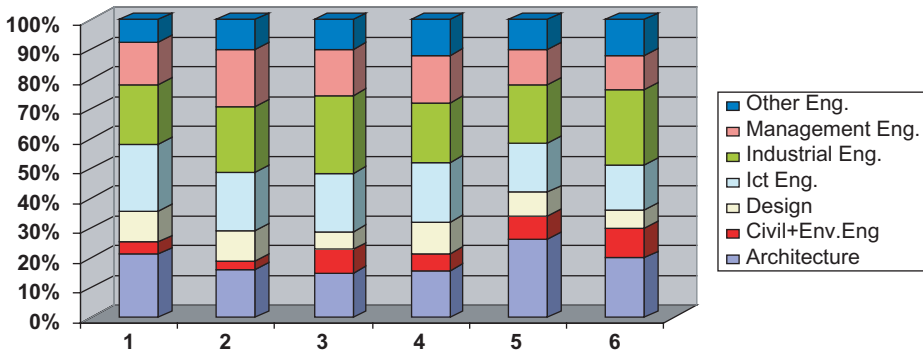
Figure 5. Distribution of ASP students of the first six cycles across the different MSc programmes.
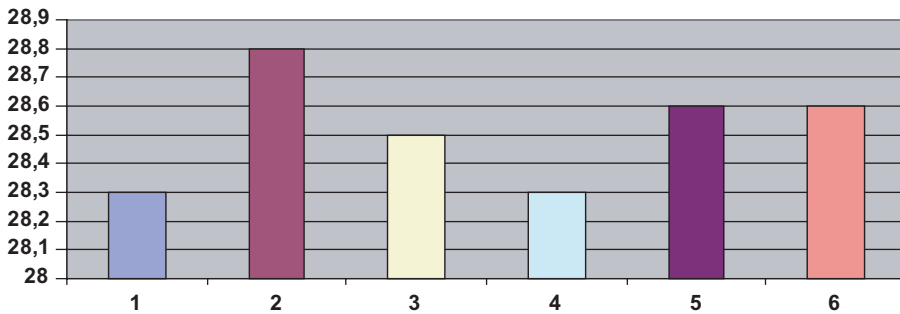

Figure 6. Average mark (*30) in the exams for single courses during the whole BSc track of ASP students (from Italian universities), for the first six cycles. In Italy, the marking system of exams for single BSc courses is x/30.
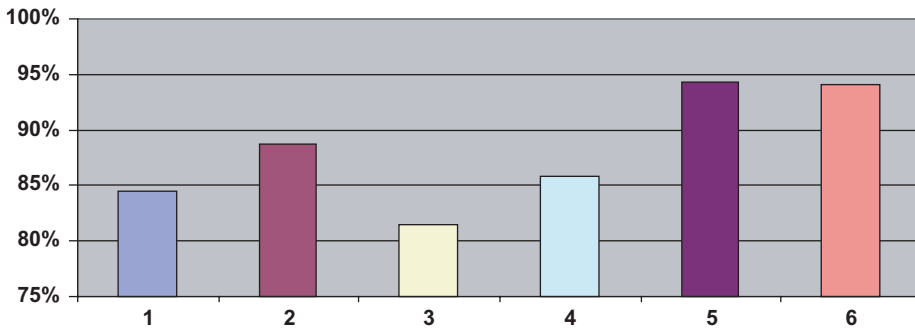
Figure 7. Proportion of ASP students (from Italian universities) achieving the BSc degree with at least 110/110 (i.e. the maximum, except for *cum laude*) for the first six cycles.

If the performance of the ASP students during their MSc career is now considered, almost 90% of the first three cycles achieved the MSc degree, with at least 110/110. A fact that is perhaps more impressive and even a bit surprising is that preliminary data from PoliTo show that, for the first three ASP cycles, ASP students typically needed the same amount of time and, in some cases, even less than their peers who were not in the ASP programme (but still achieved the MSc degree with at least 110/110), in order to complete their MSc programme.

The other side, however, is that ASP has a not insignificant number of drop-outs, as mentioned above. Over the first five cycles the drop-out rate among Italian students was about 18%, but the rate among foreign students was twice as large, indicating a critical issue concerning the

foreign ASP student population, as discussed above. The main causes of drop-out are the inability to satisfy the criteria for remaining in ASP. As an example, in the third cycle, which was just completed, approximately half of the total number of drop-outs is in this category. Approximately one-third of the total cited 'personal reasons'.

4. The cultural track of ASP

The additional contribution of ASP to the education of selected MSc students from PoliMi and PoliTo is based on two main blocks, each formally amounting to an additional 15 credits and described in more detail below:

- Ad hoc, interdisciplinary courses.
- Multidisciplinary projects.

Generally speaking, the cultural task that ASP addresses is to first build interdisciplinary links between students who are excellent in their respective disciplines but not necessarily able to (technically) communicate with each other. ASP then teaches the students how to participate in a (multidisciplinary) team, including issues related to decision making in the presence of non-expert actors, etc. Finally, it makes the students aware of the fact that, in some cases, people or more generally boundary conditions outside the conventional ball park (so-called context cultures) can play a major role in determining the result of the match.

The main cultural focus and challenge of ASP is to explore the field of multidisciplinary innovation. The vast majority of graduate education today focuses on specific disciplinary fields. Innovation certainly requires strong expertise and solid foundations that ASP students can only obtain by taking advantage of their MSc studies. However, it is commonly noticed that crucial innovation comes from the combination of different disciplinary competences. Every organisation is aware of the fact that the chances of creating innovation strongly depend on the capability of fostering cooperation between different experts and, quite often, significant innovations come from the openness to new perspectives and from the availability to change standpoints.

The focus of the ASP cultural project is the design process, arguably the most qualifying aspect in the DNA of the two universities, where the designer usually needs to move back and forth between problems and solutions many times. Many standard design problems, albeit technically very difficult in some cases, are well understood and fall within a single technical discipline. In these cases, all actors share the same goal, the technical requirements (rules of the game) are clear and the best designer is the one who first finds the solution. Clearly framed problems such as these are mostly addressed by the students in their MSc studies. In many cases, however, real problems are not shaped in a way that permits the application of standard design procedures for their solution. There are, in fact, many technical problems where the goals are pretty clear, but the technology is unclear and must be selected or discovered; or else, where the technology is clear but the design goals are not agreed upon, e.g. when the introduction of new technological products brings about social, technical or environmental controversies. In such cases, the designer should alternate several times between problem-setting and problem-solving activities before finding the 'right' solution (or a solution that is good enough). This includes accounting for its deployment within the surrounding environment.

Design is therefore an activity that copes with complex and dynamic environments and requires considerable cognitive capacities (aptitude for learning). This includes a talent for interpersonal relations (human and social interaction), the capacity to manage organisational and communicative processes, an awareness of the interests and the interactions that take place within the specific contexts and flexibility in adapting to the cognitive processes upon which the design process is

based. The ASP cultural track, as detailed below, seeks to sustain and to enhance these fundamental skills, all of which are increasingly crucial in the development of innovation.

4.1. *Interdisciplinary courses*

ASP courses are typically taught in full-immersion weeks (winter, spring or summer schools) at several different locations, most often not in Milan or Turin, in order to foster a sense of community among students and faculty. Also, a not insignificant fringe benefit of the ASP courses is that the students can sometimes meet and interact with leaders (former ministers, chief executive officers, etc), invited as speakers to the course, and this obviously provides a great opportunity for young people, a subset of whom, it is assumed, will constitute future leadership.

While previously the course coordinators were chosen *ad personam* by the ASP Board, in 2008 a call was launched for the first time among the PoliMi/PoliTo faculty to propose courses or contributions to courses. This resulted in a new course on global change and sustainability (see below).

The students attend all courses but choose three, out of the six taught at present, in which they will present a paper, which is then evaluated by the course coordinator and her/his team.

As an example, the courses offered in 2009 are listed in Table 1. The dates for the courses are chosen in such a way as to leave the (first and) third semester free for those students (typically a not insignificant fraction, approximately 20% on average over the first four ASP cycles), who may be interested in also participating in Erasmus programmes or the like, which will take them abroad to study for a considerable amount of time.

The six courses that form the ASP programme can be subdivided into three tracks, each addressing a fundamental issue:

1. Understanding the socio-technical and environmental context where innovation takes place.
2. Management of and decision making in complex multidisciplinary projects.
3. Approaches and methods to address complex interdisciplinary problems.

After each course, the students are asked to complete a comprehensive questionnaire online, in order to gather detailed individual evaluations of the various aspects of the course, as well as an overall ranking of it. Table 2 reports the overall evaluation (in the range 1–10, answering the

Table 1. Alta Scuola Politecnica (ASP) 2009 courses.

Track	Title	ASP cycle	Date	Location
I	Innovation: Why, and for whom?	5th	17–20 March	Bardonecchia
	Global change and sustainability	5th	21–24 April	Bardonecchia
II	Management of innovation	5th	27–30 July	Sestriere
	Decision making	4th	16–19 March	Bardonecchia
III	The art of modelling	4th	21–24 April	Bardonecchia
	The dynamics of creativity	4th	27–30 July	Lingotto (TO)

Table 2. Overall student evaluation of Alta Scuola Politecnica (ASP) courses.

Track		I cycle	II cycle	III cycle	IV cycle	V cycle
I	Ethics and innovation	7,2	6,1	6,4	6,3	7,7
	Drivers of innovation	7,1	5,1	7,1	6,1	7,0
II	Decision making	7,7	7,7	7,2	6,7	–
	Management of innovation	7,8	7,5	8,5	8,3	8,2
III	Logic of modelling	6,1	6,7	7,0	7,8	–
	Dynamics of creativity	6,7	7,9	6,4	6,9	–

question: 'How would you rank the course content?') of students for all of the ASP courses held from the beginning of the initiative. The table shows that the evaluations are generally good, with an overall average of 7.1 and only one below 6. This might perhaps even be considered a very good result, if one considers that ASP students form an unusually demanding class because of their excellence and that an ASP course is a great challenge in itself, for the various reasons previously outlined. However, when the degree of satisfaction of the students turns out to be insufficient (e.g. an evaluation close to or below 6/10), as has happened in a few cases in the past, the ASP Board promptly reacts by readdressing the course organisation and structure and/or its coordination. The missing data in Table 2 refer to the courses that the students of the V cycle will attend in 2010.

4.2. *Multidisciplinary projects*

ASP projects are multidisciplinary in nature. They are typically proposed by faculty members of PoliMi or PoliTo, in response to a specific annual call, already foreseeing the involvement of faculty from both universities as well as of one or more companies and/or external public institutions. The projects can also be proposed directly by private companies or public institutions that are ASP investors (see section 6). In this case, the ASP board is in charge of assembling the team of faculty advisors who will tutor the project.

The project proposals are evaluated by the ASP Board and the selected ones are presented to the students, who rank them according to their personal interests. Based on this ranking and on the need to build teams that include the multiple disciplines that are required by each specific topic, the Board then assigns each student to a team of five to six persons. The assignment process is rather efficient as, so far, approximately 70% of the students were assigned to their first choice, approximately 25% to their second choice and only a negligible 5% were given their third choice. A single project may have up to three teams working on different aspects of it. The project work typically lasts a little less than two years and ends with the presentation of a final report, which is evaluated by the Board with the help of external experts and contributes, together with the above-mentioned course papers, to the assessment of the ASP student's career.

Based on experience so far, successful ASP projects typically result from a careful combination of the following:

- Selecting the right problems from the point of view of multidisciplinarity and innovation potential.
- Selecting the right student teams.
- Having a team of academic tutors with multidisciplinary competences.
- Defining a coherent work plan for approaching the projects.
- Asking students to manage the projects 'professionally', including the use of a limited budget which is made available to them.

Multidisciplinary projects are an educational context where students have the opportunity of applying both the vertical skills learned during their MSc studies and, in particular, the horizontal skills learned through the ASP courses, to complex problems stemming from real-life contexts. Multidisciplinary projects are perhaps the most original and challenging ASP endeavour, as their structure and organisation is significantly different from classical projects offered during MSc studies.

In the five ASP cycles so far, a total of 56 projects have been launched. Thus, it is now possible to attempt a first broad categorisation. Although not all the projects may fit a rigid classification, most of them can be clustered within two categories:

- 'Design-driven' projects.
- 'Technology- and research-driven' projects.

Design-driven projects are characterised by a broad multidisciplinarity and focus on innovation scenarios that are mostly unexplored from a technical, structural and functional point of view. Technology- and research-driven projects address a technological innovation scenario characterised by a narrower multidisciplinarity, where the field has already been explored through research activities, though typically less from the perspective of technology transfer and industrial applications. The two different clusters usually generate different final outcomes: design-driven projects deliver a final study that explores the problem situation, compares possible solutions and goes deeper into evaluating the feasibility of the most promising and innovative option; technology- and research-driven projects start from a more restricted project brief and aim to deliver a feasibility study and a real application or new solutions.

The results of the ASP projects are collected each year in a book. Three titles have been published so far (ASP Projects 1 2007, ASP Projects 2 2008, ASP Projects 3 2009), with the last one published in 2009, corresponding to the number of completed ASP cycles.

5. ASP results

The major quantifiable results of this ongoing experiment so far may be collected under two broad categories:

- Placement of the ASP alumni.
- Contributions to innovation from ASP multidisciplinary projects.

A few others, more subtle and less quantifiable but perhaps no less important achievements of ASP, have been already elaborated upon elsewhere in the present paper, namely:

- Fostering the collaboration between PoliMi and PoliTo at all (student, administration and faculty) levels.
- Educating a category of students (the top ones), which was previously not highlighted in these institutions, learning in turn about their needs, ambitions and capabilities.

5.1. *Placement of the ASP Alumni*

A very active ASP Alumni Association (AAA) was established at the end of the first ASP cycle in 2007 (see http://alumni.asp-poli.it). Among the many initiatives of AAA, a poll among the graduated students of the first three ASP cycles was conducted in the spring of 2009; 100 former ASP students replied, all of them now working (approximately 25% of whom are abroad). One of many interesting results of the poll is presented in Figure 8.
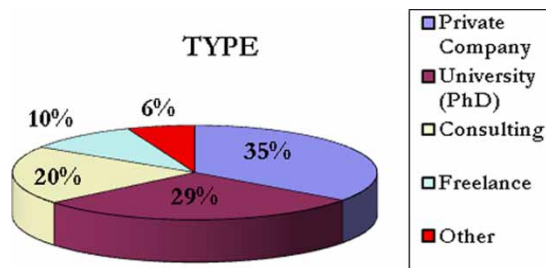

Figure 8. Employment types of ASP former students (first three cycles). University (PhD) = enrolled in a PhD programme.

Figure 8 shows that while about one-third of the ASP former students who replied to the poll found a job in private companies, almost another third continued to a PhD, while only one-fifth entered a career in consulting. This broad spectrum of careers confirms that ASP is at presently adequately satisfying the needs of an additional excellence education for a correspondingly broad spectrum of student interests, including research-oriented ones.

The poll also gave information about the time of first employment of ASP former students: approximately 20% of the ASP students who replied to the poll had already found a job before graduation, while almost 80% in total found a job within 2 months of graduation. While these figures are quite encouraging if compared, e.g. to a recent survey (Barbieri 2008) of the Italian daily *Il Sole 24Ore* on excellence schools in Italy, stating that 'the broadest majority of the graduates from these institutions finds a job within one year from graduation', they are not significantly different from the figures related to the general population of MSc graduates at PoliMi in 2007 (PoliMi 2007). This clearly shows the need to identify suitable metrics for the success of ASP in the future.

The appreciation of companies towards ASP students is difficult to assess at this time, due to the fact that ASP is a recent programme and therefore each company statistically has a very limited sample of ASP students among their new hirings. The main exceptions at this time are companies in the consulting sector (e.g. Accenture, BCG, McKinsey), which hired several ASPers and, indeed, also are or have been 'ASP investors'. Also, the full deployment of ASP-related skills and their effects on career building requires time, especially in a rather rigid job market as in Italy. However, from a very recently conducted poll among the external tutors (i.e. from the external institutions participating in the ASP projects) of the first five cycles, it was found that the average evaluation of the quality of the student team(s) with which they worked was 8.8 out of a maximum of 10, so quite satisfactory.

In the present authors' opinion, this situation clearly points to a couple of different but similar needs for ASP: 1) to consolidate its 'brand' by a suitable communication strategy; 2) to look for partners, synergies and feedbacks from companies and other institutions (including, of course, academia and the public service) by a suitable networking action (see section 6), which is important in a country such as Italy, where the appreciation of excellence does not perhaps have such a long and solid tradition as in other countries.

The opinions of several ASP alumni, now employed, on the role of the education they received within the ASP programme have also been separately collected on the ASP website (ASP 2010). Generally, ASP is described by these testimonials as a unique experience of their university life and the alumni remember with enthusiasm the breadth of the ASP studies, their multidisciplinary nature and the extraordinary and diverse community of talented colleagues that the ASP experience gave them the opportunity to meet.

5.2. *Results of multidisciplinary projects*

While just 38 multidisciplinary projects have been concluded until now, many of their outcomes and results can be considered scientifically relevant, including a few publications (Navarrini *et al.* 2006, 2007, Targon *et al.* 2006, Jacazio *et al.* 2009) and patent applications (Navarrini 2007, Carlone 2009). This is creating an increasing interest in taking part in ASP projects, both from external companies and institutions as well as from research groups inside the two universities.

Outcomes and results of design-driven projects and technology- and research-driven projects are usually different in nature.

The first ones usually address critical issues with a high level of systemic complexity and sometimes a potential environmental and social impact. For this reason, while they do not usually produce working prototypes or patents as final outcomes, they nevertheless attract public interest

and sometimes attract the attention of the scientific community by being presented in scientific journals or at conferences. As an example of this kind of result, the outcomes of the two projects, UP4tin and Italia 150-Torino 2011, can be presented.

- UP4tin, Engineering and architecture for supporting sustainable development in Ecuador: the case study of Guayaquil's barrios (external partner UNIDO, III cycle) was a project aimed to study systemic integrated solutions for implementing urban environment into degraded contexts. The project ended up developing a low budget systemic solution for water networks and related services, also through an innovative business model based on local micro-enterprises designed to offer job opportunities.
- Italia 150/Torino 2011 (external partner URBAN CENTRE TORINO, III cycle) was a project aimed at understanding the architectural, urban and territorial effect of hosting a national celebratory event. The final outcome of the project was an innovative model and a system for planning and managing the environmental impact of an urban mega-event. The Municipality of Turin is actually implementing part of this system, still collaborating with some of the team members and academic tutors.

Technology- and research-driven projects usually attempt to identify new applications of existing technologies, often incorporated into working prototypes, and in the best cases, radically innovative solutions potentially leading to patents. As an example of this kind of result, the outcomes of the projects BioFluor and SenSoBot can be presented.

- BioFluor, smart drug delivery (external partners SOLVAY and BRACCO, I cycle) was a project aimed at finding new opportunities in the biomedical application of perfluorinated fluids. The project team came up with a solution for a new 'life-saving' pharmaceutical preparation to be used in case of extreme gas embolic syndrome. The patent of the process is presently pending.
- SenSoBot, sensor and control for societal robot (ST MICROELECTRONICS INC., III cycle) was a project aimed at exploring new potential applications of robotic technology in domestic environments. One of the most significant results of the project was a prototype of a robotic desk lamp aimed at creating new ways of interacting with light. The patent of the lamp control system is presently pending.

The results presented above confirm that both design-driven ASP projects and technology- and research-driven ASP projects are not only an educational experience for training excellent students in multidisciplinary design, but also constitute an interesting innovation platform.

6. ASP sustainability and networking

ASP was financially supported as a start-up by the Italian Ministry for Education, University and Research for its first three years. Since 2008, while indirect support comes from PoliMi and PoliTo through the personnel costs of all the administrative and faculty people involved in the initiative, the significant, direct, student-related costs of ASP (of the order of 1 MEuro/year), covering fellowships, accommodations, travels for the ASP schools, project budgets, MSc fee waivers, etc., make the search for separate funding source(s) mandatory. The ASP programme is currently completely free for the students admitted to it.

These issues stimulated, on the one hand, a still ongoing debate inside the ASP Board about the kind and range of financial benefits that were affordable to provide to the students, while still guaranteeing a medium-term sustainability of the ASP programme. On the other hand, the same issues are strictly inter-related to the issue of networking, which is addressed below.

As far as the sources of funding go, the strategy so far is to work on two different levels:

1. The career and placement services of PoliMi and PoliTo propose a collaboration with ASP to interested companies (within the framework of the so-called 'ASP investor programme'), offering two different sets of 'products', namely, access to CVs and the opportunity to meet the ASP class, e.g. during ASP courses, together with the opportunity to propose a multi-disciplinary project around which the ASP Board will build a team of academic tutors and, eventually, one or more teams of students.
2. The ASP Board, with the help of the Rectors, pursues a fund-raising activity from more institutional sources such as bank foundations, chambers of commerce, etc.

The second channel is, at this time, providing the main source of sustainability for the ASP initiative for the years to come. So far, however, there has been little success in finding a significant amount of companies willing to invest in ASP, with the major exception of the already mentioned strategic consulting companies. Our understanding of this issue at present is that, at least in Italy, the only sector actively investing in excellence is that of strategic consulting, where a career is typically built around the potential of the individual. Therefore, these companies are clearly interested in getting in contact with the students as early as possible. However, they are not very interested in the multidisciplinary projects, because of their long timescale (1–2 years) compared with the typical project followed by a company (1–2 months). Conversely, when focusing on the rest of the job market, and restricting the target to medium-big companies (because they are the only ones in principle able to afford, in terms of costs and personnel, the collaboration with ASP), the situation is such that companies are typically not specifically interested in the excellence of the students (perhaps having more of a quantitative target, such as the recruitment of hundreds of engineers per year). Whereas they occasionally are interested in collaborating on the multidisciplinary project side, but there perhaps the really broad spectrum of multidisciplinarity typical of ASP (from architecture historians to hard-core engineers) may in some cases be seen as an issue rather than an opportunity. On the other hand, it is believed that the benefits of a relationship with companies cannot be reduced to purely monetary ones, but rather belong, as already mentioned above, to the broader sphere of networking.

The issue of networking has several different aspects related to it. On the one hand it is obviously essential for the students that ASP becomes better known among companies[7] (a particularly difficult task in Italy, where most of the market is made up of small businesses). These companies should increasingly consider the ASP experience of a student as an important added value to his/her education, leading them to prefer ASP graduates and, possibly, to start looking specifically for them even before graduation. On the other hand, it is quite clear that ASP should be proactive in finding partners (in academia, in public administration, among companies) that believe in its most important keyword, namely, that of excellence, as well as of innovation, beyond the standard use of these keywords as a slogan.

7.   Conclusions and perspective

The ASP's focus on the talent of students is not unimportant in a country such as Italy, where the values of meritocracy and excellence are perhaps being only recently and only partially (re)discovered.

On the society level, ASP is trying very hard to give its contribution towards creating a future leadership, able to address the strong multidisciplinary challenges typical of innovation. It is perhaps too early, five years from the start of the ASP project, to draw conclusions on this, but a few encouraging results have been presented in this paper.

On a more academic level, ASP is already giving a significant contribution to the building of a database, as presented in this paper, on the very atypical group of excellent students in technical disciplines. The ASP Board strongly believes that this knowledge will prove useful if and when more wide-ranging plans are launched and corresponding opportunities open up for this group, based on suitable networking between different actors from academia, the public service and industry.

In the future, ASP will face the challenges of its financial sustainability, which at present relies heavily on bank foundations as well as on a selected number of other public institutions and private companies, and of the consolidation of its brand. While an aggressive communication strategy is being planned to properly address these issues, an additional 5–10 years, perhaps, are likely needed for the ASP alumni to show what they are really worth.

Acknowledgements

Notes

1. 'A mon arrive aux Etats-Units, je fus frappe de surprise en decouvrant a quel point le merite etait commun parmi les gouvernes, et combien il l'etait peu chez les gouvernant' (de Tocqueville 1835).
2. The top 5–10% of the students are invited at the end of the third BSc semester to apply for a competition that selects 10 of them from Milano and 10 from Torino to participate in one of the ASP schools (see section 4.1).
3. As another example of ASP-related applied meritocracy, the top 100 students from the BSc admission test (at PoliTo) each year receive a laptop as a prize. Starting from 2009, a volume collecting the results of the ASP multidisciplinary projects (see section 4.2) has been added to the prize, as an encouragement to consider application to ASP when the time comes.
4. The term 'cycle' is used to identify the two-year period of enrollment in the ASP programme. So, for instance, the students enrolled in the academic year 2009–2010 belong to the sixth ASP cycle, those enrolled in the academic year 2008–2009 to the fifth cycle, etc. This should not be confused with the definition of the same word used in, e.g. the 1999 Bologna declaration.
5. Note that (71 To + 86 Mi)/(203 To + 366 Mi) approximately 28% of the students who received the invitation this year, the first one in which this procedure had been institutionalised, replied. At PoliTo those who did not reply to the invitation received an email enquiring about their reasons and approximately 29% of them replied, quoting the following major causes for not replying to the original invitation: misunderstanding of the terms and conditions for applying (approximately 8%, all of which then applied to the general call); preference to focus on the MSc programme; incompatibility with other plans to study abroad; insufficient knowledge of the English language; insufficient motivation for a purely non-technical study. The data above also mean that, e.g. at PoliTo, more than 50% of the students originally invited showed an interest for ASP.
6. Average mark $\geq 27/30$ and at least 40 credits at the end of the first year + average mark $\geq 27/30$ at graduation, within April of the third year
7. As an example, in the Alumni poll discussed in section 5.1, 70% of the answers suggested ASP is not sufficiently well known by companies at this time. A programme of web advertising of ASP is now being launched, in order to try and reach, in a more effective way, the different actors who could have a potential interest in ASP.

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