Noir sur Blanc

« Engineers 2000 »

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Introduction

The "Engineers 2000" survey conducted by the Noir sur Blanc Agency in Spring 2000 had two objectives:

- to carry out an appraisal of the main trends in the world-wide training of Engineers;
- by way of follow-up to list the points of convergence and differentiation in the main qualifications of Engineers in the world.

The context of the survey gives it a special emphasis since it is being done at a time when the globalisation of the "market" for young engineers - accelerated by a shortage which is more or less ongoing, especially in some sectors - is acquiring a quite new pertinence and becoming a reality which hitherto applied more to those in "sales" or "management".

Methodology. The findings of this survey were the results of analysing 107 questionnaires completed by the Universities or the Engineering Grandes Ecoles[1] of 38 countries. This analysis was followed up with a number of qualitative interviews carried out at the same time within the target group of returned questionnaires and outside this target group (including those with companies).

- **Returns.** Almost 800 Universities were asked to fill in the questionnaire. The rate of return is thus close to 15%. It is clear that this rate is fairly high for this type of survey. Without venturing into interpretations of too speculative a nature, we have reason to think (and the qualitative interviews encourage us to do so) that this level of participation points to widespread interest among Universities in developing the training of young Engineers and in exchanging experiences in an international setting.

- **Respondents.** Those in Universities most often replying to the questionnaire come in the order: Chancellors (or Vice-Chancellors), Deans, those responsible for International Development, lecturers in charge of syllabi or communication.

- **Representativeness.** One might debate for ever whether this sample is a representative one as it is a fact that the criteria for representativeness are themselves open to debate: is a maximum number of countries required ? a maximum number of kinds of University ? should one take account of the Universities' "standing" and give more weight to the more

[1] *For convenience, we shall hereafter use the term "University" which is the one which has the most resonance internationally for designating all Higher Education Institutions training Engineers, whether they are Universities as such, Grandes Ecoles on the French model or intermediate types.*

prestigious, or on the contrary, make adjustments for those who are less so ? Should one "balance out" the different systems or try to account for their respective "placings" ?...

This is a hotly debated topic which we might be criticised for neglecting. But as far as this area is concerned, we shall remain very pragmatic. The Universities making up our sample are going to "turn out" around 1 million Engineers this year over the whole globe.

This figure (and also the world-wide composition of the sample and the status of those who responded) is high enough for us to think that this sample can allow us to present a fairly accurate picture of the major debates, issues, trends and patterns...underlying developments in the training of young Engineers.

Better still, we also think that the quantitative data which we shall be putting forward throughout this report - though not "universal" - reflect fairly closely the major features which draw together the universities involved on a problem by problem and global basis.

Main results from the survey and their limits. The intention of the "Engineers 200" survey must be properly understood. We were not seeking to describe the different systems for training Engineers across the world (length, ways of gaining entry to courses, rigour of selection, methods of awarding degrees...) or to examine the economic and demographic data from the training of Engineers or even to identify the legislative and regulatory restrictions which here or elsewhere help towards shaping university courses and the organisation of studies. The survey takes all these well-known features as read

We wanted to place our analysis on another level by trying to identify the main trends characterising Engineer training irrespective of different systems of training (or, on the contrary reinforcing boundaries between different systems).

We also wanted to see how Universities involved in training Engineers - still ignoring differences in system, size, status, organisation, context, level) (or taking them into account if relevant) dealt with certain issues[2] such as globalisation, the need to nurture the recruitment pools of future students, teaching methods, relationships with industry, the actual design of Engineering qualifications, career development.

Finally we also wanted to investigate whether, apart from all these well known differences which we have repeatedly quoted, there were also any emerging issues common to all Engineering Universities and the main training profiles (and thus Engineering qualifications).

By defining its terms in this way, the survey at the same time identifies both its limitation and a gap where it can make a real contribution. To say that Engineer training varies according to systems (and where applicable, levels) and that one must take these "variables" into account is both very true and very mundane.

For our part, we conclude from our survey that apart from these basic differences (which we assume to be known and which we acknowledge) there are also other differences, other similarities and a number of trends (enabling Engineering Universities to be classified differently) which must also be taken on board by those involved in training young Engineers and those recruiting them.

[2] Of which the majority were suggested to us through surveys and round table talks...carried out at or with industrial firms recruiting a significant number of Engineers

Summary. It is these trends, similarities and differences which form the basis of this report. It is arranged in two parts: the first sets out the main items reported by the survey; the second gives a rough analysis of the responses “issue by issue”.

-1-
Main Features of the Report

Engineering training in fact raises two very different sets of questions: those on the training profile that the Universities have to design for the students (1.1) and those on the pool of potential students from which they must recruit (1.2). The first is undoubtedly the bigger problem since it leads to Universities being divided according to different patterns, quite apart from any other differences and similarities - including level - which might separate them or unite them: to put it clearly, the profile takes precedence over the rest.
Other factors also play an important part and contribute towards reinforcing features of the major patterns: the global aspect (1.3), practical experience and relations with firms (1.4), the teaching of management and "non-scientific and non-technical" subjects (1.5) and teaching methods (1.6). Finally the vision that the Universities may have of the skills expected of young Engineers (1.7) completes this overview and is fully consistent with it.

1.1 Profiles, levels and patterns

• The training of young Engineers is manifestly not consistent. It leads to wide differences in profiles from which major patterns of training may be defined.

1.1.1 Non-uniformity. Many factors argue that the training of young Engineers is not uniform throughout the world. Among those which have an impact we can pick out: sizes of the Universities (ranging in our sample from 700 to 90,000 students), rigour in selection, standard, reputation, seniority, material resources (in particular regarding scientific and technical equipment), areas of expertise and teaching, the supporting economy... regulatory restrictions, too, which may limit the Universities' scope for manoeuvre...

Each of these factors has an impact but the survey tells us that in reality this impact is not really conclusive. In fact if we list the Universities by country, size, seniority, amount of resources... we still find there can be substantial differences which cannot be explained by any clearly identifiable cause.

Certainly standard is a crucial dividing line regarding the potential of trained Engineers but ultimately it gives us very little information on the type of training (except, perhaps, the place given to some of the strictly theoretical teaching).

Clearly we have to go elsewhere to find criteria to enable us to draw up an effective and relevant classification to show the diversity of Engineer training.

1.1.2. The report from Universities. Universities also report on this non-uniformity. A large majority of Universities pick up on this disparity and attribute it firstly to differences between courses then to differences between countries. On the other hand the notion as to how this disparity is linked to differences between Universities within the same country is less well ordered.

-This last finding which is of particular interest deserves further comment. On the one hand it reflects a kind of "courtesy" and "academic solidarity"...as well as being very flimsy. Indeed this response is one which shows the greatest differentiation. Put another way, a small majority of Universities think that country for country and subject for subject, Engineering training can be compared globally whilst a large majority think that Universities also make all the difference and say so. This approach, no doubt a realistic one, also voices a competitive attitude which we come across when we deal below with the issue of the intake pool of young Engineers.

1.1.3 Illustration of the disparity. This disparity we are touching on may take very concrete forms. We may thus compare the CV of two young Engineers trained by two Universities in our sample

STUDENT A	STUDENT B
From 3 to 5 years	From 3 to 5 years
12 months in industry (training courses, project)	0 months in industry
9 months period abroad	No period abroad
30% management and "non-scientific and	5% management and "non-scientific and
non-technical" subjects	non-technical" subjects
Association with contracts carried out for industryv	"Theoretical" courses
Parts of training done through	"Traditional" teaching
self-directed learning	

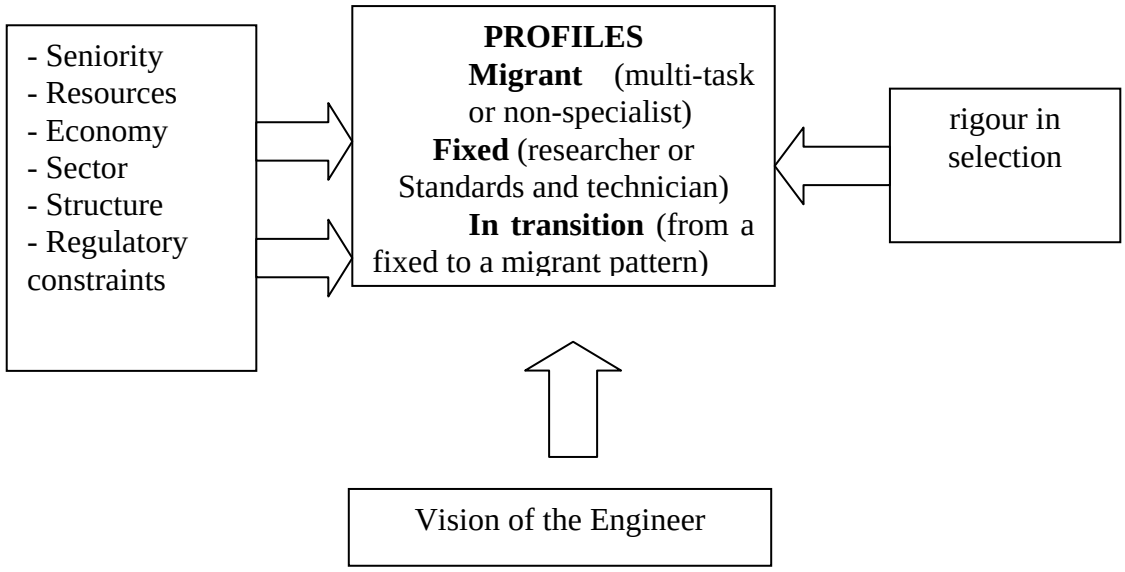
1.1.4. The patterns. Appearing behind these two CVs or better still, these two Engineer profiles there are clearly two major patterns of Engineering training.

-The first which we are calling "migrant" has in mind a young Engineer developing his career beyond strictly or chiefly scientific and technical jobs. This Engineer has an international profile, experience in industry and has, significantly, studied subjects preparing him for management.

Depending on whether he is multidisciplinary mainly on the scientific side or whether certain management aspects are main subjects he will be called a "multi-task migrant" or a "non-specialist migrant".

- The second pattern we are calling "fixed" refers to a young Engineer trained first and foremost for scientific and technical posts. They may range, for example from researcher (in the case of top-flight Universities) to senior technician (from the point of view of job-title... in the case of Universities lower in the pecking order).

- It is clear that these two profiles and patterns present a view, in depth, of the Engineer, his mission and his career. It thus correlates to an actual University philosophy which we shall pick up later that goes beyond certain controlling factors we point to here - practical experience, periods abroad, teaching of management, industrial contracts... - in various areas.



1.1.5 Primacy of patterns. The patterns we have just described have precedence over all other factors which may influence the shaping of Engineer training (except, probably, that of standard and rigour in selection...even if the impact of the latter does not really go beyond the potential of the students and then the young Engineers in question... which however is still of quite basic importance).
They are met in every country and in all types of structure (for example, some Universities in the strict sense are associated with the "migrant" pattern and others with the "fixed" pattern whereas the "Grandes Ecoles" might be linked to either pattern) and this is the case whatever the regulatory constraints affecting the awarding of the title 'Engineer' (and on the training leading up to it).

- This approach based on “profiles” linked to “patterns” of training is quite conclusive from certain points of view. It is especially so for industry. In fact industry needs both main Engineering profiles but recruiting a “migrant” profile for a “fixed” post could be catastrophic (many recruitment failures can be explained by this fact, where a glance just at the standard and field of specialisation would not be enough to throw light on them). Consequently the key to reading Universities (especially in the case of recruiting abroad) based on the patterns we have identified must have priority before even getting involved in any issues of standard and fields of study...

We must add that there is no “hierarchy” of patterns. The “migrant” pattern is not superior to the “fixed” pattern (a priori, it is from the top-flight “fixed” pattern - the researcher type - that a Nobel prize winner will come ... and not from a migrant pattern even if quantitatively, it is more broadly in phase with what industry is looking for).
It is a matter for the Universities not to be caught between the pattern to which they actually belong and the pattern with which they would wish to be associated.

1.1.6. New jobs. In concluding this first topic it is interesting to take a look at the responses to the question we asked on the sectors “outside the classic sectors” who recruit young Engineers.

Almost 40% of the Universities in the sample make claims to this “job migration” which leads a significant number of young graduates into jobs and especially sectors which are not those traditionally reserved for young Engineers. Those quoted are, in order: consultancy, banking and finance, e-commerce, insurance, certain public bodies...

- This figure is of noteworthy interest in the light of the fact that we put those Universities in our sample (which is probably slightly over-representative compared with the global reality) who associate themselves with the migrant pattern at about 40% (against 30% with the fixed pattern and 30% with the transition pattern) and that the level of overlap between the two sets (Universities linking themselves to the migrant pattern and Universities asserting “job migration” is particularly high (between 80 and 90%).

1.2 Recruitment pools

• The question of the pools of talent from which future young Engineers are drawn is quite a fundamental one. It relates to the very inelastic demography of this group of Young Graduates - the number of applicants for Engineering courses being slightly or markedly on the decline in a number of countries. It also poses the question of competition between Universities to secure the best Engineers. It also gives rise to problems over rigour in selection, standards and motivation...

On this complex and fruitful topic area we report six main findings.

1.2.1 Main trend: Increase, decrease and competition. The question to find out whether the recruitment pool of young students aiming at Engineering courses is increasing or on the decline produces quite interesting responses. In fact, the raw score is baffling since 25% of the Universities think that the recruitment pool is stable, 21% that it is declining slightly or substantially and 55% that it is increasing slightly or substantially. Two groups roughly of the same size are thus in opposition: the first moving towards stability or slight decline and the other in the direction of a slight increase.

- The first comment these figures call for is one tinged with disappointment: we are in fact unable to say whether the recruitment pool for Universities in young Engineers is on the increase or decrease !
- However, on second thoughts, disappointment gives way to real curiosity. Indeed one realises that this lack of unanimity is reinforced by the ineffective nature of the geographical criterion: thus, Universities within the same country (and this finding holds true for the vast majority of countries) are divided among stability, decrease and increase in such a fashion that we are unable to say that the recruitment pool is increasing in one region of the world and would be decreasing in other parts of it. What is not possible for reasons of geography really cannot be done either for different sectors of Engineer training (Civil Engineering, Chemical, Electronic, Mechanical) - even if certain courses are manifestly in fashion (we shall say more on this later) and therefore are more attractive than others.
- Nevertheless one must not deduce from these findings that the nature of changes in the recruitment pool of candidates for Engineering courses is “totally anarchic”. Quite the reverse. In fact, one parameter does seem to have an explanatory effect: competition between Universities. One of the ways this idea is expressed is the fact that a fair number of Universities state that they have a growing intake whilst at the same time maintaining that their national recruitment pool is in decline. Clearly stated, national or regional trends are compensated for (and may be reversed) by attractiveness, lively recruitment policies (to which we shall return), and the image.... of Universities.
- If we had to reduce our conclusion to a simple statement, we would say that the recruitment pool of young Engineers is perceived as stagnating or increasing very slightly, but that this trend may vary considerably in one direction or another depending on the attractiveness and the competitive position of the University. In any case there are evident imbalances between this development in the recruitment pool and the requirements of the economy (themselves very uneven), with these imbalances leading inevitably to an increase in the international recruitment of Engineers and a reconfiguration of the University landscape (both in an international setting and a national setting) with some in a position of sharply increasing intake and others in a situation of stagnation or even regression.

1.2.2. Towards policies of recruitment. It is obvious that the pursuit of an active policy to recruit students is directly linked both to the competitive situation which has just been identified and to the issue of changes in the pool of potential students.
78% of the Universities in the sample claim to be pursuing an active policy of recruiting students against 13% who say "not yet" and 18% who reply in the negative.
This very revealing score indicating an "offensive" approach needs to be clarified and, perhaps qualified under 4 headings.

- In the first place it is interesting to note that out of the 70% of Universities declaring they have an active recruitment policy, a little under half quote as much as one initiative undertaken in this direction or anything to identify this policy. Of course, there are no thoughts of casting doubt on Universities who remain silent on the open question of whether they take too optimistic a view of their initiatives in terms of recruitment ! The fact is that for a certain number among them, the recruitment policy pursued probably relies on a series of initiatives scattered here and there which do not necessarily fit into a coherent and perfectly organised whole.
- It is also found that a not insignificant proportion of Universities saying they do not pursue an active recruitment policy (one quarter of the 18% who are in this position, or 5% of the whole) assert at the same time that they do this deliberately since they have enough or too many students (this is the case, for example with an Italian University which has almost 100,000 registered students).
- In essence, the actions making up these active recruitment policies can be pulled together under two main headings. Under the first heading we find actions of the marketing type (in particular international), actions with press and public relations, the setting-up of exclusive links with schools and lycées. The second heading covers actions of particular interest such as improving the service to students, the creation of new syllabi (notably on especially attractive courses) or again the reorganising of courses.Thus the Universities work on their attractiveness both by communicating more and better (at least one action of this type is cited in 80% of cases where Universities quote examples of their recruitment policy) and by systematically developing their range of courses and their organisation (at least one action of this type is cited in 60% % of cases where Universities quote examples of their recruitment policy).
- Finally it is seen that 10% of the total number of Universities in the sample include recruitment of students abroad within their recruitment policy. It is clear that there is a slow trend here which is in the process of being initiated and which must be put side by side with the globalisation of recruitment of young Engineers by industry. This capacity for recruiting abroad (and therefore being known there and being attractive) is undoubtedly one of the issues which Engineering Universities must come to terms with in the years to come.

It is clear that the relative lowering of regulatory barriers can only contribute towards reinforcing this trend.

1.2.3. Desperate search for young women. The position of young women appears high on the list of objectives of recruitment policies and at the heart of the issue of student engineer recruitment pools.

Their under-representation on Engineering courses is unanimously (or almost unanimously) deplored by Universities: 95% of them think there should be more girls on Engineering courses (against 5% who think there are enough or too many of them...these 5% referring to Universities in countries where the status of women is rather different from what it may be elsewhere).

We may add that 10% of Universities in the sample place recruitment of more women as a high priority objective - and do so in spite of the fact that 60% of them identify a slight advance in the opening up of admissions to women as against 30% who note a certain stability in this area.

Young women are sought at this stage for 5 main reasons (which together make up about 15% of unsolicited comments):

- They are thought to be universally more mature and more serious than boys ... in short, they would be on average, better students.

- Young women would enrich the engineering profession, because of regard for the way it is pursued, the career approach.

- On quite another track, the emergence of certain sectors “more suitable” for young women (chemical, new technologies...) would bring down the last barriers likely to stand in the way of their playing their part as Engineers.

- In a more non-specific and political sense, Universities also cite concerns about being fair and reflecting demography.

- Finally the last reason given takes us back very directly to the issue in the title of this paragraph: young women form a substantial and relatively unexplored recruitment pool.

1.2.4. Going up and down: the paradoxes of standards. If Universities are to be believed, a higher proportion of young women would help to raise the standard of future Engineer intakes.

This question of the standard of students leads to rather contradictory responses. In fact, 24% of Universities in the sample think that the standard of students is the same as it was ten years ago against 35% who think it is slightly or definitely higher and 39% who think it is slightly or definitely lower.

We cannot do more than take note of this contradiction, providing however three further items which may perhaps in part shed some light on it.

- About 20% of Universities in the sample have a pessimistic vision of the Engineer's career, believing it to be in stagnation or decline (80% thinking on the contrary that it is moving ahead and that it leads to brilliant and interesting careers)[3]. It so happens that there is some correlation between the pessimistic view of the Engineer's future and the drop in standard of students considering joining the profession. There would appear to be then a certain rump of Universities (or academics) who today have an pessimistic overall view of their environment and their mission.

- More basically it is possible to feel that Universities do not always mean the same thing by the notion of standard. Some of them have a rigorous view centred on the purely academic abilities of students; others include wider values relating to skills such as adaptability, leadership, sense of initiative... One cannot therefore exclude the possibility that the standard rises or falls depending on whether one adopts the first or second definition of "standard"... We may add in concluding this point - without trying to make connections that are less than perfect - that Universities associated with the "migrant" profile tend to cultivate a wider sense of the notion of standard for their students'. This observation shows, if proof were needed, that the division made above between the Universities on the "migrant" pattern and Universities on the "established" pattern is one which separates (or unites) Universities on numerous criteria, echoing very widespread ideas on Engineers, their profession and their training.

- Finally it can be noted that Universities have very different ideas on rigour of selection. This question is summed up by the three parameters 25%, 50%, 25%: 25% of Universities select at entry, 50% only select during the programme of studies (to varying degrees) and 25% select both at entry and during the programme of studies.

1.2.5. Motivation. Of course, the question of the student recruitment pool and recruitment policies developed by Universities passes on to that of student motivation. We suggested 6 exclusive options (certainty of having a job, liking for science and technology, growth of the sector and the profession, opportunity to take on responsibility, opportunity to get into management posts, worthy nature of the subject) and a space for any open-ended suggestions.

[3] We may note that 40% of Universities in the sample support the notion of a state-of-the-art sector - which for them means, in order, telecommunications, computer science, electronics, environmental science, biotechnologies and nanotechnology - and feel that these state-of-the-art sectors are having a very positive impact on the Engineering profession which they are helping to enhance. We may add that these sectors are areas where Universities often take up positions when they are seeking to increase their attractiveness

The results are of particular interest as “liking for science and technology” and “certainty of having a job” come mostly grouped together at the top well ahead of the developing nature of the sector and the chance to take on responsibility, then further back still, the opportunity for management and finally in last position (mostly) the worthy nature of the subject.
Space does not allow individual motivations to be identified (would the Universities in any case not be informed on the motivations of students or would those we had suggested be relevant ?) except perhaps “image of the profession” or “excellence of students” which would be best represented in Engineering.

This result calls firstly for two comments.

- The “chance to take on responsibility” item is the one which produces the widest differential (gap) in its assessment. Put in black and white, it is a “very important” motivation according to some Universities and “secondary” according to others. This unevenness quite obviously relates to the two major patterns we identified in the first section. It is thus no surprise, given this, that the item coming second in terms of unevenness of response is “opportunity to manage”. If we wanted to be provocative, we might also say that the Universities see students in the way that they train them !

- From another point of view, it is interesting to note that the two motivations listed at the top appeal both to “reason” (certainty of having a job) and “emotion” (liking for science and technology).

1.3. The International Aspect

• In training Engineers, the idea of “international” relates to two different problems: that of learning foreign languages and that of periods of work experience spent abroad by students during their studies.
On these two topics, the results of the survey are especially interesting and show clearly that if the international aspect is becoming a real objective for some Universities, there is still a long way to go.
However we find a comparative imbalance here with the expectations of industry - which - according to surveys we have conducted elsewhere - particularly promote this global aspect both from its “linguistic” angle and the angle of “work experience abroad”.

1.3.1 One language, two languages, three languages... The issue of foreign language study remains a very “surprising” topic.

Indeed if this study is regarded as being “important” in training (it comes just after learning to work in a group) it is on the other hand only placed 9th out of 12 in the list of expectations of industry. We can add that as far as learning a second foreign language is concerned, it is regarded as “secondary”.

This result is “surprising” because it is seemingly at odds with the expectations of industrial firms, particularly European ones. In truth it deserves to be refined.

- Assessment of the importance of mastering a foreign language in the expectations of industrial firms gives rise to the widest difference, dividing between “essential” and “secondary”. On further examination it is no surprise to observe that Universities regarding the foreign language study as “secondary” are English-speaking Universities (Australian, American, New Zealand...for the most part British).
  We may however note that with some of these English-speaking Universities (essentially in the United Kingdom and the United States) there is the dawning realisation that learning a foreign language is a necessity (in order not to deprive their students of competitive advantage alongside young non-English speaking Engineers - who therefore speak another language - but who have perfect command of English).

- The secondary nature of learning a second foreign language also produces a very wide discrepancy: nearly 10% of Universities regard this study as important... the others consider it to be of secondary or negligible importance. This score is of course still very low but probably is the expression of the start of a real trend.

- The fact is that the range is still very wide between Universities who neglect the teaching of a foreign language and those who maintain that from now on it is important to have command of two.

1.3.2. The luxury of a period abroad. The scattering we have just noted is even more pronounced when we look at periods of work experience spent abroad.

Indeed the raw results of the survey are particularly revealing: not more than 20% of future Engineers spend at least one period abroad as part of their courses (whether it is a period of study or work experience) with the furthest limits ranging from 3% to 90%.
Similarly the average length of stay is short, being of 4 months (with limits going from 1 month to 12 months and a very high concentration on a period between 2 and 3 months).

- It is patent that in this area we have a particularly high factor of non-uniformity (and deriving from disparity). It is interesting to follow in this area the growth of demand from industry and the extent of the competitive advantage young Engineers will enjoy who have a strong international profile.
- Whether a sincerely-held perception or one in line with the limits of what they are able to do, Universities place international experience 10th out of 12 among what they say are the expectations of industry concerning young Engineers. Here is a very big discrepancy (the second in order of size) which clearly shows that this topic is a subject of controversy between the Universities.
  But this time - and in contrast to the study of foreign languages - there is not the united bloc of English-speaking Universities on one side and the rest on the other. The positions are much more subtle and reflect - with a high level of consistency - the division we made between the “migrant” pattern and the “fixed” pattern.

1.4 Work experience, industry and management

• The links between Engineering training and the economic world are multidimensional. We have adopted three as part of the survey: work experience in industry, teaching of management and, in another area, research contracts concluded with industrial firms. Under these three headings the survey reveals disparities which have confirmed those we identified above.

1.4.1. Work experience: from nothing to actual work-based training. The fate of industrial work experience in Engineering training is rather “surprising”, mimicking what was seen in the case of international experience.

In the first place the raw results show extraordinary differences since periods of work experience represent on average between 10 and 15% of the total time for training (which is, when all is said and done, rather little: between 4 and 5 months for 3 years of training and about 8 months for a 5 year training period) with very significant limits ranging from 0% of training time to 50% (especially in the case of studies on the French or Canadian model).

Behind this disparity there are fundamental differences in the interest shown in work experience. Indeed “industrial experience” is placed in 4th position in the expectations of industry, but with a fairly big spread. Similarly it is noted that if 20% of Universities feel that their students’ industrial experience is insufficient, about 15% think that the value added of industrial experience is low in many cases. We may also add - still following through the differences - that some Universities think that 3 months’ industrial work experience is sufficient for four-year training whereas others find 6 months too little for a five-year course.
It is evident that this examination of work placements takes us back to the main patterns identified above.

- We should also add that some Universities (5%) deplore their lack of success in setting up work placements and thus explain their low score not through choice but as a result of constraint.
- We may add finally that several Universities (which are highly representative in geographic terms) identify the sustained demand from students to have more consistent industrial work experience.

1.4.2 Management studies. In certain respects the angle on subjects other than purely scientific and technical ones and especially on management studies follows to some extent the fate of industrial placements.

Once again, the figures are particularly eloquent. 35% of Universities in the sample state that management plays an “important” or “very important” part in their programme of studies against 25% for whom it only plays a modest part at 41% for whom it plays a minor or very minor part (or too minor in about one-third of these last cases).

On average, management studies occupy 15% of the total teaching time with boundaries between 3% and 45% - the whole being very uneven and very inconsistent.

Two comments which are now clear in the light of all that has been described above:

- The place given to management studies is one of the indices characterising the patterns which have already been extensively described. A very high level of correlation is to be found between the amount of teaching devoted to non-scientific and non-technical subjects and association to one of the two major patterns (in other words, a large amount of time spent on this teaching is generally accompanied by industrial work placements, periods spent abroad, leadership training - we shall come back to this issue later) ... and other factors which are features of the migrant pattern.
- Universities have such very different approaches and views in these areas that they ceratinly do not fit the same realities to the same words. Thus, for example we found under the description “important part” or “very important part”, levels of 10%, 15%, 35%, 20%, 45%, 5%, 10% and under the description “minor part”, levels of 10%, representing 3%, 15%, 20%, 5% of the total amount of teaching time.

1.4.3. The unknown factor of research contracts. Research contracts - apart from the resources they may bring in - are also a means of forging links between industry, the business world and Universities and at least indirectly - of bringing students into association with very practical experience.

Our survey - we must admit, though it is in itself instructive - tells us rather little about this issue. Once again, we find that Universities do not necessarily put the same name to the same thing.. Thus, 75% of them think that research contracts are "essential" or "important", but 35% give details of their activities in this field (and we have every reason to believe that this silence is not explained (at least for a certain number of them) merely by reasons of confidentiality.

- In any case, this is the largest "discrepancy" informing the question. Two examples: annual receipts in connection with research contracts would be from $0 to $25 million (fortunately Canadian, in cash !). Also, the "lecturer time" spent on research contracts is on average 20% of total lecturer time (against 52% on teaching, 20% on "classic" research and 8% on admin) with such large variations that they make the spread of these data lose much of their force.
- Here the level of correlation with the patterns is weaker since the issue of "standard" place a major role...some Universities belonging to the "fixed" pattern will have a large number of research contracts with industrial firms particularly if they are top level...but in these cases the students will have very little connection with them or none at all.

1.5 Teaching methods

• Teaching methods will not delay us for long. In fact the survey cannot cover more than a few basic notions. To that extent it is perhaps a fair reflection of the place still held by the issue of teaching methods in a good number of Universities.

Two basic pieces of data illustrate this introductory remark. 84% of Universities regard teaching methods and innovations in teaching as being very important (49%) or important (34%) against only 14% who regard them as not very important or unimportant . However when it comes to giving examples of new methods of teaching, only 30% of Universities responded, and often by quoting very classic "innovations" (project work, group work, multi-disciplined approach...)

- Average lecturer time spent on teaching no doubt supplies a partial explanation of the relative low position of innovation in teaching methods - but one should be very careful here since innovative teaching is also the result of specific resources, and organisational factors.
- 15 to 20% of Universities however describe new teaching aids (computer simulations, the internet, distance-learning, CD Roms ...) which in essence directly or indirectly tie up with the idea of self-directed learning.

- It is also noted that innovative teaching methods are significantly more often to be found in the "migrant" Universities than in "attached" Universities, where they enable students to be opened up to a greater number of approaches.

- A last comment, finally, on the fact that one can detect the emergence of an actual trend towards being concerned with creative teaching methods within Universities. These innovative teaching aids - and the more global approach to teaching - probably constitute one of the competitive advantages to take on board in future years.

1.6 Skills

• Under this heading we are placing the skills which, according to the Universities, are sought by industrial firms in young Engineers. We suggested 12 skills in closed-response questions and we left a blank space for giving others. The raw results must be delivered in their entirety before making them the subject of comment.

1.6.1. Raw data. The 12 skills suggested in closed-ended questions were listed in the following order:

- ability to work in a group;
- scientific and technical skills;
- adaptability;
- industrial experience;
- ability to direct, to manage;
- creativity;
- multi-disciplinary scientific training;
- practicality;
- command of a foreign language;
- international experience;
- very specialised scientific training;
- prestigious degree.

• We may add without it coming as a surprise to anyone that the skills with the widest differences (which are thus the most unevenly spread) are: ability to direct / manage, practicality, international experience, command of a foreign language...the same skills that characterise the migrant profile (particularly the ability to direct and manage).

• The blank space itself also did not yield any major surprises. Those which significantly were quoted spontaneously: ability to communicate (only mentioned by "migrant" type Universities), the ability to continue undirected learning (mentioned almost always by "migrant" type Universities).

1.6.2. Remarks. In conclusion of the analysis we have conducted, these results speak for themselves. They only call for three quick comments.

- If we check them against different surveys we have been able to carry out with European industrial firms or large “multinationals”, the expectations of industry (setting aside the question of languages and international experience) are fairly well appreciated by Universities who, nevertheless, do not always draw all the conclusions.

- Common to both patterns are team-work, adaptability, thorough scientific and technical training, creativity... peculiar to the “migrant” pattern (at the risk of oversimplifying a little) are industrial work experience, being abroad, ability to direct, manage, practicality ... peculiar to the “attached” pattern (again at the risk of oversimplifying) and depending on the case multidisciplinary training and/or very specialised training.

- Finally - and this comment qualifies the one above - a tendency for Universities sometimes to perceive the expectations of industry and more generally their environment in terms of the ideas they have of the Engineer and by taking into account the constraints and the cultural heritage which belong to them. From this point of view, the ability to respond to expectations whilst preserving their authenticity, the ability to produce different complementary profiles fitting into all patterns is certainly another of the major issues which Engineering Universities will be faced with.

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