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Industrial Attachment Programme in Engineering: the NTU Experience

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The paper describes the conceptualization, development and implementation of an industrial attachment programme in engineering, starting with the first batch of 564 engineering undergraduates in 1984 through to the present batch of more than 1,500. The issues addressed include: looking for such a large number of placements, structuring the practical attachment programmes and matching these to the right students, monitoring and assessing the students' work performances and managing these relationships in industry.

INTRODUCTION

CO-OPERATIVE education is a particular programme model based on the broad concept of education known as experiential learning. Experiential learning involves learning through active involvement in what is being studied in order to acquire direct experience with the subject matter, rather than just reading or hearing about it. It is a plan designed to enhance self-realization by integrating classroom study with planned and supervised experience in professional learning situations outside the formal classroom environment. This form of education is known as sandwich education in the UK. To provide students with these learning opportunities, the Nanyang Technological University (NTU) has developed an industrial attachment (IA) programme for its three Schools of Engineering and the School of Applied Science.

This paper describes the NTU's experience in developing and implementing the IA programme. Statistics and feedbacks from students and industry and future plans for the programme are also presented.

OBJECTIVES

The IA programme is included at the end of year 2 for applied science and year 3 for engineering students. It requires them to undertake a 24–week industrial attachment. The main objectives of the IA programme are for students to achieve the following:

- To apply the acquired professional knowledge and skills in actual planning, design, production, construction or operation/maintenance.
- To gain first hand knowledge of the day-to-day operations in the engineering profession.
- To acquire hands-on experience of working with people.
- To learn about problems and requirements of industry, leading to the choice of specialization in their final year of study.

The IA programme also enables the University to be better informed of the problems and requirements of industry. In addition, involvement in the IA programme provides an excellent opportunity for the academic staff to interact with industry and to keep abreast with technological developments. This can also lead to consultancy services and/or develop potential final-year project proposals to be undertaken by students.

DEVELOPMENT OF THE IA PROGRAMME

The first IA programme was introduced in January 1984. Planning started a year earlier to prepare for its launch, and an Industrial Liaison Unit (ILU) was set up in January 1983. An Executive Committee, the Industrial Attachment Steering Committee, chaired by the Head of the ILU and comprising members from each of the three Schools of Engineering was formed. The tasks of the committee were to conceptualize, implement and manage the IA programme.

The Committee drafted out an IA proposal which was submitted to the Academic Committee for approval. After the proposal had been accepted, several sessions were held with staff members of the three Engineering Schools to brief them on the IA system and to gather feedback to fine-tune the details.

During the development stage, the Head of the ILU visited Australia and the UK to study the sandwich systems and co-operative systems being practised in some of the universities and institutes in those countries. He also visited organizations in local industries during this stage. Press and television publicity on the proposed IA programme were promoted. A one-day forum titled 'The Benefits of a Co-operative Programme' was held in September 1983. Two hundred industrialists attended this forum.

In developing the IA system the following questions have been addressed:

- Long or short duration of attachment?
- Compulsory or optional attachment?
- Structured or unstructured attachment programmes?
- Remuneration for work—salary or allowance?
- Pass/fail or grading system?
- Student or employee status?

Long or short duration of attachment?

The NTU studied the 3-month attachment programme offered by the National University of Singapore (NUS) and the 6-month or longer attachment of overseas universities. It finally decided to opt for a 6-month attachment for the following reasons:

- Industry feedback on the 3-month attachment programme was that it was too short. It requires 1–2 months to train a student and by the time the student could handle the job, he or she was getting ready to go back to university.
- A duration longer than 6 months would impose a financial and training resource burden on industry which might discourage them from participating. Another reason is that a longer duration could mean a possible increase in the number of years of study before graduation. This is unacceptable to the students when compared to the number of years of study required by the NUS or other universities, especially for male Singaporeans who are required to complete two and a half years of national service prior to entering university.

Compulsory or optional attachment?

In line with the objective of the NTU to prepare its graduates for more effective roles in industry immediately upon graduation, the IA has to be compulsory for all engineering and applied science students. This programme would also be helpful in gaining recognition of the degree by the various professional institutions in the UK.

Structured or unstructured attachment programmes?

The NTU decided to opt for structured attachment programmes for the following reasons:

Structured attachment programmes allow the NTU to assign staff to review and evaluate them before they are offered to the students. It would also be possible to arrange for staff to supervise programmes where the nature of work matches their background and expertise. The staff can brief as well as bring to the students' attention any special prerequisites of the attachment programme—software language knowledge, industrial engineering knowledge, etc.—prior to the training. In addition, if organization supervisors are willing to spend time on developing such a programme, it is also a testimony of their commitment to the programme.

Remuneration for work—salary or allowance?

It was decided that students be paid an attachment allowance by their organizations during their attachment instead of salary so that organizations need not apply for work permits for foreign students and also need not pay payroll tax or contribute to the employee's Central Provident Fund. This would encourage organizations to offer attachment placements to students.

Pass/fail or grading system?

Both pass/fail or grading systems were contemplated. Each system has its own strengths and weaknesses. A pass/fail system largely eliminates subjective assessments but it does not positively motivate. On the other hand, a grading system is difficult to implement in view of the diversity of organizations involved as well as the number of staff involved in the assessments, both from the organizations and the NTU. But it motivates students much more positively. After much consideration and discussion, a grading system was adopted.

Student or employee status?

In order to make the attachment training more realistic so that students can be asked to shoulder responsibilities befitting a trainee engineer, organizations have been requested to treat students as 'temporary' employees during their attachment. Students are to observe all rules and regulations pertaining to the organizations they are attached to.

THE CURRENT ATTACHMENT PROGRAMME AND ITS IMPLEMENTATION

The current 24-week IA programme commences in January and terminates in mid-June.

Evaluation and selection of programmes

Organizations perceived to be able to provide the required type of attachment training for our students are invited to participate in the IA programme. Interested organizations are required to indicate the number of training placements and proposed training programme(s) intended for the students. All proposed training programmes are to be reviewed and evaluated by our staff members

from the four Schools. In general,programmes are considered acceptable if they satisfy the following criteria:

- Provide exposure and professional experience in an engineering/applied science environment.
- Provide management experience to make students aware of the responsibilities and daily routines of a practising engineer/technologist.
- Provide hands-on experience, e.g. projects, assignments.
- Provide professional guidance in the form of an industrial supervisor assigned to each of the student.

Matching of students/staff to programmes

A list of accepted programmes and organizations involved is made available to the students, who then have to indicate nine choices in the order of their preference. The allocation of students to organizations is done using the University's VAX computer system and based mainly on the students' choices.

Allocation of academic staff to supervise the students is carried out by the same computer system. Preference is given to staff who evaluated the programmes of the organization, followed by those who have the relevant expertise and/or previous involvement with the organization concerned.

Monitoring and assessment of students

Staff appointed as academic tutors visit students at the organizations monthly to monitor the students' progress and take any necessary corrective action. On three of these visits, the NTU staff will also carry out the following assessments in conjunction with the organization supervisor:

- Progress Report and Logbook Assessment (includes oral interview)—during the oral interview, the staff is expected to let the students know their progress and their strengths and weaknesses so as to give them an opportunity to improve.
- Assessment of Work in Organization—among other things, the student's practical ability, communication ability, work attitude, personal discipline, initiative and his/her quality of work will be graded.

At the end of the attachment, students are also required to submit a written report to their NTU staff for assessment.

Using a system of weights and rationalization on the above three areas of assessment, a final mark, and hence grade, is awarded to each student. A pass in the IA is a necessary prerequisite for the students to proceed to their final year of study.

PLACEMENT STATISTICS FOR THE ENGINEERING/APPLIED SCIENCE SCHOOLS

A total of 135 organizations participated in the first IA programme in 1984 for 564 engineering students. The School of Applied Science was included in this attachment programme in 1991. To date, the attachment programme has grown to a network of more than 800 organizations, and more than 8,500 students have completed this programme.

Figure 1 shows the number of placements offered by organizations and the student population for the three Schools of Engineering and the School of Applied Science in the past 10 years. It is noted that there were always more placements offered than the number of students available.

ATTACHMENT ALLOWANCE

The allowance was conceived to cover the student's out-of-pocket expenses for the period of the attachment rather than a payment for the work done by the students. This allowance was pegged initially at a base rate of S$250 per student per month with no ceiling.

To assist the tertiary institutions in Singapore to get enough placements, the Government, through the Economic Development Board, provided grants to organizations for providing attachment training, to cover up to 90% of the allowance paid to students, to a maximum of S$225 per student per month with the rest out of their own fund. However, some companies pay more than the base rate specified. It is noted that about one-third of the civil and structural engineering students received more than S$250 in the first four years [1].

In 1988, the Government discontinued the grant. As a result, a number of small organizations decided to drop out of the programme while others reduced the number of placements offered. To avoid the possible shortage in placements, more organizations were invited to participate in the programme and the loss in placements was more than made up.

At the University's request, the base rate for all Government organizations and statutory boards was raised from S$250 to S$350 in 1992. Many private organizations have noted the increase and have made suitable adjustments to the allowance.

As shown in Figure 2, which shows the statistics of attachment allowances received by students in years 1992–1994, the number of organizations paying more than the base rate specified is increasing.

FEEDBACK

Feedback is solicited from organizations and students at the end of each attachment. Students

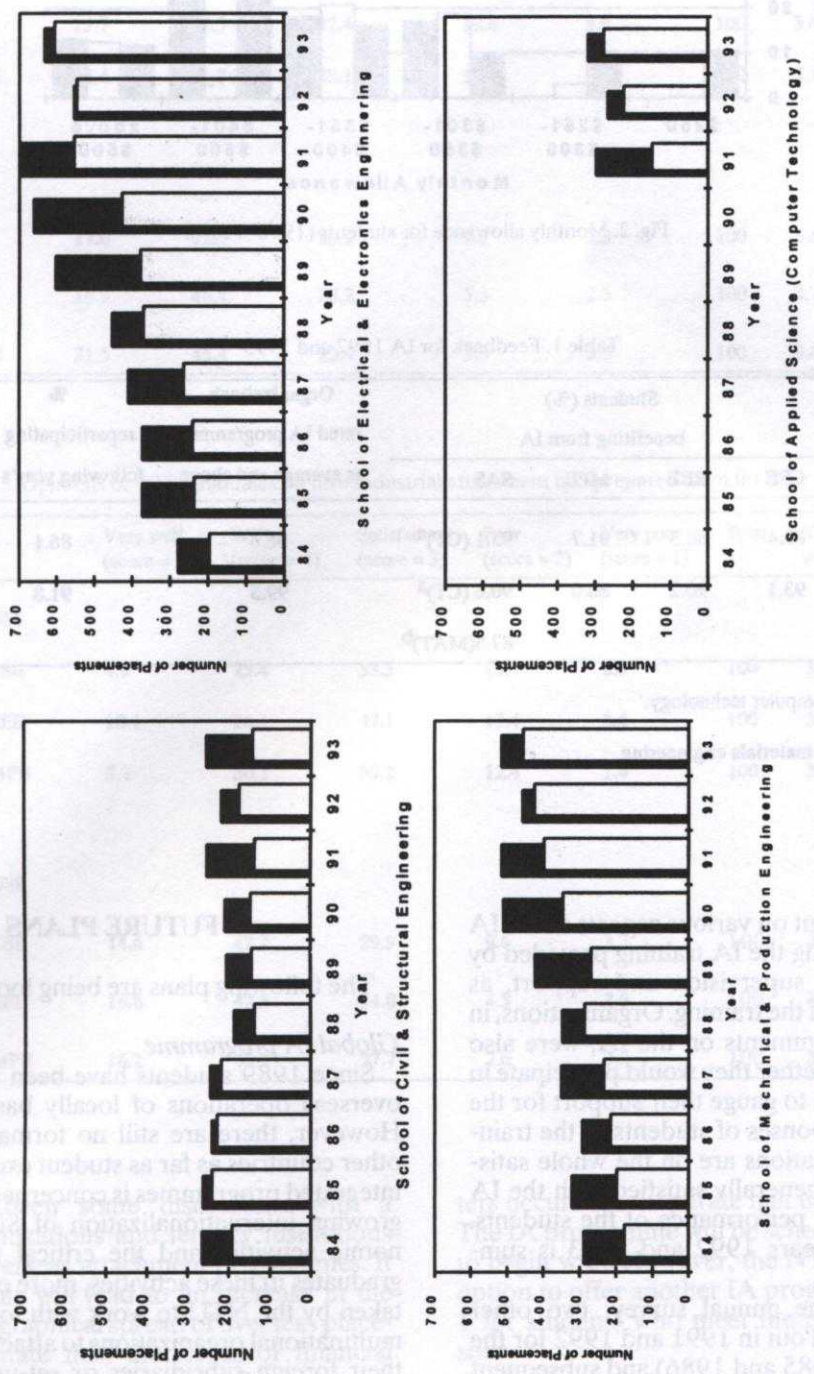

Fig. 1. Placements offered and student numbers.

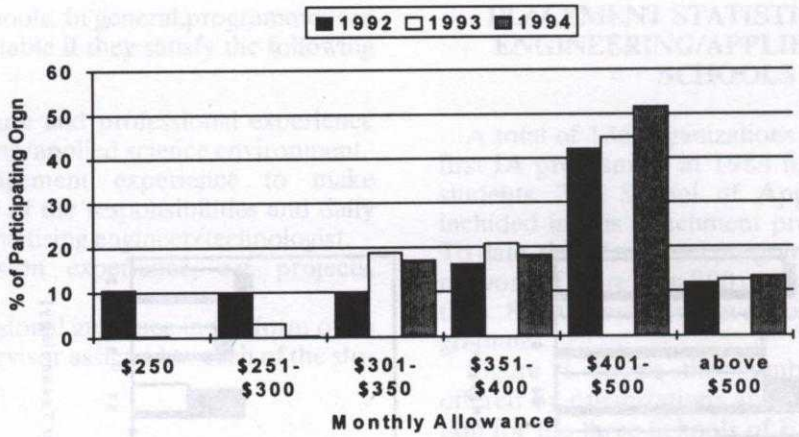

Fig. 2. Monthly allowance for students (1992–1994).

Table 1. Feedback for IA 1992 and 1993

Year	Students (%) benefiting from IA				Organizations rated IA programme as average and above	% reparticipating in following year's IA
	CSE	EEE	MPE	SAS		
1992	88.4	88.3	91.7	95.1 (CT)[a]	98.6	86.1
1993	93.1	90.2	88.0	90.6 (CT)[a]	99.5	91.8
				87.5(MAT)[b]		

[a]CT, computer technology.

[b]MAT, materials engineering.

are asked to comment on various aspects of the IA programme, including the IA training provided by organizations, their supervision and support, as well as the benefits of the training. Organizations, in addition to their comments on the IA, were also asked to indicate whether they would participate in the next programme to gauge their support for the following year. Responses of students to the training with the organizations are on the whole satisfactory. Industry is generally satisfied with the IA programme and the performance of the students. The feedback for years 1992 and 1993 is summarised in Table 1.

In addition to the annual survey, two other surveys were carried out in 1991 and 1992 for the first two batches (1985 and 1986) and subsequent two batches (1987 and 1988) of engineering graduates respectively. They were asked to comment on how well the IA had prepared them for their first job and subsequent career.

As shown in Tables 2 and 3, about 85% of the respondents indicated 'satisfactory or above' in both surveys.

FUTURE PLANS

The following plans are being looked into.

Global IA programme

Since 1989 students have been attached to the overseas operations of locally based companies. However, there are still no formal linkages with other countries as far as student exchange on work integrated programmes is concerned. In view of the growing internationalization of Singapore's economic activities and the critical role played by graduates in these activities, more efforts are being taken by the NTU to work with local and foreign multinational organizations to attach its students to their foreign subsidiaries or set-up for whole or part of the attachment period.

Reciprocal exchange programme

The NTU is seeking bilateral arrangements with reputable overseas tertiary institutions in an exchange of students for attachment to organizations participating in the respective institution's attachment programmes.

Table 2. Opinions of NTU graduates on how industrial attachment had prepared them for their first job (%)

Year	Very well (score =5)	Well (score = 4)	Satisfactory (score = 3)	Poor (score = 2)	Very poor (score = 1)	Total	Weighted mean score
1985/86							
CSE	8.3	29.0	52.4	4.8	5.5	100	3.3
EEE	15.7	27.5	42.4	10.6	3.8	100	3.4
MPE	14.4	31.7	38.1	11.9	3.9	100	3.4
1987/88							
CSE	17.0	42.5	28.1	9.2	3.3	100	3.6
EEE	18.9	46.4	27.2	5.3	2.3	100	3.7
MPE	21.5	46.4	23.4	5.3	3.3	100	3.8

Table 3. Opinions of NTU graduates on how industrial attachment had prepared them for their career (%)

Year	Very well (score = 5)	Well (score = 4)	Satisfactory (score = 3)	Poor (score = 2)	Very poor (score = 1)	Total	Weighted mean score
1985/86							
CSE	4.9	25.4	53.5	13.4	2.8	100	3.2
EEE	10.1	26.1	47.1	13.4	3.4	100	3.2
MPE	5.7	30.1	50.2	12.4	1.4	100	3.3
1987/88							
CSE	14.6	42.7	29.9	9.6	3.2	100	3.6
EEE	16.6	42.3	34.0	4.5	2.6	100	3.7
MPE	16.2	45.2	27.7	7.6	3.3	100	3.6

There have been some discussions with a number of organizations and tertiary institutions on the above overseas attachment programmes. It is hoped that this will lead to an increase in the number and geographical spread of overseas placements. To facilitate this, the issues of financial support, visas, medical insurance, airfares, accommodation, for both local and foreign students, will be sorted out with our foreign partners and local authorities.

IA programme per semester

The NTU will be implementing a new two-semester academic unit system starting from academic year 1994/95 [5]. Each of the two semesters occurs on a separate half of the calendar year. The IA programme will be scheduled in semester 2 to begin with. However, the NTU leaves open the option to offer another IA programme in semester 1 for students who meet the necessary prerequisites.

CONCLUDING REMARKS

For the past ten years the NTU has managed very successful attachment programmes with local industries. The statistics and survey results presented in this paper are indicative of the approval of the IA scheme by students and industry

alike. They have reaffirmed the important and complementary role the IA has played in preparing students for the world of work. By participating in the attachment programme, organizations also develop a close working relationship with the University which often leads to other areas of co-operation. This has definitely help to strengthen the NTU's link with industry, which is important if the University is to realize its vision of becoming the university of industry and business.

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