



TECHNOPRENEUR-21: A PROGRAM THAT COMBINES ENGINEERING INNOVATION WITH BUSINESS ACUMEN TO FOSTER ENTREPRENEURS

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A training program has been introduced into the engineering curriculum to foster entrepreneurship in students through hands-on experience at creating innovative products and services, and developing the business plans to market them. The T-21 program includes an intense immersion in the fundamentals of small business start-ups and a competition judged by successful self-made players and investors on the commercial viability of such enterprises. It has created a noticeable change in perception of the students towards venturing out on their own upon graduation. The program complements Singapore's drive to promote high-tech start-ups as the key to powering the knowledge-based economy of the future.

Introduction

Singapore is a small city-state that relies heavily on its human resource. The direction she has taken to meet future challenges is to leverage upon its highly trained manpower resources being able to plug into the new knowledge-based economy. The Nanyang Technological University (NTU) is the younger of only two universities in Singapore with engineering degree programs. It has achieved great strides in engineering education producing graduates that can compete with the best in the world. However, looking to the future, it is mindful that success in the new global economy demands from the engineering graduate not only technological competence, but also the critical ability to apply this in creating value for the employer, for a self-venture, and ultimately for the consumer.

To cater for this future need, the School of Mechanical and Production Engineering at Nanyang Technological University initiated a training program in 1999 to promote engineering entrepreneurs called Technopreneur-21, which stands for technological entrepreneur of the 21st Century. The program, nicknamed T21 for short, aims to give all students of the School some experience at using technology to create products and services in a market-driven business environment.

Background

The T-21 program preceded by a couple of months Singapore's big push to put in place changes which will transform the economy of the city-state to one more conducive for high-tech start-ups, in the belief that the 'Silicon Valley' model is the key to powering the economy in the future. (Forbes, July 3, 1999) These changes include revision of bankruptcy laws to lessen the stigma, the way in which stock options are taxed, and especially the relaxation of rules to allow the use of government subsidized public housing as registered business addresses. The last may appear trivial to many countries, but viewed from the

perspective that over 70% of the population live in high rise apartments there is hardly any opportunity for a small business starting its operation out of a garage.

The roots of the problem however lie much further back, in the education system and the value placed by the population on jobs and careers. In the first three decades since independence, the focus of the education system has been to channel the best and the brightest into professional disciplines which, it is believed, will provide relatively high salaries and lower risk jobs with major employers. Those who choose to go into business on their own are regarded as drop outs of the school system. As our Deputy Prime Minister puts it in another article (Forbes, Nov. 29, 1999), "You can't will entrepreneurs into existence, but you can create conditions that encourage people with drive and imagination and ideas to try and go for it.... In the schools and our education system, we need to give people the opportunity at a very young age to learn, to explore, to go beyond what is in their books and think for themselves. And having done well, you don't have to drop out of school in order to become an entrepreneur".

While this process must permeate all levels of the education system, the university is obviously one of the most important places where such ideas can be tried and tested. Even so, it is necessary to consider its impact on the traditional technical training that the engineering student receives.

Motivation and Preparation

The engineering curriculum at NTU comprises a comprehensive four-year program, with a common freshman year, substantial core subjects requirement for each discipline, a 6-month industrial attachment in the junior year, and selected majors in the senior year (Table 1). Where in this packed program can you built in the

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Table 1: Engineering Curriculum at NTU

Freshman 1 st Year	Common Engineering Course			
Sophomore 2 nd Year	Semester 1	Inter- Semester	Semester 2	IHPT (T-21)
Junior 3 rd Year	Semester 1	Inter- Semester	Industrial Attachment	
Senior 4 th Year	Semester 1	Inter- Semester	Semester 2	

‘entrepreneurship’ training? For the engineering student, one of the core components is an 8-week In-House Practical Training (IHPT) conducted at the end of the sophomore year. The intent was to equip them with hands-on skills such as workshop practice, computer-aided drafting and design, control system assemblies, and various specialized modules such as engines, hydraulics, etc. With the current focus on a ‘knowledge-based’ economy, it is felt that we need not train every engineer on all the skills he is likely to encounter. Instead, we place him in life-like situations and assess him on the ability to ascertain what is required and make available the means for him to acquire the necessary skills to handle these situations. Thus the T-21 program was mooted as a replacement for the traditional IHPT program. The students are still required to produce a technologically viable piece of work, but is made to realize that alone will not ensure the success or otherwise of the product.

Putting together such a program for a cohort of about 600 mechanical engineering students each year is a major exercise. Not only is it necessary to organize the students so that they can have access to facilities, resources and funding, but the organizers have also to change the mindset of about 140 lecturers, who have act as mentors to the student groups in areas often outside their specific expertise. A partnership with the Nanyang Business School (NBS) enables us to quickly equip our engineering students, and many of our engineering staff, with the essential business fundamentals necessary to start and operate a small venture. In order to bring a sense of realism into the training exercise, we also obtained the involvement of external practitioners, such as investors, employers and successful small business start-ups themselves. They are retained as advisors, speakers and judges for the program.

The Program

Primary components of the program are as outlined below.

1. Grouping. Students form groups of eight to ten members, and are encouraged to structure themselves like a small start-up company. They may engage outside help, e.g. students from other schools or establishments, as long as they declare this. The groups are expected to hold regular discussions with their mentor(s) (faculty members of the school) during the course of the project which includes brainstorming for ideas, choosing viable projects, pricing policies, discussing technology issues, business and marketing strategies.

2. Talks and Forums are held over the first three weeks. The topics for the talks, given mostly by the NBS staff, include Ideas Generation, Law, Finance, Marketing, Management, Business Strategy, Preparing a Business Plan,

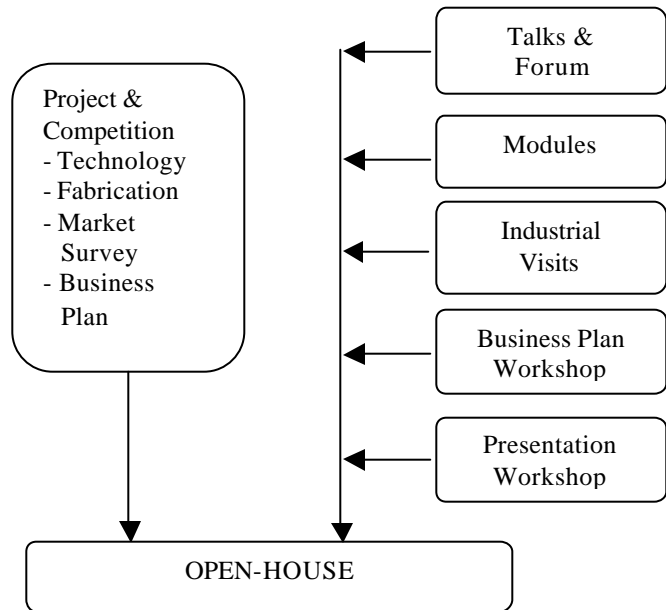


Figure 1: Structure of the T-21 Program

and Demand assessment and Forecasting with emphasis on high technology oriented products. Lectures were also given on, Intellectual Property Protection, Managing a Business and Regional Markets by invited guests from industry and the private sectors. Case Studies on some successful entrepreneurs in the engineering and high technology industries, from Singapore and abroad, were also presented. The forums are conducted mostly by external parties such as venture capitalists, successful start-up entrepreneurs, and representatives of national bodies that have schemes to promote entrepreneurship, brings them into direct contact with the students, with an opportunity for discussions and for questions and answers.

3. Industrial Visits and Workshops. To enable students to appreciate how a company operates, the functions of various departments and the product development process, industrial visits are organized to relevant companies. These range from large multi-national corporations, where job functions are well-defined, to small start-ups operated by only a few staff, each undertaking a variety of functions. Each group also attend two formal workshops covering ‘How to write a Business Plan’ (in the 4th week) and ‘Effective Presentations’ in the 6th to 7th week.

4. Project Category/Competition. As an incentive, the program is organized like a competition. For further guidance and focussing of their energies, the groups may choose to participate in one of six categories of the competition. They are:

- (i) Biomedical
- (ii) e-commerce
- (iii) Information Technology



- (iv) Miniaturization/ Portability
- (v) Green Technology
- (vi) General (others)

Prizes, sponsored by local engineering conglomerate Singapore Technologies Engineering Ltd, are awarded to the top two winners in each category, except for the Biomedical category, which is sponsored by United MediCorp Pte Ltd.

As the program is still an integral part of the curriculum, for equality in assessment, each group is limited to a budget of S\$1,200 (US\$700), covering materials, fabrication for the prototype and any presentation/ marketing materials required. One of the major deviation from a traditional engineering project is the need for each group to submit a Business Plan. Judging for the competition is by a panel of eminent persons drawn from relevant industries, financial and investment firms, legal and patent offices. The judging criteria is based on:

- (i) Novelty/ Technology Assessment (40%);
- (ii) Market Survey and Business Plan (40%);
- (iii) Presentation (20%)

5. Presentation / Exhibition. An “Open House” is held at the end of the program. Each of the 68 groups was given an exhibition booth space to promote their products, using audio and visual aids, and/or on-site demonstrations. It enables the judges and faculty members to evaluate the products in a competitive “trade show” environment. Any member of the public may also discuss possible business opportunities with the students, and the press was also invited.



Figure 2: The T-21 Open House

Program Review

The program was carried out for the first time from May to June 1999. The winners and runners-up in each category are presented in Table 2. The overall winner was from the e-commerce section, Online coupon sources, and the overall runner-up was the Smart Socket. The overall winners were decided upon after all the categories of winners and runners-up were asked to make a presentation to the judges and audience for about 15 minutes each.

Feedback from all parties involved with the program indicated that the objectives have been largely met. The ideas generated were well received by the judges. Television, radio and press coverage were extensive and very favorable. There were also numerous unsolicited calls and public inquiries about the program and on specific

Table 2: Winners and Runners-Up for the 1999 Competition

Category	Winner	Runners-Up
Biomedical	Skin Pressure Evaluator	Medicine Dispenser
e-commerce	On-line coupon sources	Electronic system for parallel importing of cars
Information Technology	Automatic passenger monitoring system	Multimedia advertising
Miniaturisation /portability	Thermoelectric cooling of a car	-
Green Technology	Semi-automated toilet seat	Alternative packaging for drinks
General (others)	Smart Socket	Hydro-Timer

product innovations. The sponsors have expressed satisfaction with the results. Their endorsement is evident from their continuing support for the program this year with an increased value for the prizes. Because of the relevance and success of the program, the schools of Electrical & Electronic Engineering, Civil and Structural Engineering and Material Engineering have approached us regarding the mechanism of setting up a program like this in their own schools.

The responses from the direct participants of the inaugural program were solicited in a specially designed feedback form. Over 73.3% the participants found the program overall to be beneficial or very beneficial. Only 22.8% found the program to be not beneficial, and 3.9% did not attend, had little or no interest at all.

Commenting on the 8 weeks allocated for the project, 4.9% says too much time was given, 47.2% found it just ample and about an equal number felt there was too little time to complete the project to their satisfaction.

When asked what is the ideal size for the group, 31.2% said 9 persons or more, 30.5% said 8 persons, 8.2% said 7, 12.6% said 6, with the rest (17.5%) saying 5 or less.

Perhaps the most significant finding was the changed perception to their future after completing the program. Prior to undergoing the T21 program the students had indicated their career plans as:

Post Graduate Studies	12.3%
Private Company	36.8%
Government Linked Company	9.4%
Civil Service	9.1%
Own Business	14.2%
Others	4.1%
Not Sure	14.2%



When asked after the program, whether they are more likely or less likely to become a Technopreneur, it is interesting to note that 13% said they are more unlikely, while 49.1% remained indifferent. But most encouragingly, a significant number, close to 40%, indicated they are now more likely or very likely to take the plunge. The negative responses (unlikely or indifferent) are not unexpected in view of the travails the students encountered during the course of the project, without any precedents to fall back on.

Equally illuminating are the comments expressed or suggestions proposed by the participants in the survey forms. Some of the more typical feedback includes:

- (i) more industrial visits should be organized to both established and start-up companies to see their operations,
- (ii) more support is needed for them to realize their prototypes,
- (iii) too many facets of the program are covered in the short period of time,
- (iv) more staff should be involved,
- (v) more time and funding should be allocated,
- (vi) given the time constraints, it is difficult to generate good business ideas,
- (vii) it is a better approach compared to the previous In-House Practical Training program as it is more focussed, and provides a good exposure to the subject,
- (viii) the program is very beneficial as it highlights the problems involved in setting up a company and other aspects of business operations.

Improvements and Future Plans

It is inevitable for such an extensive program that some improvements are required to make it more effective. Even before the above feedback was received, an internal review had recommended certain adjustments to be made. One of the shortcomings identified is that at the sophomore level, many students lack critical skills in researching, designing and making an attractive prototype. The second program which started in May 2000 and ended recently, addressed this by making available intensive training modules on core skills, initially in four areas: Data Mining, e-commerce, Mechatronics and CAD/CAM, to key members of the groups who need these skills.

Obviously, one of the foremost questions being asked is whether the program has actually resulted in successful start-ups. Firstly, you have to remember that the program is for sophomores (2nd Year students) so they still have two more years to complete their degree program. There are already increasing cases of recent engineering graduates abandoning career plans with major multinational companies or putting on hold higher degree aspirations in favor of setting up their own companies based on ideas hatched during their campus days. By providing a seeding point for ideas, the T-21 program is likely to foster more such ventures in the coming years. Some students with good business ideas are in fact considering the possibility of deferring their studies in order not to miss the 'window of opportunity' in this dot.com era (The Straits Times, Sept. 12, 2000). While the university's current policy do not encourage such deferment, there are indications that the administration will increasingly have a more willing ear.

In answer to the feedback received, the program committee is aware that no matter how well conceived, such a route is not for everyone. It is therefore happy with the responses received which generally indicate that the program has made a positive impact in changing perceptions and overcoming some of the barriers that potential technopreneurs face. Even if they do not become technopreneurs themselves, our graduates are in a better position to appreciate the workings of a start-up company and be more willing to work for one or invest in such a venture. The committee will continue to make adjustments in the program to meet the needs, keeping a careful balance between instilling a strong technical foundation for the majority of the engineering cohort but easing the path for budding entrepreneurs to branch out if desired.

Concluding Remarks

In summary, the T-21 program aims to fill a void in the traditional engineering training. It places the product developer, process designer or systems engineer in the position to directly influence the use or adoption of his innovation. Hence the ingredients necessary for success or failure of new technologies are better understood. While not eliminating the risk altogether, the potential technopreneur goes into any venture with a better 'calculation' of the risk, more befitting his 'analytical' instincts.

Having implemented this program on a large scale, we are confident that the majority of mechanical engineering schools can adopt this program with little or no dilution of the core fundamentals, while instilling a sense of realism into the learning process. However, we advocate that such a program must be of a certain size to generate the excitement and achievement felt by the participants, and make an impact in their future course of actions.

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