Beginning in the 2001/2002 academic year, the Faculty of Engineering at NUS will offer a new undergraduate programme leading to the degree of Bachelor of Engineering in Industrial and Systems Engineering. With the launching of this new programme, NUS will be the only university in Singapore offering such a degree programme.

The domain knowledge of Industrial and Systems Engineering (ISE) is derived from combinations of engineering, mathematics, statistics, computing and social sciences. The ISE discipline calls for the adoption of a holistic view in resolving problems encountered and developing opportunities presented, coupled with a strong emphasis on efficiency and productivity improvement. Such a perspective provides the decision makers with the capacity for the identification, analysis and design of complex productive systems through an integrated approach. This will lead to effective systems in both the industrial and service sectors.

Industrial and Systems Engineering is unique among the engineering disciplines in that the application of its techniques is not restricted to only specific technological or industrial problems. Its application can be found in a wide range of industries, e.g. manufacturing, engineering, logistics, defence, and service. Experiences in the United States show that a high proportion of ISE graduates work for consultancy firms or as independent consultants, helping companies to engineer processes and systems to improve quality and productivity, effect efficient operation of complex systems, manage and optimise these processes and systems. Versatility is a trait of ISE graduates.

Industrial and Systems Engineering has been recognized as an important academic discipline and a profession with high economic values in Hong Kong, South Korea and Taiwan. Empirical evidence of the importance of the discipline also comes from the employment statistics in the United States. Among the engineering-related occupations in the country, ISE specialties make up 24%, second only to Electrical and Electronic engineering (see Table 1).

### Table 1. Employed US civilians by engineering-related occupation.

<table>
<thead>
<tr>
<th>Professional Specialty</th>
<th>1997 Civilians US Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1,000)</td>
</tr>
<tr>
<td>1. Aerospace Engineers</td>
<td>87</td>
</tr>
<tr>
<td>2. Chemical Engineers</td>
<td>92</td>
</tr>
<tr>
<td>3. Civil Engineers</td>
<td>248</td>
</tr>
<tr>
<td>4. Electrical and Electronic Engineers</td>
<td>652</td>
</tr>
<tr>
<td>5. Industrial Engineers</td>
<td>258</td>
</tr>
<tr>
<td>6. Operations and Systems Researchers and Analysts</td>
<td>201</td>
</tr>
<tr>
<td>7. Mechanical Engineers</td>
<td>352</td>
</tr>
<tr>
<td><strong>Total above</strong></td>
<td><strong>1,890</strong></td>
</tr>
</tbody>
</table>

Advancing technology, R&D, and the development of new industrial systems can only be useful if the management of their exploitation in industry is successful. Also, management itself, as an art and science, needs constantly to advance by identifying and implementing better practices. All this is to help achieve higher productivity, as well as improved or new products. Having the best engineering management generally, and particularly for Singapore, is highly important for sustaining and growing the economy. Such management has to include the business aspects, to recognise that it is an integral part of the business processes within industry.

The ISE Department carries out education and research into engineering management, and disseminates its research findings both locally and internationally. The education is provided for undergraduates, graduates, and practitioners from industry – the latter as part of the NUS effort for continuing education.

### Education

The education provides tuition on the state of the art in a number of management subjects. These include the management of technology, new product development, project management, the technopreneurship process, quality planning, and logistics. These courses address the overall management process as well as presenting each element of the process in some detail. These elements include aspects of marketing, finance, tactics, strategy, human factors, company culture, design, QFD (Quality Functional Deployment), and so on. The substance of this tuition comes from a variety of sources, including the literature, the consultancy and practitioner experience of the lecturers, research findings from colleagues in collaborating universities and companies, and the lecturers own research results. The benefit to teaching of being active in research is therefore once again clearly evident.

### Research

Research into these management subjects poses a substantial intellectual and practical challenge to the researchers. The identification of the research issues is reasonably straightforward. That is done, similar to other research areas, by reviews of literature, information surveys of companies, discussion with colleagues in academia and industry, and from personal experience as a consultant or practitioner. For testing ideas or preliminary findings, it would be ideal to be able to design and carry out controlled experiments within companies. However, in most cases this is hardly possible. Thus most of the research has to be based on observing the ongoing operations of companies. Sometimes, companies might be persuaded to try out a new management approach or tool, and the researchers can then make some deductions from the companies’ actual experiences. Obtaining reliable, meaningful quantitative and qualitative information from companies is always, of course, a particular difficulty. The interpretation of the available information can also be difficult in terms of making, with high degrees of confidence, either general or specific conclusions. Nevertheless, from the world-wide experience it is clear that such research, carefully done and carefully interpreted, is highly valued by companies, and has very positive influence on them and their development. This has been much helped in recent years by the growing “benchmarking culture” in industry where companies now more and more recognise the crucial need to know how other companies succeed, or sometimes fail, in managing their operations, and the need to know what are the “best practices”. Academia plays a pivotal role in the identification of cause and effect, the development of good management practices, and the dissemination of information.
Research Activities - Highlights

The research activities within ISE address subjects which are of particular importance to Singapore, i.e. the amount and types of new product development (NPD) going on in the manufacturing companies of Singapore, the interest in NPD in those companies; the impact of national culture on NPD; the “fuzzy front-end” of NPD; tools like QFD, and the use of CAD for product design analysis.

The amounts and types of NPD going on in manufacturing companies in Singapore, and their NPD interests.

This study was carried out to find data on the NPD activity in manufacturing companies in Singapore, and their interest in starting up or expanding NPD. The need for a steadily increasing NPD activity in Singapore companies is well recognised. It is needed for the continual well-being of the existing companies, the commitment of the MNCs to Singapore, the development of business management and product design capabilities amongst staff, and for the creation of the environment required for increasing technopreneurship. The study has suggested the metrics to be used for such investigations and has yielded data that helps define the present position: i.e. it gives the “year zero” base-line against which the NPD activity in the months or years ahead can be compared – hopefully to confirm an increase. The data can also be used to make comparisons with other countries or regions. The data came from a major postal survey by questionnaires sent to 1250 manufacturing companies in Singapore. (The return rate was 20% overall, but for the ‘Electronics’ sector and the ‘Medical, Precision, and Optics’ sector, a high value of 42%). The data has been published locally, and also passed over to PSB and NSTB for their use. Some other aspects coming from the work, regarding metrics for the better definition of the type of NPD, has been published via the recent IEEE ICMIT 2000 Conference.

The impact of national culture on the management of NPD projects

The value system and the behavioural manifestation of the organisational participants for an NPD project is known to have substantial impact upon the dynamics of the NPD process and its degree of success. Comparative studies are underway to examine the preferred mode of behaviour in the organisational setting for an NPD project and link these to the underlying values of the different national culture. The insights provided by these studies will be used to develop a theoretical base that will serve as a guide to managers in cross-cultural organisational situations.

The “fuzzy front end” of new product development

The front end of the NPD process is where the product concept is formed. It is decisive in the success of NPD projects. However, it is known that this part often receives disproportionately low amounts of resource and attention and is then therefore a high risk area for NPD. The research seeks to shed light on the current practices of Singapore companies, and highlight the strength and weaknesses of these local practices in comparison with the best practices in companies at home and abroad. From this research, appropriate management improvement strategies can be suggested for companies in Singapore to implement.
QFD, Quality Functional Deployment (QFD)

QFD is a disciplined structured methodology, using quantitative and qualitative assessments, to help achieve better accuracy in defining the most likely successful new or improved product or service. It focuses on particularly listening to the voice of the customer, as well as to the requirements of the company and regulations. The present research studies are aimed at improving the methodology by refining the accuracy of the measurement system, the use of linguistic data, consideration of the likely voice of the customer in the future, analysis of fuzzy customer voices, QFD benchmarking, sensitivity and variability analysis, and categorising customer needs in Kano terms i.e. some features taken for granted, others giving progressive satisfaction, and others giving delight by being new and not previously recognised as needed.

The use of CAD for design analysis for NDP

This study addressed the use of CAD for the substantiation of product designs by companies. The results suggested that for mass and batch produced products, many companies under-exploit the use of CAD analysis and rely heavily on design / test / re-design / re-test reliability growth routines. In contrast, companies designing one or few-off capital plant or large-scale product like aircraft, exploit CAD analysis more or less to the maximum. Reasons for this, and ways for up-rating the use of CAD analysis by the mass and batch product companies are suggested. A paper on the work has been published via the recent IEEE ICMIT 2000 Conference.

Dissemination and Publication

The researchers disseminate their findings by incorporating them in their course tuition, giving seminars to students and practitioners from industry, running courses for practitioners as part of the NUS continual education programmes and publications.

Some recent publications were made via the IEEE International Conference on the Management of Innovation and Technology, ICMIT, November 2000, held in Singapore. NUS made a substantial contribution to the organisation and publications. The conference chair was from the Electrical Engineering Department, and ISE staff members were the Technical Chair and the Publicity Chair. NUS contributed 9 papers, of which 5 were from ISE. Two of the ISE papers have already been referred to in the above “research activities – highlights”. The other papers were as follows. One paper discussed the typical management shortfalls for NPD i.e. poor cohesion and poor diligence at senior level, poor review/TQM process, poor production department participation and little concurrent engineering, under-qualified project management, and unrealistic planning. The paper discussed the reasons for these shortfalls, their avoidance or the remedial action. Another paper presented architecture for organisational ‘consciousness’ as a principle for structuring organisation activities from the knowledge management perspective. A process for the creation of knowledge capital was interpreted in relation to this architecture, to illustrate how specific organisation knowledge components may be aligned to specific aspects of organisation practices. Another paper, regarding industrial processes, addressed the design of experiments considering multiple engineering characteristics. An approach was suggested for simultaneously optimising more than one response and minimising the response variance.
We would like to congratulate the following Teaching Awards winners in our department:

1. Teaching Excellence Award: A/Prof Poh Kim Leng
2. Teaching Honour List Award: Dr Lee Loo Hay
3. Letter of Teaching Commendation: Dr Yap Chee Meng

A/P Poh receiving the Faculty of Engineering teaching excellence award 2000 from Dr. Aline Wong, Senior Minister of State for Education

We would like to welcome the following research students to our department:

1. Mr Dai Yuanshun from Tsinghua University
2. Mr Lau Yew Loon from University Technology Malaysia
3. Ms Li Yanni from University of Science & Technology
4. Mr Liu Shiqiang from Harbin Institute of Technology
5. Mr Liu Shubin from Dalian University of Technology
6. Mr Tang Yong from University of Science & Technology
7. Mr Tony Halim from National University of Singapore
8. Mr Zhao Jinsong from Xian Jiaotong University
9. Mr Lee Tuck Suen from Nanyang Technological University

At NUS, students interested in the B.Eng. programme in ISE will attend a common first year engineering course. Subsequently, they will be streamed to do ISE at the end of their first year of study. Like all other B.Eng. programmes in NUS, this programme will take an average of 4 years to complete.

The curriculum of this degree programme has been carefully designed. References have been made to top overseas ISE departments, particularly those in the United States, and the needs of Singapore industry in the coming decades. As Singapore moves towards higher value-added activities and its economy becomes more globalised, the demand for greater depth of technical skills for efficiency and productivity improvement and breadth of integrative management increases. The curriculum of the ISE undergraduate program provides not only professional training in the ISE discipline but also a comprehensive and rigorous coverage of requisite skills to meet such challenges.

More specifically, two technical concentration areas are made available to match the demands of the Singapore economy. Students, if they so wish, may opt for modules in Logistics and Systems Optimisation, or Quality and Manufacturing Systems. With globalisation in all fronts, demand for logistics services will increase tremendously. There has also been a global trend in the demand for better quality products and services. Many jobs in the areas of logistics and quality engineering/management will be created and ISE graduates are best equipped for jobs in these two growing areas.

The expected job titles and sectors of fresh graduates are shown in Table 2. Manufacturing and service industries, the mainstay of Singapore’s economy, will be the main destinations of the graduates.

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Key Industries/Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Engineer Logistics</td>
<td>• Manufacturing and engineering sectors, including MNCs and SMEs</td>
</tr>
<tr>
<td>Engineer Manufacturing Engineer</td>
<td>• Service-based industries, including logistics and supply chains</td>
</tr>
<tr>
<td>Quality Engineer Manufacturing</td>
<td>• Manufacturing, particularly in electronics and other high-technology industries</td>
</tr>
<tr>
<td>Engineer Systems Engineer</td>
<td>• Companies that emphasise quality and reliability</td>
</tr>
<tr>
<td>Operations Analyst</td>
<td>• Ministry of Defence and defence-related sectors</td>
</tr>
<tr>
<td>Business Planner Management</td>
<td>• Transportation, including land-based, seaport and airport operations</td>
</tr>
<tr>
<td>Consultant</td>
<td>• Service sectors such as telecommunication, utilities, airlines, and banking</td>
</tr>
</tbody>
</table>

Table 2: Expected job titles and sectors of employment of fresh ISE graduates in Singapore.

Recent Graduates

Name: Mr Shen Xiaoxiang
Degree: PhD
Conferred Year: 2000
Thesis Title: Advancements to House of Quality in Quality Function Deployment.

New MEng/PhD Students


The Department wishes all readers a HAPPY & PROSPEROUS CHINESE NEW YEAR!