

# Should Law be Introduced into the Engineering Curriculum?\*

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*The curricula of many engineering schools all over the world have included humanities and social science subjects to broaden the scope of education of students beyond technical engineering training. A new, and perhaps unusual, law course, launched at the School of Electrical and Electronic Engineering at the Nanyang Technological University in Singapore provides interesting insights for engineering educators. A survey was conducted on the students to find out their motivation for taking the course, the achievements they have obtained, their fears before and after taking the course and the teaching methodology involved. The results should be useful information to engineering educators.*

## PURPOSE OF STUDY

MANY universities throughout the world include humanities and social science courses into the engineering undergraduate curriculum to give the students a more comprehensive education. Such training is useful because the industry employs engineers as managers. Managers with engineering training are better equipped to understand technology as it is applied to industry. Hence, management skills are necessary. Besides engineering managers, it is also useful for all engineers to understand the legal framework in an engineering environment.

Management skills and legal knowledge are best learnt with the relevant formal training and not just learnt on the job. The engineering curriculum should therefore include relevant subjects.

There must be an equal balance of technical, business and behavioural skills in order to have a complete educational program for the engineering manager. The educational process of the engineering manager is like a three-legged stool. The supporting legs are the technical skills, business skills, and behavioural or human skills. The seat of the stool, which ties the legs together into a useful item, is the company that employs the engineer and the culture of the society in which it does business [1].

Besides management subjects, it is also useful to consider other subjects such as a law course for engineers. Knowledge of the relevant law is useful and could be considered as part of 'business skills'.

Regarding the teaching of law, it is unusual to find a law course which is not a component of other subjects that is a subject on its own and one which is specially designed for electrical engineering undergraduate students. A literature

review of the syllabuses of local and many foreign universities did not reveal a specially designed law course to suit the undergraduate electrical engineering curriculum as a subject on its own. Law was part of another main course such as Management and Law, Ethics and the Law or law was part of an Engineering Management course which included labour law or industrial law. This article explores the experience of teaching law to undergraduate electrical engineering students.

Data from surveys contain a wealth of information for engineering educators who wish to design or change the curriculum in engineering schools. It is better to base decisions on survey results than on intuition, conjecture or current trends in industry. Although the current and future trends and needs in industry are important factors for curriculum development, the responses of the students who are within the school are useful indicators for shaping the curriculum.

## THE CURRICULUM

In the four-year degree programme, students have to take core subjects, Prescribed Electives, Free Electives as well as go for Industrial Attachment and In-House Practical training. The course structure is shown in Figs 1 and 2.

Core subjects are compulsory subjects which the students have to take. The Prescribed Electives 1, 2, 3 and 4 are offered in Year 4. The Prescribed Electives must be taken from the subjects in the option group which the student is taking. The final year students are allowed to specialise in only 1 of the 6 option groups. The 6 option groups, which are the same for the 1st and 2nd Semesters, are:

- Power Engineering
- Electronics
- Computer Engineering

\* Accepted 1 May 1997.

Year 1	Year 2	Year 3	Year 4
<b>First Semester (July to October)</b>	<b>First Semester (July to October)</b>	<b>First Semester (July to October)</b>	<b>First Semester (July to October)</b>
<b>CORE</b> G101 Electric Circuits G102 Mechanics 1 G103 Mathematics G104 Computing G105 Economics G106 English Proficiency G107 Laboratory & Workshop 1	<b>CORE</b> E201 Network Analysis E202 Analogue Electronics E203 Engineering Materials E204 Engineering Mathematics I E215 Communication Skills E221 Laboratory I E222 Engineering Design I E223 Project I	<b>CORE</b> E301 Control Engineering E302 Communication Engineering E303 Integrated Electronics E304 Computer Engineering E305 Power Systems & Machines E321 Laboratory III E322 Engineering Design III E323 Project III	<b>CORE</b> E415 Human Resource Management E422 Engineering Design IV E423 Final Year Project (extends to second semester) <b>Prescribed Elective 1</b> <b>Prescribed Elective 2</b> <b>General Elective (Technical)</b>

Fig. 1. The course structure of the School of Electrical and Electronic Engineering—first semester.

Year 1	Year 2	Year 3	Year 4
<b>Second Semester (January to April)</b>	<b>Second Semester (January to April)</b>	<b>January to June</b>	<b>Second Semester (January to April)</b>
G111 Electronics G112 Mechanics 2 G113 Engineering Physics G114 Graphics G115 Materials & Processes G116 Technical Communication G117 Laboratory & Workshop 2	E205 Electromagnetic Theory E206 Digital Electronics E207 AC Circuits & Devices E208 Engineering Mathematics II E224 Laboratory II E225 Engineering Design II E226 Project II  <b>General elective</b> —Financial Management and Accounting, a humanities free elective is recommended  <b>May and June Compulsory</b> E229 In-House Practical Training (8 weeks)	<b>Compulsory</b> E329 Industrial Attachment (24 weeks)	E425 Engineering Design V E423 Final Year Project <b>Prescribed elective 3</b> <b>Prescribed elective 4</b> <b>General elective (technical)</b> <b>General elective (humanities):</b> —Law for Engineers —Industrial Management

Fig. 2. The course structure of the School of Electrical and Electronic Engineering—second semester.

- Control Engineering
- Communications
- Microelectronics.

Subjects belonging to that particular option group are offered in each semester. An example is that Power System Analysis and Control and Electricity Utilisation Systems for the Power Engineering option are offered in the 1st Semester.

In addition, students have to take a certain number of General Electives which are subjects offered by the school and/or approved subjects offered by *other* schools. General Electives could be taken in any year but the recommended scheme is to take General Electives from Year 2 onwards, as shown in the diagram in Fig. 2. Law for Engineers is part of the General Electives (humanities) option (shaded). The other subjects in the same category are Industrial Management and Financial and Management Accounting. General Electives (technical) are other technical electrical engineering subjects offered by the school outside the selected option group.

At the time when the survey was conducted, the curriculum was in a transition stage to the current academic unit system. Going back into history, Law used to be part of Industrial Management, like the programme in many universities. In 1995, there was a change whereby Year 4 students could opt for the Law for Engineers, *as a full course*, as an alternative to Industrial Management. There was apprehension as to how engineering students would take to law. The positive response of the students to the course prompted the author to conduct a survey on the students.

The students at the School of Electrical and Electronic Engineering were taught these topics:

- Intellectual Property
- Employment Law
- Factories Legislation
- Workmen's Compensation
- Contract
- Tort
- Dispute Resolution

Law for Engineers is a 26-hour course comprising lectures and tutorials. The medium of instruction is English.

All the topics listed above are relevant to engineers. As there is a shortage of time to cover all the topics which would be useful for engineers and also a shortage of time for each topic, there has to be a wise choice of topics and prioritisation. Only topics and cases which are important to electrical engineering students are covered in greater detail.

For example, for the topic, Industrial and Intellectual Property, students are taught the law of copyright, patents, trade marks, passing off and the law of confidential information. Under the sub-topic of copyright, cases on copyright infringement of computer software are dealt with. Then, under the topic of Employment Law, the

local Professional Engineers Act, a significant Act to professional engineers, is taught. If more time is allocated to the course, more topics could be included.

Although Singapore has its own Acts of Parliament and cases from its own courts, our laws are similar to English law. As Singapore was a previous colony of Britain, we had for some time in the past received English law into our jurisdiction. The result is the introduction of the common law tradition into Singapore. Therefore, although we are not bound by the rules of law in English cases (but are generally bound by the rules of law in Singapore cases), the English cases are of persuasive authority. Singapore judges could refer and follow English case law where relevant.

## METHODOLOGY

The study mainly involved conducting a survey. The views of engineers, who have many years of practice in industry, were also considered.

Firstly, a survey was conducted on the final year electrical engineering students at the School of Electrical and Electronic Engineering at the Nanyang Technological University in Singapore to find out their response to law courses. The degree course is usually completed over 4 years. The survey was conducted on the completion of the law course to two groups of undergraduate students. Final year students have to opt either for Law for Engineers (Law) or Industrial Management (IM). About two-thirds of the 640 final-year students opted for IM and about one-third opted for Law.

A combination of statements and questions were given to the Law and IM groups. Most of the statements could be answered by indicating on a Likert scale, some require simple Yes or No answers and there was 1 multiple choice question. The Likert scale is a scale of 1-5 with:

- 1: strongly agree
- 2: agree
- 3: neutral
- 4: disagree
- 5: strongly disagree.

For an analysis of the results, the author has combined the results of 1 and 2 to agree, 3 remains neutral and 4 and 5 as disagree, for ease of explanation. Lastly, respondents were allowed to comment.

## RESEARCH RESULTS

There were 194 respondents for the Law group and 202 respondents for the IM group. The Law group was given a lengthier survey form than IM group. The IM group answered fewer questions which were the same or similar to the Law group.

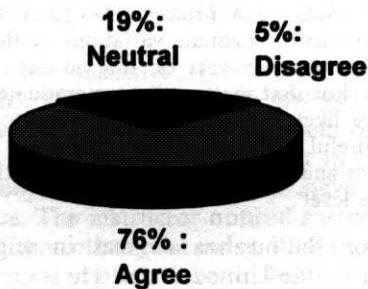


Fig. 3. Motivation—useful.

The results below pertain to the Law group except where mentioned otherwise to the IM group.

#### Motivation

There seems to be reason or reasons enough for the student-respondents to opt for the subject. The motivation or the reason for the choice of Law was that it was useful to them professionally as indicated by 76% of the students, see Fig. 3. Also the subject is interesting to 86% of the students who chose the subject. Other reasons included interest in new subjects and that legal knowledge is good for an overall education.

#### Fears before and after taking of the course

Three questions addressed the fears of the students before taking and after taking the Law course to find out their preconceptions before taking the subject and to determine if there was any change after taking the course.

From past questions asked of the instructor, many pertain to whether proficiency in the English language is a necessary pre-requisite for the study of Law. The medium of instruction is in English. Therefore, the author included the statements to test the significance of these points.

The first statement was: 'I have a fear of wordy subjects like Law'. Before the course, 43% of them said that they were afraid, 32% said that they were not and 25% were neutral. There was a change of feelings after the course whereby those who were still afraid declined to 32% and those in the neutral category increased to 36%. The numbers for those who were not afraid remained about the same. A similar question was given to the IM group. 39% of IM students (students who did not opt for Law) stated that they did not like Law as it was a wordy subject. 31% of the IM students were neutral on this point. This response of the IM respondents substantiates the fear of wordy subjects that is in the minds of the student-respondents.

The next statement addressed the respondents' fear of Law as it involved a substantial amount of reading. Again, the general trend was a shaking off of the fear on completion of the course.

The last statement under the heading of Fears Before and After the Course referred to proficiency in the English language. 'I fear Law as I do not have a good command of English'. Before taking the course, 46% answered positively, 21% had

neutral feelings and 33% did not fear. After taking the course, 29% were still afraid, 36% were neutral and a similar number did not fear.

Although, the fear of not having a good command of the English language may not be a problem in countries where English is the mother tongue or where law is taught in the local language, this 'local peculiarity' of the fear of not being proficient in the English language may not be so localised. The fear of proficiency in the English language for the study of law could occur in countries where the circumstances are the same or similar to the circumstances of the present survey. The same factors could occur in Commonwealth countries where the mother tongue of the local population is not English, where the medium of instruction is in English and where the laws are similar to English law. The results of the survey on the proficiency of the students in the English language could be useful in these circumstances.

#### Achievement

Having completed the course, 57% of the respondents felt that they understood the legal environment in which they will be working in, 36% were neutral and only 7% said that the course did not help, see Fig. 4. Another achievement was that 35% were less afraid of the subject than when they began and 50% were still neutral. Others said that they learnt to think logically, they developed language skills and one respondent even enjoyed the learning experience of understanding the law!

#### Teaching methodology

78% felt that cases were interesting, 15% were neutral and a few felt it was not. Secondly, 52% felt that the way the subject was taught was important and 41% were neutral. The graphics on the transparencies (with a mixture of words and pictures), apparently, were not important. The bulk, 45%, were neutral on this point and 31% felt that the subject was interesting because of the graphics.

Understanding of the topics taught occurred most frequently after tutorials, followed by after the lecture and during the lecture. There were some students who gave a combination of answers such as understanding occurred *after* lectures and tutorials and a small number stated understanding occurred *during* and after lectures and after tutorials.

Further, during tutorials, the case study method

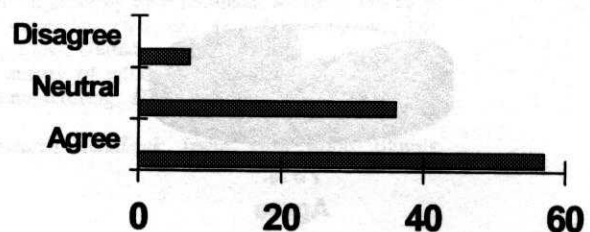


Fig. 4. Achievement—understanding the legal environment.

used is interesting and useful for understanding principles. 87% of the respondents indicated that was so. By the case study method is meant setting tutorial questions based on facts of an imaginary case. Students answer questions on legal issues based on the facts given. (For a sample, see the Appendix.)

Next, 71% of the respondents felt that student presentation in tutorials is useful to help them to answer questions. By the student presentation method, students are given the tutorial questions before the actual tutorial. During tutorials, they present their brief answers in point form on transparencies or on the white board. Thereafter, the tutor corrects the errors in the answers and discusses the issues involved.

### Curriculum

73% of the Law group felt that law is a useful supplement to other subjects taught in all the four years in the engineering school. 15% of the respondents were neutral on this point, see Fig. 5. Then, about 55% of the law group felt that the law course should be given more hours in the curriculum. It may be some hint of an appreciation of the law course. Further, about 50% of the law group felt that law should be a compulsory subject whereas 70% of the IM group (the group which did not opt for law) felt that law should not be a compulsory subject.

## INTERVIEWS

Dr Dennis Ballou, a Professorial Fellow at Nanyang Technological University, was asked on how law fits into an engineering curriculum and how it helps the engineers.

'In general, at some time or other in their career, engineers have to deal with the law, such as contractual relationships. They have to deal with other parties such as vendors, contractors, consultants, insurance companies either on behalf of the company they work for or for their own company. It is therefore useful to learn the law pertaining to their environment and to be familiar with legal terminology. However, knowledge of the law is more useful probably to the more senior engineers compared to a fresh graduate, who may need it later on. A senior

engineer could be a project manager who has to deal with clients, negotiate variations, settle disputes and advise their lawyers on the various clauses in contract. For that matter, the postgraduate students are more likely to find a law course more immediately useful but that should not detract from the usefulness and relevance of the course at the undergraduate level'.

Professor Ballou has degrees in engineering and law from the United States. He is an engineer cum lawyer with over 30 years of experience in project management and administration all over the world. Among the posts which he has held is one as the project director of the Mass Rapid Transit System in Singapore supervising a peak work force of about 15,000 (1985-1989) in a US\$2.5b project (in 1985).

Another engineer is Dr Tan Geok Leng, the Managing Director of Goldtron Telecommunications Pte Ltd., a subsidiary of publicly listed Goldtron Ltd. Goldtron Telecommunications, has built one of the largest telecommunications R&D centres in Singapore. This centre has developed an extensive range of paging products, cordless and cellular phones. Dr Tan holds a B.Sc. in Electronics and Communications from Birmingham University, United Kingdom, and a doctorate degree in Digital Communication from Cambridge University. His work experience encompasses telecommunication product development, technical consultancy and he has been responsible for building Goldtron Telecommunications to its present state. When he was asked on how important knowledge of the law is to the engineer, he has this to say:

'It is important for *all* engineers to have a working knowledge of the law. For engineers who choose to be technical specialists working in a research and development environment, a working knowledge of legal aspects of intellectual property rights would be essential. Then, for engineers who move into the management ladder, they should in addition know about the legal aspects of technology transfer and licensing agreements and joint venture agreements. For engineers who are entrepreneurs and want to build their own companies, all the above are important'.

Dr Tan was then asked whether law is more important than subjects like Entrepreneurship and Human Resource Management. He said: 'It depends on what the engineers do. It is hard to say which is important. At least, law is as important as Entrepreneurship and Human Resource Management'.

On being asked the same question, Dr Robert Gay, the Director of Graduate Programme, GINTIC Institute of Manufacturing Technology, an industry resource centre, has this to say: 'Basic knowledge of the law would be more important than entrepreneurship or banking, for instance, but less important than Human Resource Management'. He believes that engineers should have some basic knowledge of the relevant law to the extent of realising when they need legal advice.

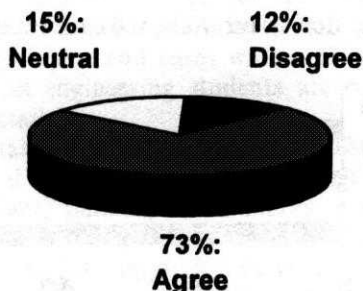


Fig. 5. Curriculum—useful supplement.

## EVALUATION AND COMMENTS

As already discussed, the student-respondents were highly motivated to study law as the subject is perceived to be both useful to them professionally and is interesting. The interest in the course extends beyond the students who have opted for the course. The instructor noticed the presence of students from other courses such as from the IM group and from other schools. Many engineering lecturers have expressed interest in the subject. These lecturers mentioned that they did not have the chance to study the subject. Such interest should be noted by engineering educators who develop the curriculum.

There was also a gratifying feeling after the course as the student-respondents felt that they have learnt something potentially useful to them professionally. However, there are fears of the subject such as requiring a good command of the English language and as being too wordy. These fears may be relevant in some countries. Many of these are pre-conceived misconceptions which could be dealt with by giving preliminary talks about the course to students and dispelling fears.

Regarding teaching methodology, cases could be used to teach and illustrate principles. As expected, the way a subject is taught is important. Tutorials are useful and important learning sessions for students. Case studies, as defined, are useful methods of instruction during tutorials. Further, student presentation helps in making the students apply the principles taught during lectures and are useful learning experiences.

More hours could be allocated to the course than the present 26-hour course. Given a 30–36 hour course, more topics could be covered.

There are meaningful implications for engineering educators who develop the curriculum. Should law be introduced into the engineering curriculum? Law is a useful subject to add to the curriculum. It is well received by students who are taking the course. It should not be a compulsory subject but a general elective to be taken by students who have an interest and inclination towards the subject.

To cite a point from a discussion on engineering education under the sub-heading, 'A Vision For The Twenty-First Century':

'Ideally, the education engineers obtain at the undergraduate level will be broad enough to provide a strong basis not only for a career in engineering but also for careers in other professions. This will give them greater flexibility to pursue interests and other opportunities in other fields—such as medicine, law and management—where they can bring in their technological perspectives to bear in useful ways, as well as to respond to changing market conditions for engineers' [2].

Learning law which is relevant to the engineers does not only provide students with an opportunity to take a peek into another world and to try out their hand at another discipline but it provides them with a knowledge of the legal framework in an engineering environment. Such knowledge is useful whether they remain in the profession or not. Should the engineers decide to become lawyers, their 'technological perspectives' will be useful in understanding law grounded in an engineering context like construction law (especially for civil and structural engineers) and computer law.

The usefulness, relevance and even importance of a 'working knowledge of the law' as it pertains to the engineering environment, is supported by the views of engineers who are in industry. The importance is not just to engineering managers but to all engineers.

Lastly, engineering educators should be careful not to plug in a business law course into an engineering curriculum. Not any law subject goes. Nor any topic. The contents of the course have to be specially selected and tailored to suit the professional engineer in his working environment. It is important to note that a law course designed for engineers is certainly and should not be a watered down version of any business law course.

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### APPENDIX: SAMPLE OF CASE STUDY (FOR TUTORIALS)

Lim is the Managing Director of Win-Win Pte Ltd (W), a company which deals in multimedia products. Lim wanted to expand his business into the development of software and PC video cards. He set up a Research and Development which developed these products:

- a new video card which was effective and cheap
- a new software for children called 'Fun With Maths'.

As Lim did not have the facilities in his factory to make the video card, he sent the designs contained in diskettes to a printed circuit board manufacturer, Perfect Circuit Makers (PCM). Lim spent money on advertisement and the marketing of the video cards and the software package. After one year, he created a niche for W in the market for video cards and the software package.

Recently, Lim noticed another firm, Images, (I)

selling video cards which were very similar to his cards. Lim did an investigation and he found out that I was owned and run by a former employee of PCM, Tim. Tim was in charge of the making of the cards for W, when he was working at PCM.

Lim managed to obtain an order for the search of I's factory. He found diskettes containing the Printed Circuit Board design with W's company's name written on it.

1. Advise Lim of W's rights and the remedies in the light of the evidence found.
2. In the search of I's factory, Lim found equipment and programs which could be used to disassemble software. To his horror, he also found that his software, 'Fun With Maths' was disassembled. Apparently, Tim wanted to add modifications to the program and to sell it as a new software package. What further cause(s) of action, if any, could Lim pursue for W?
3. What are the possible defences to Ws action?

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