Integrating a key but not core topic into the engineering curriculum

Ruth Soetendorp¹, Jim Roach², Robert McLaughlan³, Bill Childs⁴,

Abstract – There is currently no coherent pedagogy for the integration of intellectual property rights (IPR) into the engineering syllabus. IPR is recognised as a key skill for graduating engineers. Yet it is a matter of chance whether or not students are introduced to IPR during their studies. A growing number of faculties are recognising that IPR competence and awareness are key attributes contributing to engineering graduate employability and entrepreneurship. As a result, there is a growing interest amongst engineering academics as to how best to include IPR in the syllabus. Intellectual property law academics, who have traditionally been responsible for delivering IPR to lawyers, appreciate that IPR has direct relevance across the disciplines, despite the challenges. The time would appear right for academics from engineering and law to collaborate on developing pedagogy, supported by web based resources, to integrate IPRs into the engineering syllabus.

Index terms – entrepreneurship, intellectual property rights, pedagogy

1.1 WHAT DO ACADEMICS ENGINEERS AND LAWYERS HAVE IN COMMON?

All academics acknowledge pressure from many sources to keep curricula developing. Often pressure has a source external to the academic group or discipline. The curriculum must develop to enable an institution to compete in the market for home and overseas students. Government expectations can have a clear impact on curricula as can the drafting of new legislation imposing regulation or requiring compliance. New technologies influence curriculum change as a result of the impact they have on styles of learning and teaching. Last, but not least, employers, professional bodies and accrediting institutions contribute to the process of curricula change that finds expression within revised academic programmes.

National and international policy making impacts on curriculum design, as does new development in business management and strategy. Environmental and ethical issues also shape the context in which the curriculum is defined.

1.2 WHY DO ENGINEERS AND IP LAW STUDENTS NEED EACH OTHER?

Engineering students need to understand the way in which the law influences engineering professional practice. Health and safety, product liability, environmental regulations, contracts, employment relations, confidential information and trade secrets, and intellectual property are all significant in the production of innovative solutions. Project commercialisation is a key element of engineering enterprise. Enterprise is about turning ideas into working reality. Enterprise involves being able to generate and work with ideas, design solutions and exploiting value from the solutions. Intellectual property rights in the form of patents and designs are the way in which ideas can become commercially exploitable. Intellectual property rights give value to innovative solutions.

Trainee lawyers are being trained to be able to understand and apply legislation and to analyse and apply legal decisions. In addition, they need to develop skills in working with clients. A good legal adviser is able to elicit from a client what he needs to know, even if the client herself is not certain that she knows the information. Introduction to legal issues gives the engineer another perspective on the technology of their creative work.

2.1 ENGINEERING COMPANIES NEED INTELLECTUAL PROPERTY

Engineering companies are at the forefront of commoditising intellectual property. Students increasingly expect to be equipped with an awareness of the skills involved in trading in those commodities. Take the example of IBM. Their patent portfolio gives the company the freedom to do what they need to do through cross licensing. It gives them access to the inventions of others that are key to rapid innovation. Access is far more valuable to IBM than the fees it earns from its thousands of active patents, about $2 billion per year (Bessen,
processors are designed, produced and sold and selling its cheap technology, the company established industry forever. By licensing, rather than manufacturing early 1990s, it changed the dynamics of the semiconductor revolution. When ARM Holdings plc (NASDAQ:ARMHY), ranked by individual patents interact over entire portfolios. Some, rather than licence carefully chosen competitors’. Some, rather than licence carefully chosen worldwide. Other firms obtain patents in order to ‘block competitors’. Some, rather than licence carefully chosen individual patents interact over entire portfolios.

ARM Holdings plc (NASDAQ:ARMHY), ranked by Dataquest as the number one semiconductor intellectual property supplier in the world, emerged as a pre-eminent force in the semiconductor revolution. When ARM pioneered the concept of openly-licensable IP for the development of 32-bit RISC processor-based SoCs in the early 1990s, it changed the dynamics of the semiconductor industry forever. By licensing, rather than manufacturing and selling its cheap technology, the company established a new business model that has redefined the way processors are designed, produced and sold.

2.1 WHAT DO ENGINEERING STUDENTS NEED TO KNOW ABOUT IPR?

Engineers are expecting to develop enterprise and entrepreneurship skills alongside their technical skills. They will require capability in business, legal, and IP skills alongside their engineering and design. They will start with questions, ‘what is a patent? a trade mark? or copyright?’ They will want to know where to find relevant information. They will want to know when it is the right time to call in an IPR expert, and how to communicate most effectively with an IPR professional adviser. Increasingly, the aim is to facilitate the generation of entrepreneurial designers who have an understanding of commercial and technical issues. Engineering students need to understand that the intellectual property cycle commences with an initial novel idea which must be treated as confidential, and only disclosed in circumstances in which the recipient undertakes not to breach the confidence. With the idea thus recognised and protected, the engineer is at liberty to pursue other more robust forms of protection, including patent or design registration.

2.2 WHY IPR IS IMPORTANT TO ENGINEERING STUDENTS

For European engineering companies, the shift in manufacturing and production from high cost to low cost areas of production has pushed companies to look for income generation that stands apart from manufacture and production. This has driven forward changes in company structure. Companies are increasingly aware of protecting the IPR aspects of their assets.

Owning IPRs implies positive and negative rights. IPRs offer an incentive to invention and creativity providing right owners an exclusive right for a limited period of time to market goods and services. IPRs are key intangible assets of public and private enterprises. Kaplan and Kaplan (2003) are U.S. patent attorneys and academics who include intellectual property in their university engineering classes. They suggest ‘IP knowledge is important for engineers: engineers should try to under- stand IP basics to protect their creations. Also, IP searches can indicate the growth of different engineering fields. Further- more, the proper use of IP promotes the progress of a field. Engineers should become familiar with the basics of the three traditional IP areas: copyrights, trade marks and patents. They should know which IP rights are needed to protect their creations. All of the students have reported that they enjoyed the information and will use the material in the future. The best result came well after the completion of the course. Ms W returned to thank the professor. Apparently she impressed an interviewer with her knowledge of IP and received an engineering position because of it!’

The idea of engineering enterprise surfaced in the UK Government’s 1980 Finniston Report as part of the undergraduate experience is gaining ground. In May 2003 Philippe Busquin, EU Research Commissioner said ‘The Commission is proposing the objective that all students in science, engineering, or business studies receive at least basic training on intellectual property rights and technology transfer.’ The UK Engineering Council current standards for the training and registration of Chartered and Incorporated Engineers [UK-SPEC] sets out for the first time threshold standards of IP competence and commitment for a Chartered Engineer, which includes an ability to ‘secure the necessary intellectual property rights’. This is a breakthrough, which should influence academic curriculum designers to include opportunities to develop IPR awareness and competence.

Takagi (2004), Executive Director of World Intellectual Property Organisation, said ‘In view of the expanded role of IP in knowledge-based economies and societies, it is increasingly important to teach IP to students who do not have a legal background’. WIPO recognises that those in need of training in the field of IP has expanded. ‘The increased scope of beneficiaries and consequent interdisciplinary-nary nature of the task at hand is underscored by a brief look at the consecutive steps in the IP value chain: IP assets creation, protection of IP, commercial exploitation of IP, and the maintenance and management of IP. This continuous chain will create sustainable economic development with an accumulation of national knowledge and the enhancement of technological capacity. An effective IP value chain needs not only proactive support from the government and civil society, as well as academia, but also the mindset of innovators, entrepreneurs, inventors, authors, and performers who are actual creators of IP assets’.

IRPs pose challenges, risks and benefits to any operation. If IPR is to deliver its true worth to an organisation, its value needs to be understood in many different contexts, including buying, selling, and investment. Most companies these days will not undertake a new venture without a thorough analytical IP plan. In the commercial and business world, the development of new tactics and new strategies for deployment of intellectual property rights for commercial advantage has been identified as the next corporate challenge on the battlefields of the Knowledge Economy (Rivette & Kline, 2000). ARM Holdings plc’s ARM® technology has shaped a new era of next-generation electronics: ARM Powered® processors are pervasive in

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The strategy for embedding intellectual property in the undergraduate curriculum to achieve awareness and competence in graduating students should be undertaken in a comprehensive manner. Ideally, there would be support from the central offices of the University for implementing intellectual property across the disciplines of the different faculties. In such cases the institution may invest centrally in electronic resources and a parallel staff development programme. At Faculty, Department and Programme levels implementing the map will require a level of commitment to ensure the suggested amendments to current curricula and syllabi survive the academic democratic processes that have a default tendency to preserve the status quo, rather than to innovate.

The implementing team should have the support, if not the membership, of the Faculty Head and should include Head of Learning & Teaching, together with programme leaders, at least one of whom would be a committed IP competence supporter of the introduction of IP to programmes make. An IP competence champion will be required to ensure that syllabus changes take place, and conform to course documentation and accreditation requirements. The IP competence champion will also be instrumental in ensuring staff development opportunities are in place to enable colleagues to develop subject content and produce IPR related learning resources.

Another level of implementation may be at the subject co-ordinator, “grass-roots” level. An IP subject co-ordinator can work ad-hoc across the Faculty without the need for a widespread, systematic and planned implementation. There are a range of options (levels) available depending upon the suitability of the subject and the capacity of an educator to integrate IPR within their environment. The design and delivery of IP teaching within any particular syllabus will depend on a number of factors including learning outcomes and resources. The IP lecturer will be involved in a series of decisions including what aspects of IP to focus on, including legal, financial, ethical, commercial, strategic, or risk; as well as when and how students will best learn about intellectual property.

It is unlikely that a Faculty team, especially one with no IP expertise, will be able to achieve integration of IP into the learning and teaching of students across programmes without external assistance. The IP implementing team should bring in some one with expertise in the teaching or practice of IP management, from the e.g. university’s Technology Transfer Office, Business or Law faculty local Patent Attorney or IP lawyer, or National IP or Patent Office. Assistance with the design of staff development activities as well as learning and teaching resources would be valuable.

3.2 DEVELOPMENT, ASSESSMENT & IMPLEMENTATION STRATEGIES

Development:

Opportunities for staff to develop IP management skills will increase their confidence in working with students. It should also enhance their professional abilities.

Brief the Library and Learning & Teaching support staff to be prepared for intellectual property queries from faculties other than law. They should be able to locate useful recent hard copy acquisitions or electronic additions to resources. Workshops on curriculum development, involving colleagues from different faculties, will be useful. As will interdisciplinary groups to develop case studies, discuss interdisciplinary assessment tasks, and placement opportunities. Developing a cross faculty group to share good practice via a virtual learning environment would eventually build into a valuable resource.

Assessment:

Summative assessments [for which the mark achieved goes towards a named award] and formative assessments [from which the learner receives formative feedback] are both appropriate means of reinforcing intellectual property learning.

Summative assessments: Award a proportion of marks in a technical assignment to:

- An evaluation of the intellectual property inherent in innovative project work
- A review of patents that relate to the technology
- A review of design right or design patent that protect individual character
- An outline of steps to taken to protect copyright in a creative work
- A critique of a media report of an intellectual property based business decision or dispute
- Draft a patent specification [or design or trade mark specification] for assigned work

Formative assessments:

Small group analysis of the intellectual property in a well known consumer item, followed by database search to identify registered IP
Implementation over Time

Embedding IP into the curriculum takes time. It will not happen overnight, nor as a result of a big bang. Here’s how it might work over a 3 year period in an engineering faculty where there had previously been no IP education and where the faculty is committed to incremental development of IP education within the syllabus.

First Year
- Level 1 Induction – an introduction to intellectual property – UKEC SPEC
- Guest lecture from IP professional
- Introduction to national office website
- Review IP in a consumer item
- Level 2 Search patent database for patents similar to technical assignment
- Level 3 Review confidentiality and non-disclosure arrangements for final year show

Second Year
- Level 1 Include IP references in learning & teaching materials, module handbooks, case studies etc
- Level 2 Review patents and trade marks policy of placement company, or major industry player
- Use case studies with intellectual property references
- Level 3 Review intellectual property policy of the University and discuss how it impacts on student work

Third Year
- Level 1 As in first and second years
- Level 2 Draft a patent specification for technical assignment
- Include IP references in learning & teaching materials, module handbooks, case studies etc
- Level 3 Intellectual Property Management optional module available
- Core module includes reference to intellectual property recognition and protection
- Final Year dissertation to include intellectual property reference

3.3. EXAMPLES FROM ACADEMIC PRACTICE

The 'advice letter' is one way to present student engineers with intellectual property learning in a way that does not make excessive demands on their resources of time. Nor does it require intellectual property expertise from their tutors or professors. Instead, the ‘advice letter’ involves the engineers in a self-managed learning exercise.

The advice letter

IP lawyers, who in turn provide a letter containing IP advice. The IP lawyer’s advice can be quite wide ranging, determined to some extent by the information provided by the engineer. Advice can be provided about national and international commercial exploitation. Engineering students are advised that the legal rules concerning employee’s patentable inventions don’t apply to undergraduate project work [that is, so long as there has been no additional undertaking that someone funding the project has rights].

IP Law students at Bournemouth write one assignment as an IP Adviser to a design engineering student ‘client’. The IP students must advise the design engineers on the intellectual property potential of their final year projects. The assignment tests the IP students’ ability to identify appropriate advice and apply it. Whilst the text of the advice letter must be intelligible to the design engineer, the IP student is expected to submit a full appendix of the legal authority on which her advice has been based. The exercise has benefits for both groups of students in enhancing graduate employability skills. The IP lawyers get clinical experience of drafting advice. The design engineers receive intellectual property information they would not otherwise have had as well as receiving clinical experience of presenting their ideas in dialogue with a professional adviser. This assignment helps reduce plagiarism because the advice has to be tailored to the client’s needs.

When the most recent cohort of engineers completed their feedback sheets, there was overwhelming support for doing the ‘Advice letter’ exercise again next year. Most of the engineers had had more than one email contact with their IP lawyer. If anything, the engineers were asking for more contact with their IP advisers earlier in the project cycle, and for more contact. They found the information in the advice letter useful, and would use it in compiling the design report they are expected to produce for their project work.

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Benefits of working in partnership with a law student, rather than seeking advice from other sources, are clear. By having to describe the project to the lawyer, the engineer is rehearsing the process of articulating his work to a non-engineer. There is the opportunity to test ‘consumer’ aspects of the project work. There is also the chance to experience for the first time describing his work to a professional adviser. Following the ‘advise letter’ assignment, two engineers decided to approach a patent agent with a view to pursuing a patent for their invention. The patent agent wrote to their professor ‘It was such a pleasure to meet these two. They were able to describe their work in words and drawings. It took much less time for me to formulate my advice to them. Being able to communicate so well saved me time, and them money!’

The Enterprise Agenda

Universities are increasingly urged to integrate enterprise education into programmes. It is often a challenging task to squeeze yet another topic into the crowded syllabus. Where students are encouraged to participated in a ‘client adviser’ encounter across the disciplines there is an added bonus. By involving students from engineering or technology and students from business, finance, management or law both groups are encouraged to think along ‘enterprise’ lines. For law students, in particular, finding opportunities to infiltrate enterprise thinking alongside substantive legal study is not easy. The students can bounce ideas off each other. Together they can explore ways in which an innovation can, through wise use of the law, be exploited commercially.

The Intellectual Property tool box

The Intellectual Property tool box is a ‘device’ for bringing together different aspects of intellectual property, as they might impact on the graduate engineer during her studies, or after having left the university. The ‘tool box’ can comprise hard and electronic resources, as well as inputs from engineering academics, professional advisers, managers, lawyers, accountants.

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<tr>
<th>CONTENTS OF THE GRADUATE ENGINEERS IP TOOL BOX</th>
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<tr>
<td>• Broad, rather than deep, understanding of intellectual property</td>
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<td>• Awareness of implications surrounding disclosure and confidentiality</td>
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<tr>
<td>• Linkages between IP, innovation and business development</td>
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<td>• Awareness of cultural differences between university research and business development</td>
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<td>• How not to be taken advantage of in IP matters</td>
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<td>• Who to ask for advice</td>
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<td>• Where to find and How to use patent information</td>
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At a more sophisticated level, students should be able to understand

- What goes into a patent application and why
- Time scale and costs of patent protection
- Implications of steps to be taken, or avoided, in the patent process
- Relevance of patents
- IP is more than just patents – Trade marks, copyright, design rights
- Intellectual property ownership
- Non disclosure agreements

Learning outcomes

Skilful use of learning outcomes in the design of a programme can provide the framework within which intellectual property awareness and competence can be learnt as an outcome of professor led or self managed student learning. The scope of an independent learning outcome is determined by the amount of resource available, and the level of the student. For the integration of a key, but not core, topic into the curriculum, learning outcomes can reflect its significance. In the worked example below, students product design engineers were allocated only one two hour period for intellectual property rights. The lecturer responsible for the class had no intellectual property expertise and was unsure how to get the most out of the session. The learning outcome for the students was that they should be able to locate and apply intellectual property information.

It was felt that if the lecturer prepared a two hour lecture, it would be impossible to cover all the sources of information and the ways in which it could be used. The UK Patent Office was an ideal resource to deliver a focussed, deep learning experience where the teacher is not an expert in the field. The site is a very well thought out resource which has been constructed to meet the needs of complete ‘IP’ novices, as well as IP professionals. By being introduced to the website in class, the students became aware of the different substantive IP rights [patents, copyrights, trade marks and designs]. She can see how they are recognised and protected. She can also see how much it costs to apply for and maintain patents, trade marks and registered designs, and how the intellectual property rights work together in respect of any particular innovation.

By being introduced to the databases of registered rights, i.e. Patents, registered trade marks and registered designs, the student understands the importance of research before investing time in ‘reinventing the wheel’.

Patent databases in particular are valuable sources of technical information. They are increasingly becoming recognised as an indispensable in the engineer’s ‘tool kit’. Drafting a learning outcome to include ‘the student will be able to search a patent database’ or ‘the student will be able to prepare a report of relevant patent applications’ provides the student with an opportunity explore e.g. The European Patent Office’s database, Espacenet. Students respond positively to working in this way with an internet resource.
It was stressed that patents, in particular, should not be taught uncritically. Students need to appreciate that applying for a patent is not always the most appropriate course of action. Teaching should involve use of role models and case studies. Learning outcomes should focus on a mixture of attitude, competence and knowledge captured in this matrix:

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<th>Attitude</th>
<th>Ability to: appreciate the ethical view; recognise that intellectual property is integral to an engineer’s work, that awareness of intellectual property rights is everyone’s responsibility</th>
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<tr>
<td>Competence</td>
<td>Ability to: implement initial steps to protect; know who to consult for further advice, and when; identify the context in which intellectual property rights are being used or created</td>
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<td>Knowledge</td>
<td>Ability to: understand the legal frameworks governing intellectual property rights and their commercial exploitation; fulfil responsibility of managing an intellectual property portfolio; appreciate the human resource issues and recognise the benefits of learning from history</td>
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4. CONCLUSIONS

Young engineers should not expect to become IPR experts, but they do need to know enough before graduating to be able to use IP resources in the future, and to feel confident they know

- where to find patent information,
- when it is time to call in an expert,
- how to commence the dialogue with a professional intellectual property adviser.

Karl Heinrich Oppenlander (1990) was the first to say ‘If a young engineer comes into contact with patent information at a very early stage, during his training if possible, he will use this source of information regularly since he will already be familiar with it’. If taught early, starting in the freshman year, and often throughout undergraduate education, intellectual property will become ingrained into the students’ creative thought process. If they have an innovative idea, it will be second nature to check whether something similar has already patented by doing a quick database check. It fosters respect for the value in innovative ideas, which in turn underpin the new business model based on licensing rather than manufacture.

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