Engineering Enterprise through Intellectual Property Education – pedagogic approaches

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Abstract: - Engineering faculties, despite shrinking resources, are delivering to new enterprise agendas that must take account of the fuzzying of disciplinary boundaries. Learning and teaching, curriculum design and research strategies reflect these changes. Driven by changing expectations of how future graduates will contribute to the economy, academics in engineering and other innovative disciplines are finding it necessary to re-think undergraduate curricula to enhance students' entrepreneurial skills, which includes their awareness and competence in respect of intellectual property rights [IPRs]. There is no well established pedagogy for educating engineers, scientists and innovators about intellectual property. This paper reviews some different approaches to facilitating non-law students' learning about IP. Motivated by well designed 'intended learning outcomes' and assessment tasks, students can be encouraged to manage their learning... The skills involved in learning about intellectual property rights in this way can be applied to learning other key, but not core, subjects. At the same time, students develop the ability to acquire knowledge, rather than rely on receiving it, which is an essential competence for a 'knowledge' based worker.

Key-Words: engineering enterprise, intellectual property, curriculum, self managed learning

1 Introduction

1.1 Innovators & IPRs

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.

Intellectual Property Rights [IPRs], are the result of national and international legal regimes translating intangible new, original, innovative ideas and creations into marketable commodities. 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 understand IP basics to protect their creations. Also, IP searches can indicate the growth of different engineering fields. Furthermore, 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!'[1]The idea of engineering enterprise surfaced in the UK Government's 1980 Finniston Report[2] as part of the undergraduate experience is gaining ground. In May 2003 Philippe Busquin, EU Research Commissioner said[3] '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][4] 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' [5] WIPO recognises that those in need of training in the field of IP has expanded. 'The increased scope of beneficiaries and consequent interdisciplinary 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.'[6]

IPRs 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)[7]. 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, 2003)[8]. IBM Microelectronics' makes sure its broad IP library, leading-edge semiconductor process and manufacturing capabilities are available to designers worldwide. Other firms obtain patents in order to 'block competitors'. Some, rather than license carefully chosen individual patents interact over entire portfolios. An engineer from the first day at work may be required to sign agreements concerning disclosure, development, and ownership of IPRs, so it is important to hit the ground running. Engineers are exposed to and create a company's proprietary and confidential information. They need to be aware of the risks and obligations in using someone else's proprietary IPR. IPRs affect an engineer in all aspects of professional development, whether as an employee or running their own business. Such attributes are needed not only by students wishing to go into business for themselves, join start ups or become involved in technology management in a large corporation. They are equally necessary for students who will be an intra-preneur, within a small or medium sized company at a more mature stage of its development.

2 Problem Formulation

2.1 IPR in the curriculum

Students are beginning to have encountered IP concepts at school. In Japan, IP education in school is emphasised because ‘Knowledge about the protection and utilization of intellectual property rights is important to every citizen in order to ensure that Japan establishes for the 21st century a society based on creative science and technology’[9]. Kingon et al (2002) sees IPR and other legal issues as a component of entrepreneurship curricula in the engineering schools, alongside business modelling, finance, negotiation skills, marketing and opportunity recognition.[10] At Pennsylvania State University engineering and business school academics have developed required and elective units, which include one comprising finance, marketing and IP.[11]

Hennessey[12], at Franklin Pierce Law School suggests that there are three barriers to the inclusion of IPR in the non-law curriculum

(i)the engineering curriculum at most engineering and technical institutes is very concentrated and focused on acquisition of the knowledge and professional skills needed to become licensed as engineers

(ii)professional engineering organizations do not require an understanding of IPR as an area of knowledge within the engineering discipline

(iii)the absence of a member of the faculty who is qualified to teach the subject. His last suggestion is supported by research which showed staff responses[13] to requests to teach non-core professional skills included:

- I shouldn’t have to teach this
- I don’t know how to teach this
- If we had decent students in the first place, I wouldn’t need to teach this.

Once the students understand the link between IPR and commercial exploitation, they respond positively to IPR classes, particularly when examples and case studies relate to their practice.[14] Expecting graduates to wait until they start their careers to learn about how IPR operates in the workplace leaves them vulnerable.

A few years ago a final year student wrote to an international low price furniture manufacturer describing his innovative project, and invited the company’s support. The company replied that they did not work with students. Six months later his item appeared in their catalogue. In four years of an engineering product design course, no-one had flagged up to the student the importance of confidential disclosure to the student. A patent agent recently commented: ‘What I suspect is incontrovertible is that the more aware of the basics, the less likely engineers are either to throw away valuable assets for themselves or their employers.’[15]

2.2 Academic Engineers feedback

When engineering education conference delegates in Europe, Australia and Japan, discovered I was an IP academic they were anxious to discuss the status of their own intellectual property, Most had not mentioned IPR to their students.

Questions put to engineering education conference delegates:

Do your consider IPR awareness to be an enterprise skill? *85% yes 15% no*

Does IPR feature in your undergraduate engineering course content? *25% yes 57% no, 18% not sure*

If **YES**

in which module is IPR taught? *Management, Professional Practice, Innovation, Law*

at which level is it taught *Level I or Level H*

Who teaches IPR awareness? *Specialists, Law Faculty, Engineers, not sure*

How many hours are students expected to spend on IPR [contact]? *Responses ranged from 1hour – 30 hours*

What resources are used? *Government publications, lecturer’s own, not sure*

Is IPR awareness assessed [formatively or summatively], and if so how? *Responses included: part of a written assignment, exam question, probably not*

If **NO**

Is it because:

The syllabus is too crowded? *29% agreed*

Engineering academics are reluctant to teach an unfamiliar topic? *31% agreed*

IPR is not an explicit benchmark or accreditation requirement? *22% agreed*

Other reasons:

Qualitative reasons for not teaching intellectual property implied an aversion amongst engineering academics to get involved with teaching IPRs, and reasons given included:

- It is no one person's responsibility
- It would be seen as a 'soft' subject rather than 'hard' engineering
- Awareness is not there yet
- It's only a matter for those in industrially related research
- It's a subject that ought to be taught by experts
- If a colleague really wanted to teach it, maybe time would be found
- There are more important things engineers need to know about: standards, safety etc.

Most reasons given for not including IPR were grouped around the following, and bear out Hennessey's suggestions above:

- The syllabus is too crowded,
- Academics are reluctant to teach an unfamiliar topic.
- IPR is not an explicit benchmark or accreditation requirement.

Engineering academics who recognise the need to present IPR to students, may find it hard to find support. An engineering colleague wrote 'I want to bring home the bits of IPR that will affect them. As I am not an expert on the subject I am inclined to keep it in general terms and hope that the basics sink in. Any comments as to how I can enhance the learning experience would be much appreciated'. His materials showed he knew what the students *ought to learn* about IPR, but was not clear how best to use the short time at his disposal to ensure they *actually learnt* and retained some understanding.

There is no consistent approach discernible from a review of university websites. 'In engineering, faculty who are interested in, but not formally trained in, entrepreneurship, management, or business are initiating the offerings'[16] Where an engineering dean or professor has had personal experience of the patent system or has been involved in setting up a spin out company, s/he is more likely to introduce IPRs to students, especially if responsible for promoting entrepreneurship and enterprise.[17] Where such teaching takes place, it is likely to be innovative and experimental, 'with little apparent constraint imposed by academic conservatism'.[18] Dr Rob McLaughlan[19] observes that there is no well established pedagogy for the diffuse integration of this non-specialist education into the engineering curriculum.

The development of such a pedagogy would help higher education institutions develop student capacity in these fields in a more integrated and intentionally connected way than is currently done.[20]

It is important not to underestimate the primacy of core strands. The prime intended learning outcome for a civil engineer must be to design a bridge that won't collapse. Safety and standards are the most important elements of an engineering programme. If the syllabus really is crowded, and there is no IPR specialist available, are there ways in which non-core aspects, like IPRs, can be shoe horned in to the students' learning experience?

3. Problem Solving

3.1 Learning & Teaching initiatives

Where an engineering faculty recognised the need to include IPR, there are several ways in which material can be taught and assessed. Hennessey[21] identifies five styles of intellectual property law teaching:

- The case method
- The problem solving method
- The simulation model
- The clinical method
- The doctrinal method

Each may be appropriate, depending on the time available in which to deliver the material, the background and level of the student, and the intended student learning outcome for the course.

The case method involves students considering an IPR issue through reading an actual decision in which legal principles have been applied. It is an appropriate method to use with a post graduate group taking a credit bearing unit, where the expectation is that the students will undertake additional IP law reading in support of classroom [or equivalent online] activity.

I have used the case method with a small group of postgraduates in a patent law unit on the MA Intellectual Property Management course at Bournemouth Both the students and I were nervous as to how the group, with different undergraduate experience, would respond to the exercise. The group comprised a diverse range of disciplines including law, business, science and technology. In the early stages of discussing the case, the lawyers explained legal terminology, the science people could explain some aspects of the technological subject matter. The business oriented students could look from a business perspective at why the two parties were in dispute, rather than choosing to settle out of court. It was a refreshing encounter, from which all members of the group went on to engage with more confidence on the legal principles of the case.

The problem solving model provides opportunity for effective classroom activity which can be adapted for groups at any level, in credit bearing units or 'brief encounters'. I have enjoyed the feedback of students who, knowing nothing about IPRs, engage in animated discussion of why two companies were locked in courtroom battle over a patent. The students contribute what would they have done in their place, and are then more receptive to learning about patent law and licensing.

The simulation method can be used effectively by presenting students with a low tech, simple patent specification and encouraging them to write one for their own innovation. A local patent attorney could be invited to comment. Students who have had hands on experience of drafting their own patent application, however simple, learn the importance of describing their work in language that will make future meetings with patent advisers easier, shorter, and slightly cheaper.

The clinical method can be used successfully where intellectual property law students work with engineering students to give 'professional' IPR advice on their technology project work. The 'engineers' get practice in articulating their technical innovation in a way that makes sense to a professional adviser, and benefit from dialogue with the 'lawyer' who presents written IPR legal advice. The 'lawyer' is encouraged to look holistically at exploitation potential in the 'engineer's' work. The students' work can be formatively or summatively assessed.

The doctrinal method doesn't encourage the student to appreciate the continual evolution of intellectual property law, nor is it designed to equip the student to know where to access up to date information, at the appropriate level .

Two further examples illustrate how different Universities have approached the design of effective learning experiences for non-law students, using traditional legal education tools. At Hong Kong University of Science and Technology, engineering students use a standard law faculty teaching tool, the student moot court[22]. Their moot court debates reinforce student understanding of intellectual property concepts, and reinforce analytic, verbal and reasoning skills. At Massachusetts Institute of Technology a licence negotiation role play gives computer science students at the start of their course the opportunity to participate in a role play simulation of an intellectual property licence negotiation.

In all of these examples, the non-law students are presented with a learning activity that relates to their core discipline, and offers meaningful engagement with IPR principles and concepts. They have all been designed by academics who have acquired IPR expertise, for delivery on courses which acknowledge IPR sufficiently to allocate it some resource of time.

Some engineering academics suspect that students might experience assessment difficulties studying a subject from another discipline. This would result in lower assessment grades, which would reflect negatively on the work of the engineering faculty within the institution. (Dodridge 1999)[23]. This has not been the case in Bournemouth, where the Design Engineering and Computing faculty has noted no disparity between marks scored for IPR exam questions and questions on other aspects of professional practice[24].

3.2 Japanese Model

The Japanese Government sees IPR competence as key to increasing international competitiveness of industry and stimulating the economy. They passed legislation (2002)[25] that requires universities and similar institutions to promote education and learning on intellectual property. Four Japanese universities have been tasked with researching IP education at four stages: school, undergraduate, postgraduate, and lifelong learning.

The Osaka Institute of Technology[26] is required to research the undergraduate stage. It has identified a human resource need for 'para-intellectual property professionals' who have an understanding of science, technology, and intellectual prop erty management. It has recently received government approval to run a four year undergraduate programme that covers

- Fundamentals of intellectual property
- Related areas within engineering
- Venture creation and industrial management
- Intellectual property prosecution
- Intellectual property management
- Intellectual property strategy
- International legal affairs
- Internship in the intellectual property department of a large company, or with an intellectual property attorney
- Preparatory research
- Thesis research

Osaka Institute is well aware that the degree in Intellectual Property will not address the issue of integrating IPR across the undergraduate non-law disciplines. It will be interesting to monitor the influence of an IP department operating outside of a law school, working in close collaboration with science and technology faculties. Tanami(2004) acknowledges the difficulties imposed by the absence of an established pedagogy for the inclusion of IPR in the non-law curriculum. There is insistence from Japanese government and business that such a pedagogy be developed.[27]

3.3 Using self managed learning

Engineers, like most academics, are justifiably reluctant to stand in front of students to teach unfamiliar topics. But is it essential to be an expert to create an effective student learning experience? It is easy to use ignorance as justification for keeping rigidly within disciplinary guidelines, when ignorance can in fact be a valid starting point for facilitating learning. Dr. Johnson said 'Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information on it'

When a client requested the Law School to provide a short course on IPR for their staff working on embedded software, the request was accepted, even if none of the IPR team was exactly sure what embedded software was. Before proceeding to design the short course, the IPR team commissioned a one-hour tutorial from an expert in electronic engineering. He was able to pass on sufficient understanding of the rudiments of embedded software, for the team to contextualise their IPR teaching. The staff participants enjoyed the course sufficiently to commission a second one.[28]

Knowles'[29] theories of the way in which adults, as opposed to children, learn make the following assumptions: that adults need to know **why** they need to learn something, need to learn **experientially**, to approach learning as **problem-solving**, and that they learn best when the topic is of **immediate value**.

Undergraduates are adults and appreciate **why** they are being introduced to IPRs, and are motivated to learn about intellectual property because it is relevant to their future career.[30] . Getting students to undertake tasks that engage them with website resources gives them necessary **experience**. Students' resourcefulness should not be underestimated. They are well able to respond to IPR **problem-solving**, bringing skills from their core discipline. Integrating the students self managed IPR work into the assessment strategy of the course satisfies Knowles' requirement that the learning be of **immediate value**.

By linking independent learning outcomes with assessment strategies, using appropriate resource based learning activities, students can be motivated. Kaplan(2003) acknowledges ‘Engineering professors are known to give projects, but not many incorporate IP into their project requirements. References are sometimes required, specifically to copyrighted material but rarely are patent or trade mark searches required for projects. This is a disservice to engineering students.’

It does not require IPR expertise for an engineering student’s project work assignment to require a brief report including:

- evidence of having searched the appropriate patent databases,
- retrieved the necessary information, and
- applied the findings to the project

Through preparing that brief section of the report, the student will have achieved intended learning outcomes, which could include the ability to

- locate and compare patent documents
- identify the stages of applying for a patent
- evaluate appropriate intellectual property protection, and more.

If independent student learning outcomes are be drafted to include IPR awareness and competence[31], activities can be designed which give the student an opportunity to gain the relevant knowledge. UK Patent Office[32] and European Patent Office esp@cenet[33] websites are intended to be used by IPR lay people. They are well designed to answer questions, and provide all the necessary information to understand how the IPR system works. They are user friendly, and ‘free at the point of consumption’. Worked examples that relate to the three stages of undergraduate study, using the UK Patent Office and European Patent Office espacenet websites are available as a resource.[34] They are designed to be used effectively on courses where there is no intellectual property academic to manage student learning of IPRs, and little time to devote to the subject. Simultaneously, the student acquires relevant career skills since engineering will become more knowledge based, where value will be placed on the active ability to acquire and apply knowledge, rather than the passive tendency to wait to receive it. Assignments could be designed to enable students to demonstrate what they have learned, and assessed summatively, formatively or on a completed/not completed basis.

Where a course team lacks intellectual property expertise, it could be useful to call in the help of an intellectual property academic or practitioner to sit down with the technologists to draft outcomes and activities, and explore possibilities for assessment[35]. Research amongst IP academics reveals a growing number prepared to engage collaboratively with science and technology faculties across disciplines.[36]

3.4 Transdisciplinary approaches

We are witnessing radical changes to University work, including traditional approaches to academic research. The classical or liberal model of the university[37]is disappearing. ‘Massification and democratization mean that universities are no longer so intimately associated with the production of scientific and professional elites’ (Delanty, 2000). These are significant changes that can be seen as opportunities to forge collaborative cross faculty partnerships, which might undertake applied, industry facing research that will produce transdisciplinary knowledge, which Gibbons (2000) identified as Mode 2 knowledge, in contrast to single disciplinary knowledge, which he labelled Mode 1.

Gibbons’ Mode 2 knowledge is intended to be useful, whether to industry, government or society. It can be produced by coalitions of academics working across the disciplines - within the university, or with external partners in industry and commerce. Engineers would work well with IPR specialists in Mode 2 with benefit to both disciplines:

- Engineers would know how to build safe bridges, AND how to exploit their innovative techniques of building bridges safely.

- Lawyers would have a clearer understanding of how the law impacts on their clients' business interests
- Engineering and Law academics could develop opportunities, separately and together, to conduct transdisciplinary research, and enrich their teaching.

Simulated inter-professional encounters help break down the walls between traditional, highly specialised functions leading to more fluid forms. Research and development alliances in large global enterprises involve engineers working with different professions, each bringing their expertise to complex problem solving. But the fuzzying of disciplinary boundaries[38] is happening very slowly in universities. Graduates from different disciplines need the capacity to cooperate with experts from other fields, to see problems in a complementary way, because employers want flexible, multiskilled graduates, open to learning, and equipped to respond to the rapidly changing nature of the workplace.

It is not easy to set up transdisciplinary institutional structures within the academic community, where a sense of disciplinary identity is the norm: engineers must be able to design a bridge that won't collapse, lawyers must have lawyering skills. But it is necessary to find a balance, to promote and manage both.[39] Intellectual property has traditionally been taught as a law subject to law students in law faculties. Suggesting IPR be introduced as a transdisciplinary element of a science or technology programme, might challenge the established concept that it has to be taught by lawyers. It opens the way to developing a pedagogy of engineering enterprise education, which embraces IPR as a key skill to be acquired through innovative student centred learning resources.

4. Conclusions

Engineers do 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.

Kaplan (2003) says 'Of all the academic disciplines, engineering may encompass most of the patentable breakthroughs, yet some engineering students are never exposed to IP education. If taught early starting in the freshman year, and often throughout tundergraduate education, IP education will be ingrained into the students' creative thought process. It will also give the undergraduate engineering student other options upon graduation, perhaps to study patent law or technology transfer.'

Change in the Knowledge Economy is rapid, for students and academics. The 'threat' to non-law academics of having to include intellectual property awareness in the curriculum should be seen as an 'opportunity' to engage with a vital topic that links commercial, legal and technical disciplines. Karl Heinrich Oppenlander (1990)[40] said 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'.

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