ASSESSING THE UNDERSTANDING OF INTELLECTUAL PROPERTY IMPLICATIONS OF AI USE IN PRODUCT DESIGN UNDERGRADUATES

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ABSTRACT
This paper examines the understanding that current first year undergraduate product design students have of three key topics: intellectual property (IP); artificial intelligence (AI) technology in product design; and the intellectual property issues related to the use of AI technology. 62 students were asked 15 questions relating to these topics resulting in various findings.
This study underscores the need to deepen and broaden product design degree course curricula on IP and AI tool use, to meet the uptick in AI tool use in design practice to preserve an alignment with the expectations of accrediting bodies and students.

Keywords: Industrial design, intellectual property, artificial intelligence, generative AI

1 INTRODUCTION
As of the time of writing, the last few years have clearly shown a general progression and adoption of AI technologies throughout work and life. Although the term is used liberally by companies, with many being purely a marketing gimmick, there are countless instances where AI technology has truly been utilised as part of a workflow. This increase in use has seen with it an increase in concerns regarding the ethics and legality of using AI technology, specifically generative AI (GenAI), where the large datasets at the basis of each technology's training data coming from the open web. These concerns raise questions around intellectual property and ownership of images used for training and those created by the GenAI tools. This increase in AI adoption has seen a resulting increase in discussion in technological and legal spheres, around the Intellectual Property (IP) issues relating to AI technology use but is also found in general public discourse. Of course, an understanding of IP is clearly one of the business-related topics that is integral to the learning outcomes of any design degree, yet these business-related topics in many cases is found lacking in design education [1] even though calls have been made in recent years to increase [2] and broaden [3] the teaching of IP issues in design education.

2 BACKGROUNDS
An example from recent times where the discourse on patens reached a wider audience were the "patent wars" between Apple and Samsung Electronics Co. between 2011 and 2018. In various US-based legal cases, each party accused the other of infringing on their patents with the design of the Apple iPhone and Samsung Galaxy smartphones. Within the design ecosystem, product / industrial designers must be cognisant of the full gamut of IP types, dealing with the physical performance and look, as well as graphical and others, a case well-made by Stauffer [2]. With this increase in discourse on IP, is it perhaps time to amend the curriculum of our engineering and product design students? Do engineering and product design students require a greater understanding of IP topics so that if they use AI tools within their design practice during their studies, they do so from an informed position?
The current AI applications within design practice are diverse, with countless more in development. Figoli et al provides a comprehensive review of various applications of AI across the design sphere over the last twenty years [4]. In product design, studies have examined AI technology applications, ranging from concept generation phase [5] to use to when sketching [6]. Although the trend of AI use within design is on the rise, the latest studies still indicate that in various use cases (i.e. mechanical design [7]) results have to considered critically, especially in terms of the viability of results [8], [9].

This critical standpoint extends beyond the quality of the AI-generated results themselves, to the meta-attributes of the results, around various issues, including IP. The two key IP concerns with the use of AI technology in product design: copying the work of others, and the ownership of the work created. Infringement on existing works is nothing new in design, but with the public-web-sourced training data and black box approach taken by AI technologies, there is a risk of uninformed infringement [10], or miss attribution [11]. There is debate as to the ownership of AI-generated, with many calling for further discussion and change, i.e. Hudika et al. [12]; while others suggesting a solution, i.e. Guadamuz [13].
For professional bodies such as Institute of Mechanical Engineers (IMechE)[A] and the Institute of Engineering Designers (IED)[B], to achieve course accreditation, students must demonstrate and apply their knowledge of engineering management principles, which includes IP. Professional body course accreditation is a point of pride and a major selling point for many universities with it being the initial step towards chartership (through the Engineering Council's Accreditation of Higher Education Programmes (AHEP)[C], with chartership, and its required topics, too being of value to employers.

2.1 Research Aim

The aim of this study is to determine the extent of understanding that novice design students have on both artificial intelligence technologies that are relevant to design practice, and intellectual property subjects with a view to identifying what need there is for a change in IP education to reflect the influence that AI technology is having on design practice. To address the research aim, this study looks to answer the following research questions:
RQ1*: What understanding do novice design students have on current design-related AI technology?*
RQ2*: To what extent do novice design students understand the subject of intellectual property as it relates to design?*
RQ3*: To what extend do novice design students understand the issues relating to the use of AI technology in design practice and intellectual property?*

3 METHODOLOGIES

As the research aim and questions consider novice design students, a cohort of first year undergraduate students in their first semester of study were required. These novice students were given time within class and given instruction to answer a questionnaire on various topics, using Microsoft Forms. A total of 15 questions were asked in a specific order (shown in ***Table 1****Table 1*) to lead the student towards the topic of IP issues when using AI technology. An initial 4 questions set to gauge the students understanding of AI technology in general and how they relate to design practice, providing data to answer RQ1. A follow on 6 questions were asked to gauge the students' understanding of IP issues in general and how they relate to design practice, providing data to answer RQ2. The final tranche of 5 questions were designed to assess the students' understanding of IP issues relating to AI technology use in design practice.

4 RESULTS

First year undergraduate students (referred to as Novice Design Students (NDSs)) attending the University of Strathclyde in the Department of Design, Manufacturing and Engineering Management (DMEM) who were enrolled into engineering design-related degrees were selected by the researchers for the study. Data collection was conducted during class time with 62 students consenting to participate during a first-semester lecture. This time was chosen to fit with the students' schedule and to ensure the students were settled into their studies. This section will provide the data given per question, or per question set where follow-on questions were asked.
For Q1.1 and Q1.2, students were provided with three response options: *I have used them extensively*, *I have used them a little bit*, and *None*. Q1.1 responses (***Table 2***) indicate that the majority of NDSs have a small amount of experience using text generating AI tools. Q1.2 responses (***Table 2***) show the majority of NDSs have no experience with text to image generative AI tools. Q1.3 response (***Table 3***) indicate that the majority of NDSs have used ChatGPT.
As to not lead the participants towards a specific topic, Q1.4 was designed to allow students to organically identify IP-related issues to this question without prompt. Students were encouraged to suggest multiple answers to this question, therefore some students answered multiple times. Of the 62 participants, 10 did not answer this question, or stated they could not think of any suitable answers. 66 barriers were identified by the participants, which were classified based on topic and these topics were

collated into various themes, shown in ***Table 4***. Some participants suggested more than one barrier that were categorised into the same theme (i.e. Participant 07 suggesting *plagiarism* and *privacy* as separate barriers), while others were assigned separate categories, (i.e. Participant 40 suggesting *plagiarism* and *creativity reduction*). Of the barriers identified, only 7 participants (12.1%) suggested IP issues as a barrier to use, with the majority of barriers relating to the lack of *human touch* in the design process though the reduction of creativity, skill and control being key issues.

Table 1. Novice Student Designers AI and IP Understanding Questionnaire Questions

No.	Question
1.1	Do you have any experience with text generating AI tools (i.e. ChatGPT)?
1.2	Do you have any experience with image generating ai tools (i.e. Stable Diffusion, Mid-Journey, etc.)?
1.3	If you have used generative AI tools before, which ones have you used?
1.4	What do you think the barriers are to using AI in a professional design job?
2.1	On a scale of 1 – 10 (1 is none; 10 is expert), how familiar are you with intellectual property as a concept?
2.2	List the various types of intellectual property as you understand them?
2.3	Are you aware of any of the following intellectual property related terminologies?
2.4	Have you received training/lessons specifically on intellectual property before?
2.5	To what level have you received training/lessons to specifically do intellectual property before?
2.6	How much time was spent on teaching it? If this was more than one module (a series of classes on the same topic) i.e. Business Studies and Modern Studies, please consider the total cumulative time spent
3.1	What publicly discussed IP issues around AI use are you aware of, if any?
3.2	What problems, if any, do you think there are in general to using AI tools in the design process?
3.3	What is your understanding of the IP-related issues when using AI tools in design?
3.4	Should the use of AI tools for design tasks be taught during your undergraduate degree?
3.5	How important was your degree's accreditation in your decision to enrol at DMEM?

Table 2. NDS Experience with Text-To-Text and Text to Image Generative AI Technology

Response	No. NDSs	Text-to-text AI Percentage of Cohort	No. NDSs	Text-to-image AI Percentage of Cohort
I have used them extensively	5	8.06%	2	3.2%
I have used them a little bit	47	75.81%	18	29.0%
None	10	16.13%	42	67.7%

Table 3. AI Tool Types Used by NDSs

AI Type	Theme	No. NDSs	Percentage of Cohort
None		13	21.0%
General text-to-text generative AI tools	Chat GPT	45	72.6%
	Inferkit	1	1.6%
Text-to-image generative AI tools	Inferkit	1	1.6%
	Midjourney	1	1.6%
Integrated AI functionality in existing platform	Adobe	1	1.6%
	Canva	1	1.6%
	Solidworks	1	1.6%
	Copilot	5	8.1%
AI Study tools	Merlin	1	1.6%
	Goodnotes	1	1.6%
Social media	Snapchat	5	8.1%
	Ticktock	1	1.6%

Q2.1 – 2.3 asked participants to evaluate their understanding of IP issues, to prompt them to think of specific IP types without unprompted, then to provide a definitive list of IP types to establish familiarity of terms. Given a 1-10 scale, the average student rating on their knowledge of IP issues was 3.79.
Responses to Q2.2 were categorised (***Table 5***) into *Pieces of work* where the participants would give an example of work (i.e. artwork) rather than a specific IP type; *Definition*, where participants provided an definition of an IP type, rather than a type itself; and *Examples,* where responses were examples of IP types. Of the responses provided, only 45% of the participants provided suitable examples to this question, with *Patent* (21) and *Copyright* (23) being the most frequently named.
To answer *Q2.3*, the participants were provided with examples of IP types and were asked to select which they were aware of, shown in ***Table 6***. It is noteworthy that when presented with a list, the acknowledgement of IP types increases significantly, with all but *confidentiality agreements* and *non-disclosure agreements* being recognised by more than 85% of the cohort.

Considering Q2.4-2.6 responses 12 participants had received prior education or training IP issues, with 10 having learned about this at school education, shown in ***Table 7***. The majority of these participants received a single lesson on the topic that was less than 1 hour in duration. Notably, one participant who received classes on IP issues exceeding 120 minutes as part of two separate design-related topics.

Table 4. Themes of NDS Identified Barriers to AI Use in Design Practice

Theme	Topic Classifications	No. of answers	NDS per theme	Percentage of responses
IP Issues	Plagiarism, stealing ideas, copyright, ethics, privacy	11	7	12.1%
Ownership Issues	Ownership, credit	4	4	6.9%
Human touch	Creativity reduction, lack of personality, Dependence, skill loss, loss of control	38	31	53.4%
Errors & Inaccuracies	Errors, usability of designs, unfeasible concepts, data quality	7	7	12.1%
Business Issues	Cost, job loss	6	6	10.3%

Table 5. NDS Response Categories (Left) & IP

Category	No. NDSs	Percentage of Cohort
Examples	28	45.16%
Definition	15	24.19%
Pieces of work	6	9.68%
Don't Know	20	32.26%

Table 6. IP Types Recognised by NDSs

IP Type	No. NDSs	Percentage of Cohort
Copyright	61	98.4%
Trademark	57	91.9%
Patent	53	85.5%
Confidentiality Agreement	33	53.2%
Non-Disclosure Agreement	32	51.6%

Table 7. Level of IP-topic education taught to NDS cohort

Duration	No. of NDSs	Percentage of cohort
One class/lesson for approx. 30 - 60 mins.	4	33.3%
One class/lesson for approx. < 30 mins.	3	25.0%
>One class/lesson for approx. 30 - 60 mins.	2	16.7%
>One class/lesson for approx. 60 - 120 mins.	2	16.7%
>One class/lesson, for approx. > 120 mins.	1	8.3%

Q3.1 – 3.3 focus on the confluence of AI use and IP issues. In response to Q3.1, 41 participants (66.1%) could not identify a single publicly discussed IP issue relating to AI use. 18 participants (29.0%) were able to provide one or more examples, while the remaining participants stated that they were aware without giving any examples. Those examples that were given focused on three main issues, *copying*, *providence* and *quality*. The 15 participants gave examples that discussed *copying,* while 4 provided examples relating to the *providence* of that which was created, while one participant highlighted the variability in *quality* of the data produced by AI. In response to Q3.2, participants identified 55 general problems, which were classified based on topic and these topics were collated into various themes (***Table 8***). The most frequent of these (with 13 examples) related to *copying,* while another 12 relating to *originality* and a further 3 relating to idea *ownership* and *legislation*.

When asked about IP-related issues when using AI tools, the results differ, as 45 NDSs were unable to suggest any issue. Of those who did, 10 were categorised as *copying* with a further 5 categorised as relating to idea *ownership.* 60% of NDSs want to be taught AI tool use as part of their degree curriculum. With Q3.5 written to gauge (1-10 scale) the extent to which their degree's accreditation was a deciding factor in their course selection. The average score provided by the participants was 5.95.

Table 8. NDS Identified General Problems with AI use in Design

Theme	No. of DNSs	Percentage of cohort	Theme	No. of DNSs	Percentage of cohort
Copying	13	30.2%	Humanity	6	14.0%
Originality	12	27.9%	Providence	2	4.7%
Quality	10	23.3%	Legislation	1	2.3%
Skills loss	10	23.3%	Glib	1	2.3%

5 ANALYSES

5.1 AI Familiarity

Considering Q1.1 and Q1.2 responses, 54 participants (87.1%) had some experience using either text-to-text or text-to-image GenAI tools. Compared to the previous year's cohort (surveyed as part of a study by Holliman & Brisco), where only 15.38% of 52 participants had experience with GenAI tools [6]. This indicates a profound increase in uptake with AI tools in a single year. The results of Q1.4 indicate that the greatest barrier to using AI tools in design practice are concerns around what the authors have called the *human touch.* These qualities and attributes are inherently human, like personality, but responses in this theme also highlight concerns around the loss of control in the design outcome. These are themselves more emotionally motivated responses, in comparison to those around errors or IP, which were both joint second most stated. For IP-issues, words such as "plagiarism" were often used, showing a degree of naivety, or lack of IP-specific technical vocabulary, yet illustrates concern within the NDS community. In response to RQ1, there is limited understanding of current design-related AI technology, but this understanding will likely increase, considering the yearly increase in NDS AI tool use.

5.2 IP Comprehension

Although the self-reflection score of IP awareness indicates a general lack perceived understanding of IP, the average score given by those who had received some form of training on IP, their average was significantly higher (4.58) than the rest of the cohort who had not (3.6). When considering that the time spent learning IP issues was less than 1 hour, even a little time spent on the topic has value. The value in this prior learning is also shown in the responses to Q2.2, where those with some training were able to provide either an answer that was a definition 40% (6), or actual examples 46.67% (7). This is in stark contrast to the responses from those without training, where *don't know* responses were 35.19% (19), *definition* 16.67% (9), and *examples* 38.89% (21). The *definitions* responses indicate the need for clearer question writing in future studies. Although not as significant, this increase in understanding is also shown in the responses to Q2.3, where the overall average number of IP types identified was 3.80, with those with training averaging 4.08. Overall, these findings suggest that there is poor understanding of IP by NDSs and that even a short time learning has some clear, albeit unsurprising, benefits. Considering RQ2, the level of understanding had by NDSs on IP topics is poor. There are some who may have received tuition prior to their enrolment, but that even then the level of awareness is low.

5.3 Awareness of AI & IP

As such a high number of NDSs were unable to identify even a single IP issue relating to AI use (66.1%), there is clear need that this topic is covered early in NDS's learning, especially when we see the increase in AI tool use, shown in the responses to Q1.1 and Q1.2. From a litigation perspective, it is encouraging that the most frequent issue identified by the NDSs was *copying* which is the most likely cause of recourse if occurred. It is also the most frequently discussed issue in literature. It is further interesting that the NDSs identified issues classified as *copying* more frequently to Q3.2, which was left broad to capture all possible issues. This indicates that NDSs have some novice understanding of IP related issues but are perhaps unaware of what comprises of an IP issue. Considering that a previous question provided a list of IP issues, IP terminology definitions is certainly an area to be addressed in future.

Considering the RQ2 findings, it is not surprising that the answer to RQ3 is similarly poor. There is some awareness and concerns around AI technology use that, from an informed perspective, could be considered IP-related, yet the NDSs themselves do not consider them to be such. As for accreditation being of importance to NDSs when selecting their degree, with an average score of 5.95, there is still perceived value in it, but more emphasis of its value is needed prior to enrolment on the degree course.

6 CONCLUSIONS

From the research findings and the resulting answers to the research questions, NDSs have limited understanding of intellectual property issues in general and that their awareness of those issues relating to AI technology use is also limited. Therefore if we as design educators, increase the discourse and teaching time of IP and include the IP issues of AI use in design within those teachings, then we too should teach the responsible use of AI tool concurrently. Teaching both the ramifications for inappropriate AI use and how to avoid them to provide a robust, holistic teaching approach on the topics. There is demand from NDSs to be taught AI tools use within their degree and there is a lack of knowledge of IP issues, therefore we must increase the time taken to cover deeply and broadly the IP

landscape, its issues and specifically how it affects product design education and practice. This should take place earlier in the curriculum, as with the increased use and widespread availability of AI tools, provides greater opportunity for NDSs to use them equally earlier in their academic and design career.

7 FUTURE WORK

This study should be a starting point to develop suitable pedagogical approaches addressing the shortfall found in students' understanding and desires to learn about AI within design practice. Further studies should be conducted to understand how other student cohorts (i.e. business students) perceive the importance and significance of AI and IP issues to better understand and develop broader pedagogical approaches to address them. Furthermore, a longer study engaging with the same cohort over their degree, could to track the changes in perceptions and understanding of these discussed issues.

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