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Boosting creativity, design and prototyping skills for Engineering Innovation

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Boosting creativity, design and prototyping skills for Engineering Innovation

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Subject Area: Specialist Design

This case study has been developed from data gathered through observations of the teaching component; interviews with the tutor and recent graduates; and a student focus group.

Background

In this unit, final year MEng mechanical engineering students can opt to conduct a masters-level design project instead of completing a research dissertation. This year, 18 students have chosen the unit from the 120-strong cohort. The students work on their own open-ended design brief for a whole academic year; part-time in the first semester and full-time in the second semester. The teaching methodology is based on some of the methods used in Product- and Industrial- Design courses, weekly sessions are based in a studio setting where brainstorming and skills sessions take place. Design work is reviewed and critiqued on a weekly basis and students are expected to contribute to other's work and elicit responses to progress their own designs.

The projects themselves are complete idea-to-innovation projects, in which students are expected to: question, expand and develop the brief; identify and pursue the research needed for their project; define a product specification; develop a range of design concepts; develop detailed solutions and deliver working prototypes. Prototyping takes place in the model workshop, where students are trained at the start of term. The project ideas come from a variety of sources including other academics, industry or students own suggestions. The students are all assigned an individual project supervisor drawn from across the mechanical engineering department.

A number of workshops (classes) are given in the first five weeks to introduce new design skills to engineers such as: user research; technology audits; market analysis; competitive product analysis; mood boards and product styling; and ergonomic studies. Once the students start working on their projects full-time and developing prototypes of their ideas they are allocated an area of lab space where they can work and safely leave their work as it develops. This and simple hand tool areas of the workshops can also be accessed out of hours. The main engineering workshop machinery is bookable during technician supervised times. From week 6 onwards the timetabled sessions are used for design mentoring and peer group tutorial sessions. In week 10 the students present their ideas so far to the peer group. In semester 2 the students move on to the prototyping and product development phases full-time. They meet weekly with individual project supervisors and about 3 times in the semester as a group for a tutorial style session.

There is a moodle page for the unit which outlines the activities and assessment deadlines. This is also used by students to upload coursework submissions such as the mini-studies (short reports on research particularly relevant to their own project) completed in weeks 5 and 7. The early stages of the unit are very structured and encourage students to take a front-end approach to their design development, seeing the importance of researching and developing a detailed product specification before developing design ideas and prototype solutions. All the deliverables are introduced to cope with the difference in nature of the projects − enabling each student to excel. The marking criteria place an emphasis on the quality of the process of design rather than the quality of the final product or report.

Reasons for introducing this teaching method

Elies observed a number of individuals choosing engineering *"because they like designing things"* and this module aimed to fulfil *"their original reason for doing engineering, for choosing engineering."* One of the graduates commented that *"for me that module was basically exactly what I wanted to do at university".* The module has been developed acknowledging that there are a large number of underpinning analytical and technical subjects needed to qualify for a Masters in engineering and a balance has to be struck*; "there's isn't enough space in the curriculum for enough design content for those who are really motivated to do design".* Elies was also motivated to raise the value of prototyping in engineering education *"… there's not enough of that in engineering design in general in the education of engineering design"* encouraging a change in design attitude *"that it's not just good enough to say that it will work on paper, it has to work for real".*

Lecturer's perspective

This methodology was introduced to improve the experience of the students wanting to specialise in design and innovation. The aim is to expose them to the types of product design activity that take place in industry. Through their projects Elies observes that many students understand − for the first time − the importance of market needs and end-users, in driving successful product innovation. As well as the tutor in study, the unit is supported by a Royal Academy of Engineering Visiting Professor (VP) for Innovation − Gareth Jones − who contributes to the timetable teaching and acts as a mentor to the students as they work on developing their product ideas. Gareth is also a VP for the Royal College of Art but sees himself as an engineer first. He feels this complements Elies' interest in the process of the design and passion for the more user-focused and creative side of product development.

This unit has been developed year-on-year, as part of her reflective practice Elies makes notes after each session on what worked well and what activities might need further work before repeating the following year. *"I've structured it quite carefully so that they get exposure to all these techniques and all this [type of design] culture and some of them completely adopt all of it and work all of it into their project and use all the different kinds of tools and techniques and methods that they've not come across; and others will just kind of observe it, watch other people using it and continue with their project as they see fit, it's purposefully designed so that people, I guess, make their own learning journey."*

Elies is proud of the range of design careers that students have gone into following completion of the specialist design unit from freelance consultancy work to starting up their own businesses or using their skills within multinational companies, *"again showing the validity of those skills in all different types of careers".* For her *"the whole thing is a bit unexpected"*, and she has *"been surprised by how much this one unit has affected what people have gone on to do".*

Students' perspective

Overall the students rated the module very highly *"it's the best one I've done at the university, hands down"*. Graduates commented *"I think it's a fantastic module to be teaching to engineering students"* and *"it has really helped me later on in my career and later on in other things that I've designed"*. They were motivated to participate by a desire to get a *"broader view of mechanical engineering"* and the opportunity to develop their own products.

The students highlighted the flexibility of the unit: "*we're given a starting point but then it's really up to us to decide where we want to take it"; "it's good that they're very flexible and open to let you come up with your own ideas"* and the freedom *"to do what we wanted to" and "to make mistakes"; "treating us as adults straightaway"* but within an appropriate support structure *"it was structured properly though, to represent a design project"; "to be given too much freedom then it's bewildering, there's so many things you can do, I guess with the deadlines it focuses you a bit more".*

The students valued the experience of their tutors and links made between the approach the unit took *"it's more representative of design, isn't it"* and industrial processes and practices: *"they always seemed very closely tied to how you'd do it in industry, they gave that impression by giving lots of examples"* and *"I think it was refreshing to have people who are actually giving examples from industry ... to actually see these in the real world…*". The processes and approaches introduced were *"very well backed up by the mentors that came in and talked about their experiences".*

The visits from external visitors also helped to motivate the students, for example recent graduates and design consultancies *"it was kind of like, wow, you could actually do something quite impressive"; "you can actually make something out of your project rather than it just being a project to get you through your degree type of thing. I think that added a bit more motivation"* and *"I think that was quite good, we had a little inside see what the whole design consultancy do, we don't really usually get that from other lecturers".* Overall they felt encouraged to see the unit as being much more than an opportunity to gain marks: *"Elies is very keen for it to be more than a project, she wants you to get a product out of it".* This philosophy also continued for the graduates *"…the foundations of specialist design course and innovation and engineering design degree it's given me so much more than a qualification, it's a chance to start something which has gone on to be my livelihood and gone on to become a reality".*

Issues

The students noted the constraints of this module needing to fit within the structure of the overall Mechanical Engineering programme *"The main thing that I think has been holding it back is the fact that it had to be in line with the main engineering".* The size of the cohort was noted "*I think the group size helps with that [friendly environment], there's not too many of us here to get lost*" and the need to preserve this in the future *"the problem is once it becomes more popular it might lose this sort of personal touch. Like we said, I think we have the perfect number in the group".*

Benefits

The benefits of a number of the approaches were highlighted by the students, for example the need to develop and present a prototype *"A lot of the time you can have an idea that looks good on paper but when you try to make it you see lots of issues with it"* and user-centred design *"giving this idea that there is a slightly softer side that is equally valid".* The range of approaches was also seen as an opportunity to *"get away from the computer, it's a breath of fresh air. I sit at a laptop all day long, you go down to the workshop and use the machines, a completely different type of work".*

The design tutorial approach used in semester two has helped to develop a community of practice *"and it's not a competition in terms of who gets the better marks, everyone wants to do well and everyone is really willing to help each other out, give advice, so it's a nice little community that you get with the specialist design"* and a valuable support network *"so it's fostered quite good friendship between the whole group as well and when it comes to doing the prototyping I wouldn't know how to use a machine so I'd go ask him to go and show me how to use and vice versa, like how to use a laser cutter, they'd come along and I'd show them, so it's quite nice, it feels like a friendship within the group, and it 's like a support network because Elies can't be there all the time, so we help each other out".*

As well as adding value to the students' experience by providing an opportunity for peer to peer learning *"I think you see basically what's possible and potentially how that can be applied to your project"; "it's better to do it then [present a draft] it's constructive"* and *"somehow she's created an atmosphere in a group where it's perfectly fine to criticise each other and it's always constructive".* The multiple opportunities to present their work gave students confidence in their communication skills, *"personally I feel now I'm a much better presenter than I was at the beginning of semester 1, more confident", "We're used to doing that at every single stage and when we have the group feedback sessions when we've brought our prototype along and we'd all ask questions quite openly of each other like 'why haven't you done this?' or Gareth or Elies would be 'why are you doing this? What's the point?' It makes you prepared, like you realise that you need to figure out more problems and have answers ready for them rather than trying to come up with them on the spot".*

Reflections

Both students and the recent graduates interviewed made reference to the value of the background and previous experiences that Elies could bring to the unit. Elies commented *"I think it's good that I've had experience as an in-house designer as well as a consultant"* and a graduate said *"you've got to have someone, who you know has got the right level of encouragement and knowledge and enthusiasm".*

Both the tutor and the graduates highlighted the key to this unit being about a change of mindset , highlighting that design is not a series of patterns to follow, not something that can be read from a textbook and because of this they reflected on the need for it to be led by colleagues with this mindset and the experience of working in this field for it to be successful:

…I [the tutor] kind of feel that for it to be transferable in another engineering department it would have to be taught by or there'd have to be some kind of involvement of someone who has learnt to develop, who has the experience of developing products in that way with that sort of risk taking that is more natural to industrial designers…I think it would be hard to implement all these activities without the understanding that there is a way to develop products that isn't a linear, straight, step by step engineering design, conventional engineering design process.

One graduate commented on how instrumental Elies was in moving the module forward. *"I think that she had seen that there was a sort of space in the department, sort of missing in terms of, harbouring creativity within engineering and taking all the useful skills that you have learnt over the years and then being able to apply them in a lot more creative manner".*

Graduates interviewed also valued the module in changing their approach to design *"I think almost more than anything else it's almost like the mindset that you have when you are approaching problems"; "encourages you to be slightly more broadminded about the customer's problem"* and providing the necessary skills for their respective roles *"so I certainly took, without fail, all of the skills which we learnt in that specialist design module and applied those directly"*.

In terms of future development Elies has been considering how the product development work could be taken forward and more students supported to start up more small businesses, *"we've wanted to do this all along which is to have funding so … people can stay on to do what we've called the Innovation Year where they take their project and they get a bursary at the university to work for a whole other year on their project … that's not finished, definitely not".* This was echoed in the student feedback with *"I think for future they ought to add in maybe another talk on like the entrepreneurial side of design engineering, how to set up your own business would be useful".*

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