Like Water & Oil: Merging Human Science Insights with Natural Science (Engineering) Thinking... the Experiential Way

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Oil and water: a common expression describing two things that do not combine well. In this paper I will discuss some of the wins and losses; successes and failures in my efforts to explore the contested territory between Human Science, abductive thinking and Natural Science, logical preconceptions within a Danish postgraduate engineering stream. This course was designed to help young engineers to step outside their normal positivist system of thinking and to explore, embrace or at least suspend judgement on a form of emotional/meta-physical logic. Students were introduced to practical (logical) methods for developing deeper insight into specific human experiences and to apply this genuinely human-centred perspective to their 'engineered' solutions.

In the engineering world, there are various ways in which oil and water are known to combine if only temporarily. One method of combining them however 'unstably' is by shaking them vigorously i.e., applying energy to take them out of their normal stable state into one that is different for a time and where their best qualities can be realized. i.e., oil and vinegar dressing. This is one aspect of my approach in this instance; to shake young engineers out of their comfort zones and to explore an unfamiliar topography, one that was both without and within themselves.

Alternatively, emulsifiers or surfactants are known to assist in the merging of two 'opposing' elements. In the position presented in this paper, the emulsifier used, was a mixture of philosophical/theoretical/practical epistemological lenses through which each student's experiential knowledge was filtered. My goal being to help students to come to a deeper understanding and appreciation of the people for whom they proposed to design 'solutions'. The entire pedagogical process was intended to disrupt their preconceptions in such a way as to help them see any situation more clearly; a process of in-sight based engineering.

Keywords:

Phenomenology; Critical Thinking; Experiential learning; Embodiment; Flipped Classroom

INTRODUCTION

I'm an engineer not a sociologist. (Male student in course, initials 'BB', 2014)

The title of this paper draws on a common expression "Oil and water don't mix", which of course in many instances holds true but most people would know that under certain circumstances these two oppositional chemistries can be combined in ways that enable something special happen. In this paper I draw on the oil-and-water analogy to help me describe a phenomenological view of this anomaly as it appears in engineering education. I probe the classic phenomenologists question, what is it like? ... as a student and a teacher, to cross traditional epistemological boundaries? I will describe activities within my Experience-based Designing course that offer phenomenal perspectives (both mine and the students) on these two traditionally divergent modalities of thinking (Natural and Human science) that have been brought together, like oil and water. Representing the 'oil' side of the story, I have Master of Science Engineering students at a Danish University who had been accustomed to a traditional technocratic, Natural Science (positivistic) approach to problem-solution teaching and learning in most of their graduate and postgraduate coursework. Opposing this, representing the 'water' character, I have myself, presenting a Human Science, Phenomenology (lived experience) based course designed to introduce students to more empathic ways of understanding the human beings for whom they intend to engineer 'solutions'. In the academic sphere, it is a relatively rare occurrence for engineering students to be required to take a course in something as 'soft' as 'Experience-design'. In my designing of this course and over many iterations I fortunately had the freedom to develop, revise and evolve a program that enabled the students and myself to somehow harmonise the two traditionally divergent epistemologies.

Efforts to find a way to blend these differing pathways to understanding the world are evident in both academic and industry sources. Both contexts seem desirous of achieving essentially the same goals, that is, to reconcile the ability that people have to engineer products, services and systems with an ethical responsibility for the results of their actions. The search for a deeper understanding of the implications of what is referred to as an 'Ethics of Care' is well under way in

engineering, health, education, economics, architecture and other fields¹. At the heart of these concerns for professional responsibility lies the level and nature of awareness (including empathy²) that practitioners employ on behalf of the recipients of their work. Without genuine empathy and understanding, engineering outputs become something that is foisted upon a majority of *others*, further casting engineering as simply a tool of industry, robbing engineers of their own humanity and sense of justice (Held, 2006).

The relationships between human understanding (empathy), ecological responsibility and engineering responses are underexplored themes in contemporary engineering education. They do not sit well within the dominant technocratic paradigm enshrined in a growing focus on STEM thinking at all levels of education K-12, Graduate and Post-Graduate (Gunckel, 2018). The need for practical 'processes' that merge hard science with soft science thinking in engineering and other STEM oriented educational settings has led to a growing field of critical discourse on the role of human understanding in the 'doing' of engineering (Hess, et. al.2012; Walther, 2017). These discussions centre on the need for engineers (and many others making decisions that affect ordinary people) to adopt a broader perspective on who benefits from the cultural, socio-technical, biological, political and economic impacts of their work and not just the *Return on Investment* for their immediate employers or business clients. The need for engineers and designers to play an active role in making the world a more just and equitable place is becoming a well populated field of discourse (see footnote 1 below), but the problem of practically achieving what is required, within the classroom, is still a nascent field of inquiry. Adding an A to STEM thinking in education settings may be a start, but does not offer sufficient practical skills for engineers to become more environmentally aware and socially responsible. Merging two traditionally opposing mindsets like engineering and human science thinking assists engineers to deeply empathise with the people for whom they intend to design artifacts. It can inject a much-needed level of "justice-oriented agency" into the socio-technical problem space and help engineering education move towards a more ethically just and socially equitable direction:

Engineers must be able to consider both the problems they are addressing and potential solutions they design from the multiple perspectives of the people impacted by their designs ...Educating engineers and students to care about the human dimension of problems thus becomes as important as developing the technical expertise to design solutions. (Gunckel, 2017. p.4)

In this paper I will describe not so much the contents of the course specifically, but by way of illustration, I will relate some of my (and students) experiences of building empathy with research partners, embodying that empathy (within the *self*) and applying it practically in project design outcomes. I will present some of the hits and misses, successes and failures, things that

¹ See excellent discussions and associated literature on the role of care in Engineering (Gunckle, 2018); Care-Ethics in Business (Elley-Brown, 2019), Feminist Economics (Frazer, 2016; Praetorius, 2015); Philosophy and System Science (Hamilton, 2017) The Built Environment (Imrie and Kullman, 2016).

² This definition of empathy from Walther also describes the essential goal of the course depicted in this paper i.e., to give young engineers "the ability to understand people by perceiving or experiencing their life situations and as a result gain insight into structural inequalities or disparities" (Walther, 2017 in Gunkel. 2018, p.28)

were encountered together that either worked or didn't. In the style of phenomenological writing, I have used students' personal (anonymized) comments where possible to exemplify my points and showcase the meaning of what took place during the course. 142 student comments were gathered over five iterations of the course. Using an open coding system, the collected data was sorted into categories to aid description within this paper (Strauss, 1990).

Setting the Scene

My classes were populated by a reasonably even mix of male and female, first and second year, Master of Science, Engineering students, primarily from European countries and predominantly from Denmark. Approximately half were international students whose first language was not English or Danish. Experience-based Designing was a core subject which all second-year master students were required to attend and it was a free course for the Danish students.

From my perspective, the processes of helping engineering students to learn about people (at least experiential aspects of their lives) has always been somewhat of a research project in itself. Students in my course initially came to classes very uncertain about what the field and topic was really going to be about. They made comments like; Human Experience? We know what that is don't we? We are engineers so why are we studying this and what is the payoff? How will I use this when I am employed? These were common perspectives based on student's previous experiences of prescriptive engineering coursework. Their past experiences of learning appeared to have set up an initial resistance to learning within my course. And in many cases, this ran counter to my course which required deep personal reflection (what do I feel?), philosophical exploration (what do I think?) and confronting uncertainty when the 'problem' is not evident (what do I do when there is no algorithm to guide me?). It is this kind of thinking that the course was designed to promote and expand.

From my perspective, research into human experience and my teaching others about it are intertwined such that whatever I learn from my teaching experiences feeds back into my understanding of human experience which in turn changes my teaching practices and what is taught. In this sense, yes, my students are also subject's in my research, but they know this going in as I make this point very clear at the outset. This honesty also helps to establish the atmosphere of an 'experiment' (admittedly, this was not something that all students immediately embraced). My goal is to turn the learning process into an adventurous journey together; one where nobody including me, has all the answers; there is most often, no right answer (something that engineers tend to require); and the class can jointly make better sense of this murky area of human understanding together so as to better appreciate its rich complexity. My goal is to help young engineers to see that the complexity represented in striving to understand people is just as exciting, just as complex and just as rewarding as wrestling with the logical principles that underpin the engineering side of their studies. Some students embrace this kind of thinking as another skill that they can draw upon, and others do not. Some embrace their fear of the unknown (no algorithms) while others want to hold onto the safety of certainty.

One should be prepared to live with the uncertainty, frustration, and risk that the search for genuine insights may require. (van Manen, 2017. p.823)

FORESTRUCTURES AND PREDISPOSITIONS

Among the key problems associated with blending oil and water are their innate properties or the manner in which they each uniquely exist in a world which predisposes them to behave in certain predictable ways. This is not to say they cannot behave any other way, just that it is harder for them to change. People can be said to have this 'predisposition' towards certain behavior that is innate. In human psychology this has been described in many ways but in Phenomenology (my field of interest) this is referred to as a person's Forestructures, and within the methodology of Phenomenology, the idea of Forestructures is important to consider if you wish to bring people with 'oil and water like' differences together. Simply put, Forestructures are the socio-cultural and past-experiential background that each person brings to the activities they pursue in acting out their lives (Geanellos, 1998). Forestructures shape and can define a person's predisposition towards the way they live, the work that they do and the ways that they apply their thinking. I say can define because their predispositions are not fixed and unchangeable. Forestructures are varied and various but are not immutable. They can be influenced in other directions however they are at least what a person 'starts with' when they approach a task or situation requiring their attention. During the Experience-based Designing (XbD) course my own Forestructures and those of the students naturally came together. This intersection of human Forestructures might be called the site of *Nepantla*³, the contested space or the liminal borderland between different ways of seeing and thinking (Anzaldúa, 2002). In the hermeneutic branch of Phenomenology, it is the 'horizon of understanding' that Gadamer refers to where people come together and develop a new understanding out of their disparate points of view.

In the process of understanding, a real fusing of horizons occurs - which means that as the historical horizon is projected, it is simultaneously superseded. (Gadamer 1975, p. 306).

Learning or Teaching

The key question guiding my pedagogical aims for the course is always, how can I facilitate experiential learning experiences and not just teach about experience? The course is about human experience so I also want to know how students' experiences in my classes can assist their experience of learning to be more powerful and lasting? This question is as fundamentally important to my own experience of teaching as it is to my student's experience of learning. If it isn't a rewarding experience for me, then it is unlikely to be one for the students? It has been said that if classes are not experientially satisfying then what happens in them can be referred to as teaching, but when the classroom becomes more experiential, then learning can become more profound (Boud, 1990; Brew and Boud 1995). To open a student's eyes to the unique possibilities of their own humanness and for them to re-connect with the intrinsic wonder of everyday experiences are two things I find most rewarding as a teacher.

³ *Nepantla*: a place where the basic ideas, tenets and identities inherited and accumulated from family, education, cultural and social influences are questioned and were-evaluated in an iterative process of transformation. A site and condition of transformation from a foundational position to a less fixed position. (Anzaldúa, 2002)

In an introductory class I warn students that I favour the Socratic method of learning, that is, I will try my best to help them to learn but I will not teach them. The following is a comment from one of the students that highlights their reaction to this approach.

The teacher did not give us information directly, he asked questions instead so that we could get the knowledge we wanted to achieve. ... At the time, I understood that the goal was to examine possibilities and this can only be done by asking questions instead of giving answers. The aim was to make us think and by giving us some methods, reach the knowledge by ourselves. (Female student, 2015).

I am very encouraged by student reactions to this approach as it seems to have had the desired effect i.e., to stimulate critical engagement and discussion so that students develop not only their own learning but also their desire to learn. Of course, not all students agree with this theory and some find the 'exploratory' approach to be threatening and unnerving particularly if they are looking for concrete guidelines and clear-cut problems to solve. The messiness of the phenomenological territory is frightening for some. This can be alleviated to some degree by providing guidance where they need it and tools, techniques and processes for those who relate more to such things.

From a teaching experience perspective; my pedagogical style flows from my interest in human experience, requiring my manner of delivery to be also experientially based; in other words, I want a good experience of the classes for myself. This means that I need to be more actively engaged in the learning experience myself. This requires that I need to step back and let students take the lead as much as possible but to carefully choose where and when I participate so that I can facilitate a co-construction of their learning. Students are not talked at, not lectured to and certainly not left to find out for themselves, but they are supported during their personal wrestling with their doing. They are encouraged to find their own sense of achievement by accomplishing challenging tasks, to evaluate the journey of their learning and to recognise their achievements and growth through reflection (more on this later).

Trust and independent thinking

Trust is not something that you automatically achieve in a classroom; it is something that has to be earned ...and it goes both ways. Gunnlaugson rightly describes the early stages of a course as being 'unstable' in that students are not quite sure about their own modes of thinking and wonder if they will be able to 'fit' with the course goals. This is largely because a 'climate of safety and trust' has not yet been safely established; one that allows for mistakes and for unfettered exploration. Once trust has been established the group can enter the 'inquiry' stage which can be seen in the 'story time' discussions described later. The final 'creative' stage mirrors what was experienced in the exhibition assignment (discussed below) when student's freedom to creatively interpret research outcomes saw "new understandings and insights emerge" (Gunnlaugson, 2006. p.7) With each of these events, trust is building, reaching its zenith in the exhibition and exam where students know they are supported and I am confident they will succeed.

Trust allows the independence and autonomy of students to thrive; this is a vital aspect of experiential learning. Students need to have an experience of learning if they are to successfully retain information in the form of knowledge; it follows that their experience of learning needs to be fostered in an environment of trust. Students need to trust that I will provide them with the useful and relevant information that supports their intellectual growth and that I will be there for them when they need support as they take responsibility for their own learning.

Conversely, I need to trust my students to accomplish their learning tasks without micromanaging them so that they have the space to experience learning which can only be done autonomously. This is a feature of Problem Based Learning (PBL) (EEM, 2006), as well as a key factor in Experience Based Learning (EBL) (Kolb, 2005). Trust in all spheres of life is of course earned not given, so students need to produce good work when it is required. They need to feel comfortable contributing and engaging in the class as well as during individual activities. This also requires that they learn to trust each other, to work with each other in supporting their individual and group learning. On the other hand, I also need to earn their trust by being flexible (open to their ideas and suggestions) and confident in guiding them when they need it.

SHAKING THINGS UP: DISRUPTION: FAMILIARIZING THE UNFAMILIAR< DEFAMILIARIZING THE FAMILIAR

In the engineering world, there are various ways in which oil and water are known to combine if only temporarily. One method of combining them however 'unstably' is by shaking them vigorously i.e., taking them out of their normal stable state into one that is different for a time and where their best qualities can be realized. i.e., oil and vinegar dressing. This analogy describes one aspect of my approach in this instance; to shake young engineers out of their comfort zones by exploring unfamiliar topographies both outside and within themselves so that they can realise new ways of thinking and seeing the world. A fundamental aspect of the pedagogical process in my course is to disrupt student's preconceptions in such a way as to help them to see ordinary everyday life-events differently and more clearly (defamiliarize); to evaluate unfamiliar situations involving people more empathically (familiarize); and thus, to develop engineering responses based on embodied knowledge mixed with external information; a process of in-sight based engineering.

The first few classes were very challenging and really rocked the boat. It seemed as though it was madness, and it was very provoking for an engineering mind. But looking back now, it seems as though it wasn't coincidental that the first readings and classes were so far from what were used to. ... first, get roughed up a little by surprising and challenging literature, next are nursed back to health with understandable and interesting techniques and finally blossom into enlightened and inspired XbD products. (Female student 'JR', 2012)

Storytime: For a YouTube generation

One way of shaking up student's preconceptions of what an engineering class should be like is to let go of the rigid role of the 'teacher'. My goal in each class is to achieve the highest experiential quality possible. This means varying the content and the delivery so as to gain maximum engagement. If students were not interested or are distracted, I assume it is because the material is not engaging them sufficiently. For example, I tell them at the outset of the course that if I see a laptop open, I will assume it is because they are bored or more interested in what is on the screen than what is going on in the class. If that is the case, then they need to tell me and I will adjust the content to make it more interesting. This is a 'pact' negotiated as a kind of social 'contract' between myself and the students at the outset. It places some of the responsibility for their participation and the quality of their learning experience back with them.

Emotionally it has been a rollercoaster ride from start to finish. The teaching style varied from being very abstract to concrete and back to abstract. I loved the movie clips from matrix etc. as it gave training in going beyond the obvious. For me it was unexpected to end up thinking of this as a useful course. What is even more surprising is that I have not noticed before writing this reflection essay how far I have moved. (Male student 'SH', 2012)

Each class is broken into two sessions. Broadly speaking the class time is divided firstly into exploring philosophical/theoretical aspects of the topic (Experience Design) with the second half focusing on practical or project-related activities. Each session generally starts with a short philosophy/theory lecture using PowerPoint slides with very little text, many images, and some video material designed to relieve the static quality of the presentations. This is generally followed by 'Story Time', a period of workgroup and/or class discussion about the weeks set readings or material from *YouTube* (Figure 1) chosen for its relevance to the week's lecture topic. In the early weeks of the course, I lead the discussion as students get used to each other and their group dynamics. As student's progress in the course and they become used to the various social dynamics at play (the students who always participate V's those who are reluctant to), I encourage students to take the lead and own the discussions. Within a few weeks, students get the idea that it is their debate not mine and that it is up to them to make it interesting and worthwhile. I form students into teams of 3-4 who take turns to run critical discussions in class time. After a few weeks of my choice of videos to discuss, students start to request that I play videos that they have found interesting. I vet these to make sure they are appropriate, but mostly give them a free rein as long as their choices contribute to stimulating a healthy discussion and aren't completely off topic. These student choices are very popular and they begin to vie for the honor of having their video choice discussed. Discussion sessions are vibrant and productive as students increasingly buy into the debates and they become more involved as the semester progresses. These Story Time sessions also enable me to introduce aspects of the course theory and practice into the video discussions that they have instigated, increasing the theoretical relevance of the material as they begin to 'own' the discussions. I judged this approach to be successful when, even after the course has ended, students continue to send me links to videos that they think will be relevant to the course 'next time'. Below I have listed some of the video topics that seem to resonate strongly with students. Web links can be accessed in the references section.

- Ramsey's 2008 *The cave: An adaptation of Plato's allegory in Clay* - A simple story about opening one's mind to other possibilities.
- Vsauce, 2019 *Is your red the same as my red?* - A very stimulating exploration of the individuality of senses and sensing.
- Falling Down, 2006 *I want breakfast* - How people respond to the systems of control that surround them and are taken for granted in everyday life.
- And more generally, movies such as: *The Matrix* (1999); *Surrogate* (2009); *Mr. Nobody* (2009); *Transcendence* (2014); *ex Machina* (2014); *Chappie* (2015) and other dystopian/ utopian stories.

Broadly speaking, many of these video choices are intended to generate vibrant debates about the way human beings use technology (the artificial or synthetic) and the ways that human beings direct their technologies *at* other human beings.

Nobody wants to read anymore

Teachers (at least the ones I know) often say, *how do I get my students to do the required readings?* Engineering students are no exception in their reluctance to read deeply. Shaking them out of this malaise and motivating them to engage with philosophical and theoretical papers (the readings), even the more entertaining or easy to read sources, is at least initially, less than successful. Over a number of course iterations, I have experimented with ways to motivate students to do the set readings for the week and to come to class prepared to discuss them. I have had some success with different styles of theatrical presentation which I will share here. In Week 2 students are randomly formed into small work groups of 3-4. A schedule is set where each week, one of the groups will present their choice of the readings (there are usually two papers each week to read). I ask them to present the essential points of the reading in a novel or theatrical way, to 'act out' the message within the paper. Types of presentations include the 'News reader' presenting 'bulletin' points; a Political style panel debating the pro's and con's of a topic; a 'design panel' discussing a paper from opposing points of view. In this way, the whole class gets to hear the key points of the readings and at least some of them engage deeply.

During the short discussion sessions that follow, students are invited to be actively critical of the reading material, the lecture content or topics introduced by other students during the day's presentations. There is only one qualification to this open forum; their critique had to be well-argued.

During the course my understanding has gradually evolved, because of the discussions in class, the articles and also because of the video's. I have been very pleased with the way they have been used during the course and they are of good value for my learning process. (Male student 'HG', 2014)

My objectives when developing either a full course outline or an individual lesson plan are always the same - to be entertaining, engaging and informative. That is to keep students interested, involved and growing intellectually. I consider this approach to be successful when I

learn from students learning. That is, they advance to the point where they challenge my own understanding and provide me with surprising additions to my knowledge base. In my view, this is when teaching becomes research and this feedback loop in turn advances the propositions that can be presented to students 'next time' and so the research/teaching cycle improves organically. I find that this kind of *generative dialogue* (Sharmer, 2003) promotes a partnership in the learning process where students see that the teacher is sharing (and not dominating) the learning experience and it gradually becomes transformative (Sterling, 2010).

Embodiment and immersion

One of the most successful 'shaking up' successes in the course is the student's introduction to 'embodiment' activities. This involves a field exercise where they are asked to actively immerse themselves in an experience of their choosing; something that they wish to understand better. In week two, students are asked to come to class having chosen an experience that they have NOT had previously i.e., something that is simple, cheap and not dangerous⁴. Over the following week they undertake to have the chosen experience for an appropriate amount of time and write a one-page reflection on their having of it, including but not limited to the emotional and cognitive aspects of the experience through their eyes. This sounds rather simple however, many students struggle with different aspects of it. Some think it is silly and inconsequential until they do it and write about it.

The process of working hermeneutically with the written material gathered after the embodiment helped cement this learning. Because I had tried it myself, I was able to use my emotional intelligence or intuition if you will, to "feel" what it meant." (Male student 'EB', 2014)

At first, I thought it would be good enough to do the description as bullet points. But after trying to write it in a more engaging way I realized how rich the story became and how much would have been lost. (Male student 'JD', 2014)

The awareness and empathy that students gain in this simple practical task help them to understand the theoretical concepts of proprioceptive awareness (Isaacs, 1996) and a form of proprioceptive consciousness (Gallagher, 2005); that is, a *knowing* through *doing* approach to understanding that can significantly impact on the way a person can not only see their own world, but also, into the world of others.

Proprioceptive awareness enables individuals to explore unfamiliar ways of knowing (epistemology), being (ontology) and learning, in turn offering learners a practice to reconsider previously held views in the present, enabling new perspectives to emerge. (Gunnlaugsen, 2006 p.11)

⁴ Some examples of student experiences are as simple as having a pizza for the first time, swimming in winter, skateboarding or walking through the forest. Others took a more challenging route; living without sight; having a broken leg; attending Salsa classes; being a vegan etc. There were many creative interpretations of this task.

The embodiment impacts in other ways as well. It enables the class to come together and share their experience of the experiences they have tried in a way that opens up what Gunnlaugson refers to as a 'suspension' of views. Getting students to let go of their entrenched ways of thinking, (to mix oil to water), to open up their minds to new possibilities is one of the great benefits of this simple exercise.

Suspension invites us to listen differently to both ourselves and to other dialogue participants by temporarily loosening our habitual hold and identification with our views and beliefs. ... this creates a shared willingness to be tentative, curious and ultimately less invested in either asserting our perspectives or refuting others' perspectives ... suspension is different from reflective thinking insofar as it involves doing this in the present moment. (Gunnlaugson, 2006. p.5)

When students say that they are surprised at how much they learn from the project it, in a sense, gives 'permission' for the more epistemologically intransigent students to acknowledge that they too have had some level of epiphany in their learning about their experience and in many cases some illumination about themselves.

The idea of using myself as research object, has been mind-changing. ...I have started to pay a lot more attention to the details of what happens around me, digging into myself to understand why I think the way I do. (Male student 'JD', 2014)

Reflection and Affection

It is surprising (to me), how shaken-up young engineers can become at the prospect of writing about their own thoughts and especially, their emotions. In most of their engineering courses, they are unlikely to get the opportunity to do so and many see no need for it in their future. I explain to them that in their future they will need to compose communications (emails, message, letters) to other people and as these are human-to-human communications they need to have some level of empathy with the receiver. Assuming they are not writing a simple set of instructions, they will express themselves better with some sensitivity, emotion and humanity. This rationale represents just one argument supporting the task of writing about their experiences however, it is worth highlighting that throughout the course, one of the most effective learning tools is the reflective essays. There are four practical assignments during the semester and after students have completed each of the field assignments, they are asked to write a one-page reflection on their experience of doing that assignment. For example, after the embodiment experience had been completed, they write a very short essay (this requires them to be concise and not labored) about the experience and the having of that experience, for them. They are briefed to write about what it means to them in sensory, emotional, cognitive and existential terms. i.e., consider the question, what was it (the experience) like? Formative feedback is given to each student on each of the first three essays and the fourth is an opportunity for students to reflect on their learning in the course overall.

This reflective/reflexive process at least partially addresses Shermer's conventional learning cycle involving concrete experience (their chosen experience), reflective observation (the essay) and abstract conceptualization (writing). The embodiment assignment highlights proprioceptive awareness for them and the reflective essays are designed to increase their reflective awareness (Scharmer, 2000).

The use of short reflections is very effective in helping raise student's awareness of what they have learned and how they have progressed during the course. The four consecutive essays also have a cumulative effect in this regard. The act of writing is intentionally *experiential*, in the sense that constructing the wording brings their thinking and learning to the forefront of consciousness; and through the writing, their embodied understanding and resulting retention is deepened.

"having done the embodiment twice and by having completed the whole process of exploring and understanding, I have come to the stage where I am knowing about knowing. In other words I have gained a meta-consciousness about my first embodiments and assignment. It is now very clear that there are many things that I could do better in the future"
(Male student 'RM', 2015)

...and there were more statements like this

Flipping the classroom

As a teaching technique, shaking up the order in which material is presented is not new but for my engineering students 'Flipping the Classroom' is certainly very different from the norm. Taking inspiration from the now well documented techniques by Bergman and Sams (2012), I have produced a short video explaining a research tool that we use in class called the *Taxonomy of Experience (ToE)* and uploaded it to *YouTube* (Coxon, 2013a). This video is listed in the course program as 'required viewing'. Students are asked to come to the flowing weeks class prepared to discuss the content and further explore the concepts presented in the video through a set studio exercise. In the class, I ask students to 'design' a physical manifestation of the *ToE* concept as if they want to use their design to explain the *ToE* concept to a stranger. One student interpreted the instructions from the stranger's perspective as follows, "What do you mean you are studying experience – what is that? Take this sheet of paper and explain it to me!" (Male student: TS, 2015)

They do this exercise (and by the way, they often act like young school children with paper and crayons - they love the simplicity of the exercise) and then briefly present their design to the rest of the class in a show-and-tell session. This exercise of designing a physical representation of their perception and understanding of it is useful on a number of levels. The students enjoy it as a rare opportunity to be playfully creative in an unthreatening, yet competitive way. The exercise helps students to more clearly identify and remember the various components of the *ToE* tool – requiring them to more deeply consider its various parts and how they might be fitted together in a meaningful design (embodied knowledge).

The exercise also provides me with feedback on how well they understand the *ToE* concept through the level of sophistication communicated in their designs – I give immediate feedback to them as to how accurate it is as a representation of the tool and how it might be improved if done again.

In a similar situation to the Taxonomy above, I need to explain a rather complex qualitative research data⁵ analysis tool called *SEEing* (Coxon, 2013b). With previous class groups, I explained the 9-step *SEEing* process with a long and rather energy intensive, interactive presentation on a white board. In order to improve this mode of delivery and make the classroom time more productive, I have produced and uploaded a video of my explanation to the previous class. This video was produced as a way of expediting the learning process by allowing students to encounter the *SEEing* tool in a medium that they were familiar with (video) and that would allow them to engage with the process at their own speed and time. They are asked to watch the video and come to class the following day to work with a software version of the process that had been depicted in the video. This 'preparation' is followed in class with the students working in small groups on their own field data, in the supplied software and applying the *SEEing* tool in the manner demonstrated in the video. This *flipping* approach allows students to spend less time finding out about the process and more time in the class with peers and myself working with the process on their own data. I believe it is more effective in terms of both learning the process and achieving their analysis outcomes. But not everyone sees it the same way; this statement is from a student who did not experience the classroom being 'flipped'.

Using and understanding the *SEEing* tool was a bit of a challenge. Luckily, I took part in a great explanation of the tool (which I fear the next class will not, since it was filmed). ...I really appreciate being present when the explanation was given. I would much rather take the time to get a proper face to face introduction and explanation, than watching a video, due to the fact that, at least for me it increases my awareness and focus. ... I see it [the video] as a nice supplement to the face to face explanation."
(Female Student 'MT', 2014)

An exhibition of four-dimensional learning

Another way of shaking up my engineering students thinking is to ask them not to report their research findings, but to exhibit them. But, how do you take subjective research results and communicate them to strangers in an interactive subjective way? The final task in the Experience-based Designing course requires students to work in groups to build a small exhibition installation. The task is to design a 4D⁶ communication device that showcases the research findings from a particular everyday experience they have studied, analysed and synthesised. A short lecture about what 1D, 2D, 3D and 4D exhibitions might look like is provided and time allocated for the groups to work on their design. By leaving the design

⁵ van Manen (2017) prefers the use of words like information or 'meaning units' versus data and this I agree with, however for simplicity reasons in my classes these subtleties are overlooked and I refer to using field 'data'

⁶ A 4D presentation is one that takes 3D elements and incorporates an interactive component. In other words, the exhibition piece becomes *experiential*.

interpretation very open there are some quite spectacular results. By not tightly specifying and telling students how to do the task, results can be quite extraordinary on a number of levels. Firstly, these mostly engineering students realise that they are actually capable of very creative thinking. Secondly, they see how others have accomplished the same task and what they could have done better. And thirdly they realise that this method of knowledge exchange is not only fun and entertaining but that it is communicating at a much deeper level than they have ever previously encountered. Their knowledge base and their perception of their own competencies is changed.

I actually got a chance to feel what some of the other teams had felt without doing their field work! I did not expect that at all beforehand. ... It was a great thing to be a part of, and something I will remember in the future. (Male PBI student 'MB')

I think that this exhibition was a nice way of showing the importance of using an active transfer model. It became quite clear, due to the fact that some groups still were using a rather passive transfer model, which did not enable me to know more about their experiences. (Female ID student 'MT')

When is an exam not an exam? ...when it is a reflection on learning

Even the final examination for this course is designed to shake things up. Building on the series of three assignment reflections during the course, the final examination task challenges students to revisit their previous reflections and to reflexively consider their experience of learning over the whole course. The three reflections and the final reflection on learning are compiled into a portfolio which forms the basis of the student's oral defence with myself and an external examiner. Students are advised that in the examination an external examiner and myself will be discussing their understanding of the following points with them.

- The subject: The evolution in their understanding of experience itself: How will they now interpret it as a person, a researcher and/or as a designer?
- The field: Their current view of designing for experience: How has their understanding of the field of Experience Design evolved from week one?
- Their experience of learning: Their experience of the course and their learning: What they found challenging, unexpected or demanding?

This final deep reflection is important for them to be able to pause, look back and consider how they have progressed; to see that their progression is not simply the result of my efforts but through an evolution in their own thinking; and to subsequently come to their own evaluation about how much they have changed since the course began.

On a practical note: to assist students to actively participate in the examination and to make the event more experiential for them and the examiners, I suggest that they design a simple,

inexpensive device that will help them to tell the story of their experience in the course. Again, this is so that they can be more experientially engaged than if they simply talk at the examiners. And also, from a personal point of view, the exams are far more entertaining than the very repetitive alternative.

As a footnote to the exam process: Student's final reflection essays provide substantial material for qualitative analysis as it includes positive and negative statements as well as areas for improvement.

EMULSIFYING: BLENDING NATURAL SCIENCE AND HUMAN SCIENCE

Emulsifiers or surfactants are tools/agents/interventions that assist in the merging of two 'opposing' elements; in this case, the emulsifiers used are the series of practical methods, tools and techniques used to help students to learn about and understand the ethereal nature of human experiences. Throughout the course I use a mixture of philosophical, theoretical and practical approaches to help cater for the many epistemological lenses through which each student filters the experience of my classes. My goal in applying these emulsifiers is simply to help students to come to a deeper understanding and appreciation of the people for whom they propose to design 'solutions'. This course is designed to help young engineers to step outside their normal positivist system of thinking and to explore, embrace or at least suspend judgement on a form of emotional/meta-physical logic. This is in most cases a quite foreign concept for some students and many (at least half initially) strongly resist my efforts to help them to open their thinking to even the possibility of exploring the contestable zone between Human Science, abductive thinking and Natural Science, logical preconceptions. This means that my classes have to address wide variations in learning styles and epistemologies with a flexible approach to course content and delivery. In short, this means making sure there are adequate practical tools and tasks for those who feel they need that type of thing and allowing more space for philosophical discussion and exploration for those who embrace that kind of thinking.

Phenomenology and philosophy

From one perspective, phenomenology can be quite a good emulsifier in that it offers both a philosophy and a methodology. It blends both 'soft' aspects of thought and reflection along with practical guidelines for doing or applying techniques for understanding *lived experience*; the primary goal of Phenomenological inquiry. In the course, I start the *phenomenological emulsification* process by introducing students to the idea that there is not only one 'science'; that *Scientia* simply means *to know* or *to understand*. From this perspective, engineering having its foundations in natural sciences makes it simply one of many 'sciences'; this is quite a shocking idea for some who understand science as only embracing the Newtonian view. From this wobbly starting point, I position Phenomenology with its qualitative form of logic as part of a human science; and as differentiated from the more numerically based social science and natural science schools of thought such as engineering. Not everyone finds this idea easy or comfortable to grasp;

It has been difficult for me to embrace working with human science compared to natural science, but after having been through the process of

trying to understand experience, I have gained more insight into the importance of exploring and studying human science in general. (Male student 'BB', 2015)

Thinking Critically

In following the oil and water analogy further, it may not be immediately evident that thinking critically offers much in the way of emulsifying the education of young engineers. However, without introducing some level of critical thinking or questioning of established beliefs and positions, then as a teacher I would be failing in my duty and simply helping to prepare another generation of robotic thinkers; something that I am not prepared to do. In using the phrase 'thinking critically' here, I intentionally avoid an obvious relationship to the intellectual traditions of Critical Thinking⁷ and Critical Realism⁸; this is not what I mean by thinking critically in this instance. Asking the students to be more 'critical', I am in a way, simply advocating a healthier critique of the material that students engage with. My intention in doing this is to open up the space within which they can intellectually engage with the material that is presented to them and the questions they encounter in their studies. It is designed to free up an exploration space such that they can discover their own thinking within the milieu of what is available to them and what they confront in answering the challenges of assignments, readings and discussions.

In introducing the concept of thinking 'critically', to students I simply ask them to question everything that I and they present and information they encounter in the course, but with one caveat; I would say, "I am quite happy for you to tell me that this material is rubbish, but if you say that, you must support your claim with a considered argument for why you think it is rubbish". This was the challenge; to reflect upon their thinking about the material presented and formulate a considered response, thus fulfilling at least one of the primary goals of my course; to help students to think for themselves.

Method in the madness: a logical approach to chaos

Of course, emulsifiers are not only a way of bringing two disparate forms together, they are a mechanism for bridging two states of being (gas, liquid or solid), or in this case, ways of thinking (epistemologies). For those students who crave more grounded or practical tasks within the course I introduce a number of analytical tools which I referred to earlier in *Flipping the Classroom*. This enables those with a more concrete learning style to work in a more structured way while still retaining the qualitative principles of phenomenological analysis. Using this approach at first appears counter to the principles advocated by van Manen when it comes to phenomenological analysis in search of 'insights'.

True insights are not 'technically derived' or 'methodically produced' but rather phenomenological insights are 'encountered,' 'discovered,' 'given,' 'found,' or sometimes even 'stumbled upon.' The method of

⁷ Referring to the original ideals of Critical Theory establish at the Frankfurt School and commonly associated with Theodor Adorno, Max Horkheimer, Herbert Marcuse, Walter Benjamin, Jürgen Habermas and Erich Fromm.

⁸ Referring to the philosophy of science described as Critical Realism, advocated by Roy Bhaskar (2010) and others.

phenomenological insight might somewhat provocatively call a 'nonmethodical method'. (van Manen, 2017. p.82)

Max van Manen would possibly disagree with the *SEEing* process used to bring about understanding and insight in the engineering/experience projects as undertaken however, it might also qualify as what he describes as a "non-methodological method". One of the advantages of the *SEEing* process is in the way that it requires students to 'wrestle' with the data that they collect during field work. While most are happy to apply a process that has structure and defined steps, they are not as sure about the fact that it does not guarantee a successful or 'correct' outcome. Engineers like to feel that they have solved 'the problem' and achieved the 'right' answer. This is not the case with phenomenological inquiry which is more about the journey than the destination.

...the insight of phenomenological inseeing must be distinguished and not be confused with the more common definitions of insight as suddenly seeing the solution to a problem. ...Meaning insights are different from problem-solution and cause-effect insights ...one should be prepared to live with the uncertainty, frustration, and risk that the search for genuine insights may require. (van Manen, 2017. p.822-823)

The *SEEing* method while firmly based on Phenomenological first principles, is still a methodical, step-by-step approach to qualitative analysis of experiential field data requiring focus and deep attention to the content and meaning of the material under analysis. It is a rigorous way of working with field data so as to *develop* understanding of its meaning *through* the application of the process. In other words, the real insights are gained during the process not at the end; and there is no right answer. This is not an easy idea to sell to engineering students who often want to jump ahead and see the end result as quickly as possible. My main issue is trying to get them to understand that the process *is* the solution. It is only through their wrestling with the data that they can achieve what they want, i.e., the meaning within the experience or to better understand, 'what the experience is like'. As van Manen warns,

...some researchers are so consumed by the idea or promise of a "method" (such as a procedural scheme or program for doing 'interpretive phenomenological analysis') that will yield important qualitative understandings and insights that they don't allow themselves to recognize an insight when they stumble over it in a 'nonmethodical moment'. (van Manen, 2017. p.820)

And this final comment from one of the students seems to sum up the frustrations but also the satisfaction of arriving at a better level of understanding.

To me in particular, the *SEEing* method was good. Even though my first impression about this tool was that it was too time consuming and repetitive. Nevertheless, I realise that I gained a lot of knowledge and insights by using this tool to elaborate on feelings and participant statements. The tool triggered my thinking to find new angles and hidden

messages. Messages and issues which weren't directly mentioned during the interview, but hidden between the lines. (Female student 'VB', 2014)

SUMMARIZING KEY INITIATIVES ACROSS THE COURSE

1.0 Embodiment, engagement and immersion

Asking students to step outside of their comfort zones and to immerse themselves in the unfamiliar so as to gain a different (more embodied) perspective on the issues being addressed.

2.0 Reflection, reflection, reflection

The use of reflections and then reflection on their reflections, opens students up to deeper reflexive insights on their learning. It also provides rich material for reflecting on my teaching performance and grounded insights for improving the course.

3.0 Free discussion and Socratic debate

Allowing student's freedom to source material, explore unfamiliar topics and collaborate in a safe environment helps them to examine their deeper personal values. It fosters and enhances critical engagement and intellectual enjoyment, allowing them to playfully explore new horizons within the group.

4.0 System, Structure and tools

An experiential learning approach applied across a structured program of theoretical to practical knowledge transfer is essential. Engineers enjoy wrestling with philosophical ideas but fundamentally they like 'tools'. In the qualitative field of Experience Design they need practical methods to give structure to their subjective thinking.

5.0 Creative freedom: permission to have fun

The introduction of a sense of play is helpful to learning within the otherwise strictly serious business of engineering education. Creative activities involving drawing, making and imaginative interpretations are considered fun and elevate learning when tied to philosophy and theory.

6.0 Reflexion and uncovering 'your' truth (alethea⁹)

An overarching goal of the course is to help young engineers to think differently; to be able to face the messy and uncertain problems they will be required to deal with in their future work. Reflexion is an important skill if they are to become aware of who they are, what they are capable of and what they really wish to achieve.

⁹ van Manen uses this rather elegant term to describe the 'eureka moment' when truth is revealed as a sense of insight or bright revelation. (van Manen, 2017. p.823)

CONCLUSION

'Oil and water' has been the analogy used throughout this paper to describe the various ways I have tried to combine human science thinking with the traditionally natural science world of young engineers. Students in cross-disciplinary, non-traditional engineering courses naturally struggle with the philosophical nature of much of the material. In dealing with human experience, they are already immersed in a difficult and poorly understood field. In such a course, students are confronted with an unprecedented need for openness to a new kind of complexity and to deal with uncomfortable levels of uncertainty. However, once they recognise that while uncertainty poses a personal challenge and unsettling problem space, they already have the tools to deal with it, and they can begin to find ways to overcome the uncertainty that confronts them. This is a very valuable lesson in preparing students for a fast-changing world in which the kind of work they imagine today will not exist in the near future. The challenges they face will be ill-defined, possibly illogical and they will require a different appreciation of the role that human beings play in the engineered world. In many ways as teachers, we are preparing them for a level of uncertainty and complexity that is accepted as the modern condition.

We will create all sorts of new jobs, we'll create new skills and we'll create new technologies. But these new high-tech specialists and professional jobs are not mass labor, they are boutique. You are never going to see mass workers in software companies, nanotech companies and biotech companies. They don't exist. The new workforce is a specialized professional one. (Rivkin, 2005. p.2)

Being flexible in my approach to student learning has been successful in overcoming obstacles that many students encounter in adapting to a new mindset (in some cases this can be quite disorienting even confronting). Balancing the philosophical/theoretical content in the course with more practical exercises has allowed students with differing approaches to learning (abstract to concrete) to satisfy their learning goals in individually satisfying ways. The primary research tools presented in the course (*ToE and SEEing*) while they have a semi-logical form, are quite subjectively applied. Some students initially find these approaches confronting (as they are not mathematically based) however, with help and encouragement, they find ways to accommodate them into their learning in their own way. The tools are necessary to give engineering students much needed structure in their approach to understanding and applying the 'fuzzy' logic of human experience.

It is particularly gratifying when a certain number (not all) students really 'get it'. They seem to deeply embrace the course process and revel in the learning to the point where it becomes life changing. This is what keeps a teacher like me coming back.

...a final word from one semi-happy student,

Despite my minor reluctance from the beginning of the course I can only applaud the structure of the learning from the course. I have very rarely had a course spanning a full semester that had such a clear line through all

of the teaching material. Every step, both practical and theoretical, had a purpose to make the next step possible. In the end one is left with a very structured and complete image of the learning outcome that the course is trying to explain. (Male student 'ML', 2014)

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