Creating value in project-based multidisciplinary design courses

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Creating Value in Project-based Multidisciplinary Design Courses

Abstract

University-industry collaboration plays an important role in creating engineering programs that are attractive to students, lead to competent, employable engineers and the local impact of universities. However, academic and industrial realms can operate with different vocabularies, assumptions and routines. This can lead to mismatches in expectations as well as missed opportunities for fruitful collaboration.

This paper explores the perceived value of participating as an industry-sponsor to multidisciplinary engineering design capstone courses. Four industry partners were interviewed in the beginning, middle and end of two project-based courses (and one industry partner once) to track what value they expected from the course and what value they perceived to be delivered. The thirteen in-depth interviews averaged 50 minutes, were audio-recorded and transcribed for analysis.

Based on the qualitative analysis, the motivation to take part as a sponsor in these project-based courses initially centered around new innovative products. However, there was a continuum of expectations ranging from product concepts to ready-to-ship solutions, which often was only surfaced later on during the course. Furthermore, the drivers behind the expected value of these outcomes could be divided into novelty, concreteness and validation. It also became apparent that the value to the sponsoring company at large and the value to the liaison diverged at times. At the end of the project, the sponsor liaisons personally highlighted the value of the course collaboration as a way of driving change in the practices, portfolios or the industry of their organization.

The different types of value identified in this paper can help to form vocabulary for joint understanding in project-based innovation courses. Being able to articulate different types of value on both the university and industry side in negotiating and running these courses can help to find better matches in collaboration. As a result, all parties are better set up for successful university-industry collaboration.

1 Introduction

Project-based courses are increasingly popular in engineering education, allowing educators to target a variety of professional skills. Working for or together with external communities or industry partners can further add to the experience, offering students a unique opportunity to get meaningful real-life experiences of contextualized problem framing and problem solving during their studies [1,2]. However, while the continued existence of these courses indicates some need from the industry side, there is limited research on the value these kinds of projects provide to the sponsors. To continue to offer and develop project-based learning experiences, there is a need to understand the value they provided to the customers [3]. In this study, we focus on the company partner side of the equation, exploring how industry sponsors perceive the value of taking part in project-based design courses. Rather than attempting to quantify the value these experiences bring to the companies, the study focuses on the subjective perception of the company liaisons, who are in a critical role in justifying the sponsorship of these projects. Furthermore, this paper will explore the benefits gained for the participation of these projects, while limiting the exploration to the context of industry sponsored courses that utilize the design approach as the core methodology, and where the students are in charge of

solving complex, open-ended, real-world challenges [4]. Therefore, the main research question is identified as: "*What are the various benefits expected and perceived by the liaisons of the sponsoring companies of project-based design courses?*"

Understanding value is a key factor in strategic management [5,6] and creation of value for the customers is the key to sustaining competitive advantage and company success [3,7]. However, when looking at the academic discussion on value - one that can be argued to be as old as the concept of economics itself, with contributions by the likes of Aristotle, Plato, Karl Marx, and Adam Smith - the history on the discourse hints at how convoluted and complex the concept of value is. Even in the more modern streams of discourse that can be tracked back for three decades, shared consensus is limited. The nature of value has been described as "nebulous" [8], "complex" [9], and "multifaceted" [10], indicating that further research is required into explaining the nature, form, and dimensions of value.

Between the simpler and more complex definitions and conceptualizations of value, one fundamental aspect, however, is very broadly accepted: that value is subjective or 'perceived'. The subjectivity of the value judgement is highly inherent in the modern stream of value literature, which studies the 'perceived value' [e.g. 11–16]. The essence behind the subjectivity is that absolute measurement of value is not possible, but instead value is always dependent on the perspective of a subjective individual or collection of individuals.

Additionally, the topic of contextuality emerges in almost all of the main literature streams on value [12–16]. Indeed, when approaching value research empirically, there is a notion that value is "contextually bound" [17, p. 146] and that any concrete description of value needs to be evaluated fully in that context. Due to this contextuality, most of the existing frameworks, especially as the majority of the research is founded in consumer and marketing research, have the risk of applying poorly outside the context they were formed in.

From the extant research of value, we summarize a framework to analyze value in project-based design courses (Table 1). This framework includes six distinct and most fundamental natures of value have been formulated in format that is sufficiently broad to inform, but not limit, the exploration of value in contexts which are far removed from the contexts the literature was originally designed to describe. This includes:

1. Subjective - an individual's subjective judgement rather than an absolute value. Based on the perspective of someone
2. Trade-off - a comparison between a wide variety of benefits and costs.
3. Personal - based on an individual's values
4. Contextual - a highly context specific value dependent on the situation, time, frame of reference
5. Hedonic - a value with emotional, experiential, intrinsic, and intangible elements
6. Comparative - judged in comparison to alternatives

Nature of Value	Monroe [15], [18]–[21]	Gutman [11]	Zeithaml [16]	Woodruff and Gardial [22], [23]	van der Haar et al. [12]	Holbrook and Hirschman [24]	Hartman and Mattson [25]	Sheth et al. [26], [27]	Sweeney and Soutar [28], [29]	Holbrook [13], [30]–[32]
Subjective	x	x	x	x	x	x	x	x	x	x
Trade-off	x	x	x	x	x	x	x	x	x	
Personal		x		x		x	x			x
Contextual			x	x	x	x	x	x	x	x
Hedonic		x				x	x	x	x	x
Comparative					x			x		x

Table 1 - Summary of the literature that informed the six natures of value

2 Methodology

This paper adopts a qualitative approach to explore the various forms of value for the sponsoring companies of participating in project-based design courses. The study follows the process of grounded theory [33], adhering to the notion of interpretivism, where reality is experienced individually, and that it is a mind-dependent, and a personal or social construct [34]. This is strongly in line with the literature on value, which highlights that the concept of value itself is both subjective and contextual.

Due to the subjectivity of the value judgement, as well as the personal and hedonic aspects of the value, it was critical to focus the research on an individual. The company liaisons to the projects were selected as the focus of the study, as they are in a unique position where they interact with both the company at large and with the project-based course. The liaison is in a unique position between the students, course staff, and various stakeholders in the company. They are in the position of managing and supporting the project with the students, as well as relaying information to and from the rest of the organization. They are often in the role where they also need to justify the value of participating in the project to various experts, departments and leadership in the company. Furthermore, they are largely in charge of how the results of the project influence the company, and effectively act as champions for the project, critical for the success of an innovation project [35]. As such, they represent a rich source of data, a key consideration in qualitative research [36].

2.1 Data collection

The selection of the courses and companies in the research relied significantly on convenience sampling, but the theory and quality of pragmatic results influenced it as well. Convenience sampling is a type of non-random sampling where the inclusion of subjects are decided based on practical reasons, such as availability or geographical proximity [37].

One of the courses, which was also personally observed by the first author, served as a core premise for this research. This course was the ME310 – Global Innovation Program at Aalto

University (me310.aalto.fi). A second course was introduced for two reasons. First, the set of potential interviewees from partnering companies in ME310 is finite, and could thus yield a limited set of volunteers to participate in the study. Second, by including another course as a part of the data set, a better understanding of the contexts of the courses could be generated. While convenience sampling was also present in the selection of the second course, there was a wider set of courses available to select from, and the selection within the subset was due to IDBM Industry Project -course at Aalto University (IDBM IP, https://www.idbm.aalto.fi/) being the closest option in terms of design process and overall course focus and structure compared to the first course. Both courses were

- industry project-based, with external company liaisons and based on real project challenges from the industry
- master's level, interdisciplinary design courses following problem-based learning pedagogy, and
- following a human centered design approach, treating design not only as a process, but also as a culture

ME310 runs annually within a network of 25 to 30 different universities around the globe for a period of nine months. Each project team is composed of 3-5 students from one university and 3-5 students from another university. Project teams work together primarily virtually, but travel to meet each other typically 3-4 times during the project. Each university individually negotiates with companies for sponsorships, after which they bring this partnership into the network to form final project teams. In the four universities that together comprised the two projects that were a part of this research, the student workload varied between 15 to 60 ECTS, and the cost of participating in a single project for the partner companies was approximately 100k€. The students are expected to provide a proof of concept prototype at the end of the project.

IDBM IP runs locally within a single university, where around ten projects run annually. The teams are comprised of 4-6 students who are all in the same geographical location. Compared to the first course, the final outcome focuses more on a conceptualization of a solution, especially on the business model side, and does not require a proof of concept prototype. During the academic year, which the data was collected, the course ran for six months. The workload for the course was 15 ECTS and the cost for participation for partner companies was 20k€.

There were a total of five company partnerships that were investigated for this research:

1. The Global Manufacturing Company is a manufacturing company with 1-5 billion euro revenue range and in the 15-20k employee range. They operate in 150+ countries. Two senior R&D managers from this company participated in this study.
2. The International Component Supplier operates in B2B market with a revenue range of 15-20 billion euro range and in the 100k-150k employee range. They operate in 20-40 countries. The founder as well as the manager of Innovation Lab in this company participated in the interviews.
3. The International B2B Service Provider is a service provider that is in the B2B market. Their revenue is in the 100-500 million euro range and in the 1-5k employee range. They operate in 20-40 countries. The company had a single liaison throughout, and they worked as a Director of Business Unit.
4. The Local Retail Company is a retail department within a larger organization and their revenue is not publicly disclosed. They operate locally with 1-5 employees, from which the Product Manager participated in the course.

5. The International B2B Retail Company, with a 1-5 billion euro range had 15-20k employee range. They operate in 20-40 countries. Their Director of Business Development participated in the interviews.

The data for the research was collected through a set of 13 interviews that averaged at 50 minutes. The interviews were longitudinally spread so that the first interview for each case was after the partnership agreement had been made, but before the projects had started; the second set of interviews was approximately halfway through the course, after a key milestone; and the third interview set was between 1-3 months after the end of the course project. This spread allowed data collection which would capture temporal and situational contexts to influence the data, as well as allow the liaisons to regularly reflect on the value of the project, enabling rich data.

The interview methodology used followed the semi-structured, intensive interviewing approach, where the premise is to create a directed conversation with individuals who have relevant experiences, which – with the help of the interviewer – are reflected upon in-depth in a way that is rare in everyday life [36]. Broad open-ended questions were devised to encourage interviewees to explore the notion of value for themselves and their company. Follow-up questions and statements were used to encourage exploration, to revisit earlier branches of the conversation, and validate the understanding. The interviews were recorded and transcribed verbatim.

2.2 Data analysis

The first step of the data analysis was to focus on what the data actually showed instead of trying to synthesize or categorize it [36]. This first phase focused primarily on incident-by-incident coding of the data, but where specific insightful language was used by the interviewees, in-vivo codes were utilized as well to allow the preservation of the interviewees' meanings, especially when the underlying meaning might not have been apparent [36]. This created a thorough analysis for examining the entire set of data, which especially allowed the recognition of both explicit and implicit nuances, resulting in more meaningful findings.

Preliminary analysis led to a focused coding process as patterns started to emerge. Both the more data oriented initial coding as well as the conceptualizing focused coding happened in parallel for much of the overall coding process. Focused coding was the first conceptual step in the data analysis where significant or frequent first order codes are used to group and explain larger sets of data. All of the codes remaining after the initial and focused coding, were then further thematically analyzed in a format inspired by Gioia et al.'s data structure [38]. The resulting data structure is presented below, in Figure 1.

3 Creating value in project-based multidisciplinary design courses

Four distinct aggregate dimensions of value emerged from the data (Figure 1). While the value of the direct outcome of the student project (such as a final proof of concept prototype or a similar conceptualization) was expected to be valuable for the liaisons and sponsoring companies, other aspects also emerged as highly valuable, even to the point where they might be more significant than the face value of the project outcomes. Each of these facets of value are detailed next.

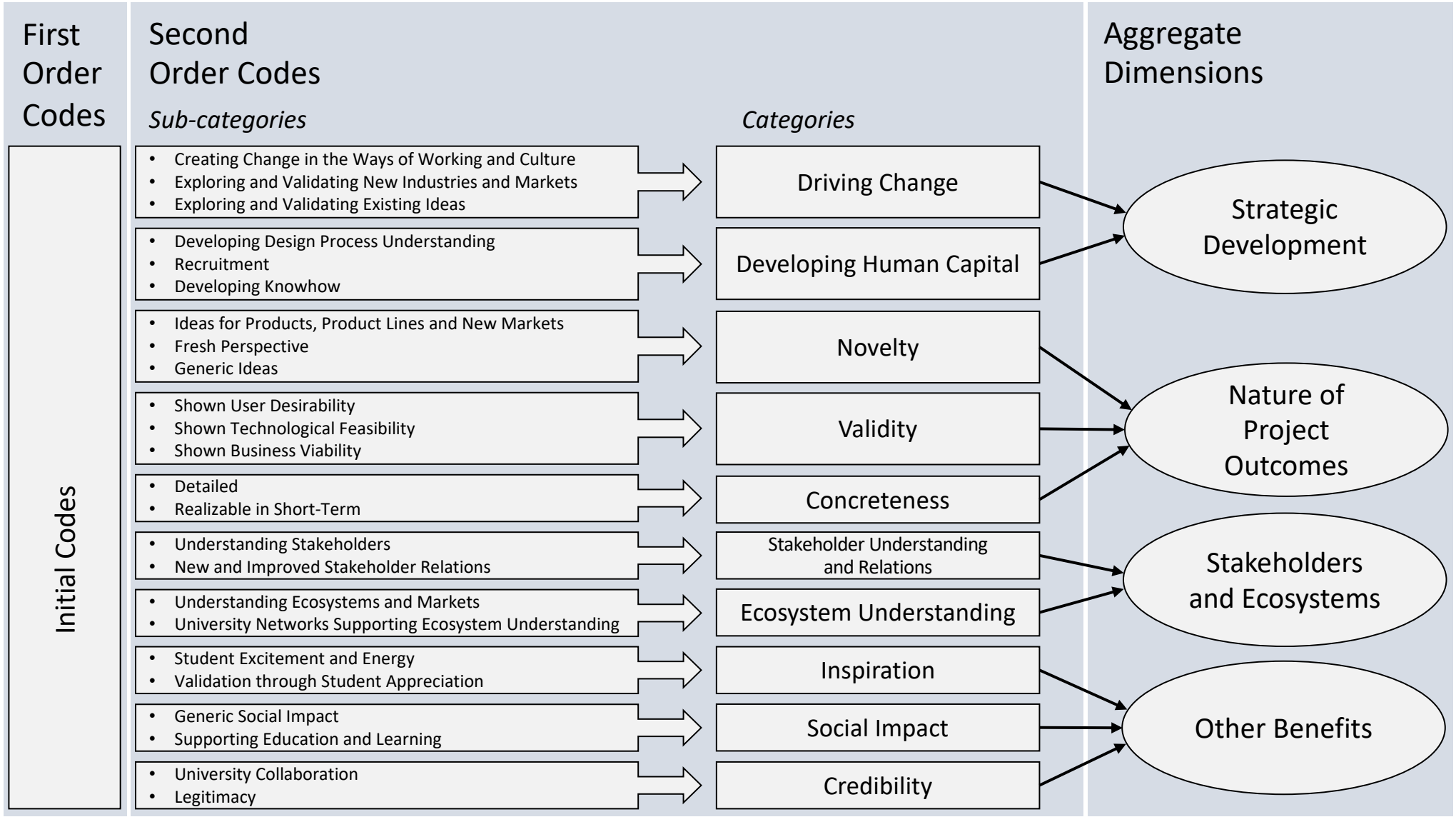

Figure 1 - The data structure on the value of project-based multidisciplinary design courses

3.1 Strategic development

Strategic development in the form of driving change and developing human capital was a major value contributor, if not even the primary reason, for participating in these projects for the liaisons. Especially when taking the perspective of the liaisons, the student projects supported the liaison in driving change in their own organizations to steer the company in the direction they envisioned it should develop in.

3.1.1 Driving change

While the main scope of the projects were to create a 'proof of concept prototype' or a similar conceptualization, the liaisons explicated benefits in how the student projects can help them drive change within their organizations. The change could be classified into three distinct areas: changing the ways of working and culture in the organization, exploring strategic aspects such as new industries and market opportunities, and finally an area that can only be classified as 'other' ideas that the liaisons were seeking to explore and validate. While company benefits were the ultimate purpose, the liaisons personal perceptions and agenda played an important role in the formulation of these values. Supporting the liaison in driving change in the organizations was a critical aspect in benefit of the projects. In two of the cases, driving change was one of the primary factors in value generation, and in two other cases it was a meaningful contributor to the value, while in one of the cases it did not emerge at all.

Creating Change in the Ways of Working and Culture showed up strongly in four of the five cases. The data shows how the liaisons view gaps between extant company culture and ways of working, and what they believe they should be. The data further highlights five different ways in which the projects can help with the culture change: they can give concrete examples that can be shared within the company (1), they can provide mental support in driving the change (2), they can give legitimacy to the new ways (3), they can serve as blueprint of the new cultures and ways of working (4), and finally they can help recruit students who then support the new ways (5). For example, some of the liaisons viewed their companies' culture and ways of working as incompatible with the innovation and design approaches, they were driving. For example, the International Component Supplier was not adapted for innovation, according to Innovation Lab Founder:

> [Our company] is very ancient company. It has a strong background, a very heavy company culture that is quite old-fashioned, because it comes from the manufacturing, production culture, so it's a lot about the quality, cost reduction, risk avoidance, a lot of processes, a lot of rules.

Exploring and Validating New Industries and Markets showed up in two cases, in which it served as a core focus for defining the brief and therefore the direction for the projects. The project briefs from two sponsors were directly aimed at exploring and validating certain new markets. While the briefs set further expectations to generate ideas and concepts for the new markets and industries, the exploration and validation of these new markets and industries held inherent value to the liaisons. The data shows three main points: that the projects are good at creating change because they are conducted by an external party (1), that the projects are used to explore and validate both new industries the companies should be engaged in as well as new markets that have opportunities in them (2), and that the projects have been able to create change within the companies, even if the change might manifest slowly (3). As explained by the Senior R&D Manager at a Global Manufacturing Company, the students

believing in a new market opportunity is something the company should listen to, giving weight to externally identified opportunities:

> Because these students recognizing that there is an opportunity and telling us, there is an opportunity, yeah- These are people who are not in [our industry]. And if it's obvious to them that there is an opportunity, then it's something we need to pay attention to.

Finally, **Exploring and Validating Existing Ideas** included strategic value from companies exploring and validating wild concepts as well as value from the projects unintentionally validating some notion that the company had outside of the project. In one of the cases, the liaison used the projects to explore risky or unrealistic ideas and concepts and how they provided value to the company. However, in the more recent projects, the liaison framed the projects in different ways, possibly suggesting that utilizing these projects for exploring risky concepts and ideas might not be valuable enough to be a core focus. Additionally, the validation of existing ideas could also be a positive hindsight and by-product on a project that focused elsewhere. Nevertheless, overall the data suggests that exploring and validating existing ideas was not perceived as highly impactful for the overall value judgement. Rather, the projects are often used to explore and validate risky and unrealistic ideas. For example, the Senior R&D Manager at a Global Manufacturing Company explained about a risky idea they wanted to validate more concretely:

> So, the reality was really for us, our objective was to test out a risky idea that was on paper. To test it out in academia and then share that. Our prompt was very solution fixated to begin with. So, it really was just an idea that had been posed that we didn't have any reason to believe could actually become a reality. And the students, they demonstrated in nine months they could make it a reality. So, the evolution of that idea has just been the acceptance of that idea.

3.1.2 Developing human capital

The liaisons expressed the benefits of utilizing the projects to develop the organization's human capital in three distinct ways:

First, **Developing Design Process Understanding** highlights ways in which companies imitated and disseminated the design process within the company and several personal insights in which the liaisons understood some critical aspects of the process better. Companies were using the courses to learn about the process and even disseminate it within their company. For example, in conjunction with the first time the Global Manufacturing Company took part in partnering one of the course projects, they attempted to utilize the course process internally as elaborated by the Senior R&D Manager:

> We had one project, a [product] development project, where we co-opted the [courses] milestones. I say co-opted because it was during the first project, so we had very preliminary understanding, and obviously we weren't - we didn't do this under the guidance of somebody from [the course].

Second, **Recruitment** was a prevalent form of value as the courses helped both in the recruitment process as well as in the employee marketing aspects. This source of value emerged in most of the cases as a meaningful source of value, and in one case was extremely impactful, explicitly being enough to make the project valuable even if the project outcome was not good. The development of human capital through recruitment of students emerged as

a value in three of the cases. The opportunities that the courses provide for recruitment are significant, both in the perspective of liaisons as well as the company leadership. The data highlights that the courses can help either directly with recruiting students and as an excellent form of a job interview, and indirectly as employee marketing. The Innovation Lab Manager at the International Component Supplier explained:

> I guess the program is the best job interview that you could have. It's way better than just seeing somebody for one hour and switching.

In addition to directly recruiting students, marketing a better company image to students emerged strongly in one of the cases, where increasing student awareness of the high technology behind a somewhat traditional industry was thought to increase interest in the company.

Finally, **Developing Knowhow** captured the rest of the knowhow development that doesn't fall under the design process. The projects can function as a stimulant to the individuals in the sponsoring company to rethink their assumptions and processes. This was of significant importance to at least one of the liaisons. In addition, the projects gave the liaisons opportunities for personal development. The data shows that there is a need for external input to help the people in the sponsoring companies to rethink their assumptions and ways of working and how the liaisons see that the projects can help with that, especially through the frequent interactions caused by the projects. Additionally, the projects can offer other learning opportunities such as developing as a manager as well as learning how to use contemporary networking methods that can provide better outcomes than traditional methods. Finally, the data shows, if only weakly, that the projects actually manage to develop the working processes of the liaisons. For example, for the Senior R&D Manager at a Global Manufacturing Company it was a significant learning opportunity to manage people related to a field in which they themselves did not have expertise in:

> Since I'm relatively new in my career, I've learned how to lead a group of people without necessarily knowing all the answers, if that makes sense. … So, being able to lead the students and direct them in the right way, even though I don't know where they're going to go and I don't know what the answers are going to be, that's something that's been my biggest learning.

3.2 Project outcomes

The value of gaining new ideas, products, services and concepts was explicitly and frequently mentioned in all of the five cases in the first round of interviews. As the projects developed and the later interviews were conducted, the liaisons were better able to formulate the nature of what was and would be a valuable outcome in terms of ideas, products, services, and concepts. Based on the analysis which looked at all the interviews in parallel, three different categories emerged: Novelty, Validity and Concreteness.

Novelty was one of the most significant needs for the liaisons for the generation of new ideas and gaining fresh perspectives, especially ones that are different from anything they have thought of internally within their company before. Getting access to new ideas to their development pipeline, getting new perspectives on how to approach the problem space, and in other areas for new ideas were seen valuable. Furthermore, the data shows an overall interest in expanding product portfolios and getting ideas for new products with business potential. Part of the perceived potential for value from novelty was seen to come from having students work on a project where they have no existing conceptions and biases towards the company

or the industry, allowing them to come up with more novel concepts. For example, the Senior R&D Manager at a Global Manufacturing Company phrased it in a way that the students don't have the same paradigms as professionals:

> That just blew my mind in the fact that [the students] have pretty open minds. It's like gathering a group of kids and you tell them, how do you solve the problem, right, and they just come up with great ideas on how to solve 'em, without- because they don't know, they have a fresh mind. They don't have the paradigms and as you learn more from something… you always have to be going away from that, trying to spread the wit.

Validity is about showing that the proposed concept is either well-founded or validated. Potentially due to the course process, the Validity came up on a very specific level, roughly following three pillars of the design process: user desirability, technological feasibility, and business viability. This was highlighted, for example, by the Innovation Lab Founder at an International Component Supplier:

> We need the students to… create not only the solution technically or in terms of user experience, but to imagine what's the business model that goes with it, and how we can bring the organizational change in the company that allow us to produce it and to sell it.

User desirability presents the aspect that the project outcome is somehow shown to address the various users' needs more thoroughly than just the designer's perspective. On one end of the scale, there is the solid understanding of user needs that leads to a well-founded project outcome. In contrast, little emphasis was placed on technological feasibility, i.e. that the concept is shown to be technologically feasible with either current technology or at least believably extrapolated to be technologically feasible within a reasonable timeframe. The liaisons showed little emphasis on the projects demonstrating technological feasibility and, on the contrary, wished that the students focused less on the technology side, because many of the case companies have a lot of engineering knowhow. The third facet of viability, business viability - showing that the concept has a viable business opportunity behind it to ensure that the company can turn the concept in one way or another into a benefit - was frequently mentioned, but the liaisons' expectations towards how this could be demonstrated were unclear in the data.

Finally, **Concreteness** reflects how specific and defined the project outcome is. There was little push towards highly functional prototypes, instead the data showed a definite need for more detailed concepts. Additionally, the liaisons expressed an expectation towards project outcomes that are realizable in short-term. For example, the Innovation Lab Manager at an International Component Supplier explained how they need more than a drawing:

> When you're somebody like [our company], when you arrive at that point, if you want to push this thing further or at least prove something to more people, you need more than just '[the project] actually ended up as a drawing.

3.3 Stakeholders and ecosystem

A third cluster of value was found in the stakeholders and ecosystems - as the companies are operating as parts in large ecosystems, their relationships to other parts of the ecosystem are of great importance and the course projects were used to increase understanding and develop relationships.

3.3.1 Stakeholder understanding and relations

Understanding Stakeholders was brought up as valuable in two of the five cases. Understanding their users can be beneficial for both overall and to companies that are already customer-centric in their processes. One of the reasons the liaisons saw their companies benefit from gaining stakeholder understanding through the courses was because they don't have the resources to do user research on top of their day to day activities. However, the lack of stated significance for the rest should not be directly assumed for a lack of importance in the design or project processes, merely that it is possible that stakeholder understanding is an intermediary step. The Director of Business Unit at an International B2B Service Provider explained how they work alongside their customers, but still can't be sure they are at the core of their users' needs:

> We have quite a good picture, so we do all of our product and service development alongside customers, so customers are involved in everything we do. But are we still always exactly at the core of it, that I am not sure about?

New and Improved Stakeholder Relations, in turn, focused more on the partnership side than on the end-user. The benefits of the projects towards stakeholder relations can be roughly divided into two aspects: enabling new stakeholder relations and improving existing stakeholder relations. However, it is difficult to draw a line where one ends and another begins. The emerging benefits were about identifying and connecting with new partners both directly and through the university network, creating new connections within existing stakeholder groups, improving the relations with existing stakeholders, and actually creating, not finding, new partners.

The data shows how companies can utilize the projects to identify and connect with new possible partners. For example, the Innovation Lab Manager at an International Component Supplier explained how they already during the process contacted two new partners and utilized the project outcomes as a starting point for discussion:

> We had two concepts, and we decided to contact directly some either potential partners or customers that we could push the concepts further with. So, we contacted [a public institution], which is in charge of [our industry], for [one] concept. And for the [other] concept, … we have a contact with a … startup, that we're talking to see how they could be interested in the concept and working together.

The university network behind the courses was also raised as a way to make connections with companies one might not have access to otherwise, to create potential new partnerships. The Innovation Lab Manager at an International Component Supplier explained that the network can bridge the gaps:

> When you work with somebody … you access a network, and the network you access when you work with a student program is not the same that you will access when you work with a private company. And often actually, going with academy program helps you bridge gaps between different companies.

3.3.2 Ecosystem understanding

Understanding of ecosystems was divided into two distinct parts due to the nature of the courses being part of larger academic networks. The first part is the value in gaining improved

understanding of the ecosystems and markets. The second part is the value of being part of a university ecosystem.

Understanding of Ecosystems and Markets emerged as a beneficial aspect in three of the five cases. Overall, the data shows that it serves as a good starting point for internal projects and that it is valuable on its own, but also that it is a mean- to-an-end to other values. A distinction between the two was not made because, as shown by the data, the liaisons also made little distinction between them. The data shows how the projects can be used to kick-start internal projects. The Director of Business Development at an International B2B Retail Company explained how the projects can serve as a starting point for their own exploration:

> This project is also – for the relevant segment – an introduction on what it is all about. … so, [our team] can kind of jump on a moving train, and then start improving and deepening their knowledge and understanding in addition to already having one concept idea.

Understanding university networks and supporting ecosystems relate to collaborating with universities, which provides a few distinct benefits. The main way in which the liaisons saw value was by utilizing the university network and ecosystem as a means to benchmarking what other companies are working on. For example, the Director of Business Unit at an International B2B Service Provider explained regarding the previous year's final exposition: "I remember the final outcome from last year's [final expo], … you could say it was enlightening to know what other companies are doing."

Similarly, Innovation Lab Founder at an International Component Supplier highlighted the university ecosystems benefit in competitor benchmarking, especially related to their strategy:

> I think it's a good way to keep a communication channel with the [university] network. … I think it's also a way to see what's up with the other [course] projects, other than [our company's]. … When you look at student projects like this, you are a little bit of looking at the strategy of other companies, so yeah, I think it's a good benchmarking opportunity.

3.4 Other benefits

Finally, three sets of benefits emerged that did not fit under the aforementioned categorizations of value and did not have significant unifying dimensions:

Inspiration emerged on its own as a benefit on its own, in two main ways: first through the excitement and energy the students had, and secondly, through the validation that the sponsor received regarding their company and project directions through the students showing appreciation and considering their direction a good one. It is, however, difficult based on the data to evaluate the importance of the value brought by Inspiration. This is because the value was seen only in a few cases, but very strongly in them, and also because the value is highly personal and emotional, making it more difficult to rationalize. While not present in all of the cases, it seems that especially for the liaisons in the most senior positions, the interaction with the younger and more energetic students is a welcome addition and potentially a significant contributor on an emotional level.

Social Impact as a principle of giving back to the society, emerged as a value factory both in a generic form, as well as through supporting education and learning. While being a very abstract and loose benefit, it emerged in most of the cases in one form or another, and while it was not a core source of value, it can still be considered a meaningful contributor. The

Innovation Lab Founder at an International Component Supplier explained in his first interview what has him excited for the upcoming project:

> I'm very excited about the topic itself. I'm really looking for a project that can bring positive change in the society and not just create business for the company. So of course, it's an important aspect that we have something to sell at the end and that we make money with this solution. But I would be personally really satisfied only if it brings value to individuals and the society and not just to [our company].

As a core, and almost sole contributor to the social impact, the liaisons expressed willingness to support the students learning experiences, even at the cost of other benefits for the company. The data shows the beneficial, largely emotional aspects in supporting student learning, but on the other hand, also being ready to dismiss unfulfilled value expectations by justifying that the primary purpose of the projects is student learning.

Finally, **Credibility** was one of the inherent benefits that according to liaisons comes from working with a university. Although the data does not highlight the more practical mechanisms of how that collaboration leads to more concrete forms of value, it's benefit was mentioned in multiple cases. While there is ambiguity regarding the benefit, it still emerged to a significant degree in the data so it was included in the findings. The data had a number of direct mentions about the value of collaborating with universities. For example, the Director of Business Development at an International B2B Retail Company stating that their "*hunger for university collaboration had grown*" and the Director of Business Unit at an International B2B Service Provider stating how "*it would be nice to be engaged in collaboration with [the university]*" as well as the Senior R&D Manager at a Global Manufacturing Company "*think[s that] just generally engaging in research with academic institutions has a great deal of value*".

One of the benefits of collaborating with these courses is through the legitimacy they bring to the liaisons themselves. The Innovation Lab Founder at an International Component Supplier explained this very directly through how their boss used to be the liaison and found legitimacy through the course and collaboration:

> So, I think that when he discovered the [university platform running the course], he finally found someone or something that could put words and terminology on his natural way of working in [our company]. And so, he had the feeling that he had always been somehow user-centered and doing user-centered projects. And so, I think he wanted that to become an institution, not just the way he did, because he felt that way, because it gave him some legitimacy in terms of network and kind of methodology in terms of the academic reference that he lacked.

4 Discussion

The liaison interviews on the forms of value that participation in project-based courses can bring to organizations clearly illustrate that the value spans much wider that the course deliverables themselves. Being part of an academic network, gaining alternative insights on the exploration of the design problem and learning new tools all carried weight for the sponsors. Furthermore, the company liaisons underlined how these design courses could be leveraged for cultural and strategic change within the organization (in line with recent research on design thinking and organizational culture [39]).

The present study highlights how value judgement is highly dependent on the context. While previous research has highlighted the fleeting, situation-specific aspects of value in for example purchase decisions [16,23], the present study shows a different form of contextuality that is inherent to the user, essentially the individual's context. When looking at a specific interaction, various forms of value might play a part, including the more fleeting forms of contextuality, as well as the context that each involved party brings to the interaction. The notion of multiple contexts compounding is an interesting one as some authors have already considered that contextuality might be the explanation for why there are so many conceptualizations for value [16,32]. In addition to contextual differences arising depending on the context of the course, liaison and company in question, the study highlighted the temporal contextuality, illustrating how expectations and value in many cases shifted from one form of value to another. For example, the Product Manager at the Local Retail Company was originally looking for some form of product or service outcome, but later on was delighted and implemented a concept that partially redefined their core strategy. Previous research has shown similar temporal changes in for example customer perception on value at the time of purchase and after use [16,23], highlighting the need to understand expectations and perceptions of value at different points of collaboration to build a solid understanding of industry-academia interaction.

4.1 Practical implications and development suggestions for project-based courses

While the primary purpose of project-based design courses is to provide students with an opportunity to learn the design process, as the involvement of real companies is critical to the courses' pedagogical approaches, it is also highly important to consider the companies' perspective as well. The current study suggests three areas of improvement in the course design and sponsor communication processes in project-based design courses: including value negotiations in the curriculum, establishing vocabulary to discuss different facets of outcome expectations and enhancing collaboration with the liaison.

First, all parties can benefit from recognizing the full scope of potential values, which in various ways extend beyond the explicated creation of a core concept, as highlighted by the findings. Especially driving change within their organization and recruitment emerged as important value creators for the liaisons. Furthermore, even for the liaisons, the realization of different forms of value formed only during the projects. Recognizing the existence of a broader set of potential values from the projects not only realizes better value judgements from the liaisons, but can also be utilized for a better learning experience for the students. By the teaching staff transparently adjusting the courses and supporting the students in adjusting their projects based on the needs of the sponsors, the students would learn how to adjust and customize their design projects in a manner that is more authentic to the projects run in a professional capacity. For example, key milestones should be created where the students, together with the liaison, to discuss, understand, and explicate the purpose of the project from the sponsor side beyond just the brief.

Second, a typology for describing the project outcome (product, service, prototype, concept) should be considered as the data showed significant difficulty in the communication of expectations towards the final deliverable. The typology of novelty, validity and concreteness can serve as a starting point for explicating those expectations. In practice, though the liaisons might consider all three descriptors critical, the data has shown that due to limited resources, they are to some extent mutually exclusive and prioritization of resources to one over another is needed. Generally, the company's own context would play a critical role in which aspects

are most valuable to them (e.g. concreteness not being that important to an engineering company due to in-house capabilities for realizing concepts, while a retail company valuing concreteness for their lack of such in-house capabilities). The courses should explicitly discuss and ask the sponsors to explicate the priority for the three aspects of project outcomes, for example by asking the companies to allocate 10 points across the three categories and explaining their reasoning behind the prioritization. The discussion and ranking could potentially be repeated at a later stage of the project once the liaisons have a better understanding themselves on what they can get out of the projects.

Finally, the analysis showed significant differences between what the company values (e.g. an actionable product concept) and what the liaison personally values (e.g. incorporating design as a part of the corporate culture). This suggests that when having discussions about sponsoring projects for the courses (from first contact to post-project discussions), the liaisons personal goals and motivations should be highly in the focus. Once the liaison can be convinced to be the champion of the project, they are then in a valuable and unique position in being able to give insight about the company itself as well as help in tailoring the communication towards the rest of the company in a favorable way, as well as personally advocate for the project within the company. The importance of this is highly emphasized regarding the strategic development aspects of the overall value of the projects. The benefits in strategic development are highly contextual and are inherently difficult to realize (e.g. cultural change). The course staffs, the student teams and the projects capability to support the liaisons in driving the change the they see the companies should go through can be a major part of the benefits the courses provide. Therefore, it is important that conscious effort is made to identify and support these goals. Furthermore, as an educational institution, the course has a unique opportunity to support the liaisons' personal development. This can be realized through written or video materials, or even be developed in to executive education that is run in parallel with the courses. The content should be focusing on what is the core process of the project or other expertise the course staff holds. For example, in IDBM IP, some of the staff members specialize in organizational change, which is not strictly parallel to the design course, but would still add significant value to some of the sponsors. By providing personal development to the liaisons, further value can be generated through the projects, ensuring future participation by companies, but it also leads to a better learning experience for the students, as the liaisons are better informed and capable to support and manage the student project.

4.2 Limitations and future research

As the present study was based on a small number of interviews in the context of only two project-based courses, more research is needed to extend sampling to a wider variety. Furthermore, while the present study focused on exploring the variety of sources of perceived value, their relative significance was beyond the scope. The present data suggests that there may be large differences in perceived significance, and further studies are needed to both assess the relative significance as well as dig deeper into the most significant contributors towards perceived value. For example, the current study suggests that the internal capabilities or field of the organization can have an influence on the relative importance of novelty, validity and concreteness in project outcomes.

Furthermore, in addition to answering 'what' values are present, a similar exploration in to the processes that support or hinder the formation of the value, would begin answering the 'how' question in improving the overall value judgements. Towards this end, multiple sources

of data would be useful, comparing company representatives in different positions, the student teams as well as the course instructors over time. As the current results suggest driving change in the company can be an important source of perceived value in the company, we suggest further studies would in particular link together the student and sponsor company processes rather than examine only one face of the coin at a time.

Finally, we hope to be able to explore in more detail how initial negotiations with potential liaisons and between the company liaisons and the student's teams can be scaffolded by vocabulary explicating and weighing different facets of value. The current study suggests discussing expectations in terms of changing ways of working, exploring uncertainty, and project outcomes in terms of novelty, concreteness and validity may be useful for better aligning the needs of the project-based course staff, students and partners. Even though project courses with industry partners are seemingly design project outcomes, the current study shows how underlying strategic development can be a key facet of value for the sponsor companies. The change that the liaisons were looking to drive related to creating change in ways of working and organizational culture, exploring and validating new industries and markets, and exploring and validating existing ideas. Being able to explicate and discuss these different facets of value can improve a shared understanding of the diverse goals targeted by different stakeholders through university-industry collaboration.

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