ABSTRACT

MIRANDA MENDOZA, CONSTANZA SOFÍA. Mapping Visual Negotiations in Innovation Driven Teams: A Peek into the Design Process Culture of Graduate Engineering Students. (Under the direction of Haig Khachaturoian and Dr. James Wallace).

Today, the boundaries of disciplines are in a state of flux. The borders are blurred and innovations occur due to the joining of different disciplinary tribes and interaction of teams with diverse epistemological backgrounds. It is not news that this increased diversity in using the design process can bring friction and clashes due to disparate interpretations of how to resolve a particular project prompt. The more ambiguous the project prompt, the more potential it has to raise disagreement.

This is exactly what happens in the ME-COURSE, a first year graduate course in engineering design that takes place in a renowned university in Northern California. The upside of all of this tension, however, is that the dissonance affords the combining and recombining of old information in diverse ways that can lead to innovation. This seems to be understood by educational settings such as this university, which seeks to recruit individuals from diverse backgrounds in order to unleash the creative potential of a team. In order for these different tribes to reach agreement and be successful, however, this dissonance has to be consciously orchestrated. For this to happen, educational strategies that foster healthy conflict need to be embraced.

Through the fieldwork I conducted for eight months with task-oriented teams from the ME-COURSE community, I learned that differences in academic beliefs exist in communities of practice that at a first glance seemed homogenous. This micro-segmentation in knowledge systems is mainly due to previous undergraduate training that plays a major role in conflict arousal within teams. Nonetheless, techniques that foster positive negotiations have been introduced through instruction in order to stage-manage this conflict and turn it into something valuable for team creativity. Some of these techniques have been heavily influenced through contact with Silicon Valley and vice versa, while other techniques emerge innately through the work of the students through construction of ephemeral trading zones (Galison 1999) and visual boundary objects (Star and Griesemer 1989). The use of ephemeral trading zones and visual boundary objects helps to effectively bridge the communication divide of team members from different disciplinary backgrounds.

In order to harness and better understand the virtues of diversity, I argue that visual diagrams and other forms of visual techniques arise naturally and become a potential strategy to tackle diversity without losing the advantages of embracing disciplinary diversity. In addition, new research methods need to be brought in to analyze things as intangible as team dynamics. Visual research approaches could be crucial in making these relationships visible for further analysis.

This dissertation is exploratory and limited in nature and scope, yet it opens the door to a new potential area of study. The study of team dynamics through visual diagrams and other visual techniques
can be used both to support work that has been already done in visual research and engineering design education, and for future assessments on team work and negotiation in design education curricula.
Mapping Visual Negotiations in Innovation Driven Teams: A Peek into the Design Process Culture of Graduate Engineering Students

by
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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Design

Raleigh, North Carolina
2013

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DEDICATION

To my family in Santiago de Chile, who have been the biggest supporters of my diverse career endeavors. To the best partner in crime, my husband Thomas. Thanks for being the most patient and critical editor. To my “PhD buddies” in sociology, psychology and engineering education: Pilar Opazo, Daniela Aldoney and Paulina Pérez for all of those long conversations in the libraries across the United States (and we did visit a lot of them!). They taught me the rigor of their disciplinary areas and they embraced the ideas coming from mine. To my designer friends Anne and Michael to let me hang out in their classes. To my designer friend Melissa Cliver for nurturing my head with ideas and making my time in the Bay Area so much better. Finally, to Dori Tunstill, for always being a great role model in research and for encouraging me to always make a leap of faith.
BIOGRAPHY

Constanza Miranda is a currently a PhD candidate in Design at North Carolina State University, where she has also been an instructor. During this time, apart from taking courses in Design, Cognitive Sciences and minoring in Anthropology, she looked to deepen knowledge in ethnographic research (apart form other methods) in order to become part of the new generation of design-anthropologists. She holds a Fulbright-CONICYT [Science & Technology Commission] scholarship for doctoral studies in the United States that extends from 2009 to 2013. From 2011 to 2012 Constanza fulfilled her doctoral research as a visiting scholar in the School of Engineering at a well-known university close to Silicon Valley. Her major interests are on innovation, multidisciplinary education, visual research, design-anthropology and social issues. These are the areas that frame her recent participation in conferences and other academic endeavors.

Having a degree in graphic and industrial design, she has carried out various professional endeavors in Europe such as Braun/Gillette, Karl Storz Endoskope, Design Continuum Milan; as well as in the US with consultancies like Cooper. Back home, in Santiago de Chile, Constanza has worked in applied and strategic research being the director and founder of the research area of one of the biggest local design studios. She has also carried out academic research in the areas of public health and social inequality. Since 2006 she has been an instructor at Pontificia Universidad Católica de Chile at the College of Design and the School of Engineering. Her near future entails the development of the Engineering Design Initiative at PUC’s School of Engineering where she will be holding a position as a researcher and professor. More on her work can be found at: www.innovacionsocial.cl or www.designforsocialinnovation.org.
ACKNOWLEDGMENTS

I would like to thank my multidisciplinary committee for setting the stage for this one-year journey to the West Coast and for a second year personal journey on writing an ethnographic representation. To Dr. Tim Wallace, who believed in me and during four years trained me as an anthropologist. Thanks for being the best academic mentor since the day I arrived to NC State. And to Professor Haig Khachatoorian for always helping me out with his diligence.

I would like to extend a special thanks to all of those who participated in this research! The best students ever: Gayle, David, Emily, Jason, Rishabh, Kristin, Scott, Tyler, Qinyi, Jacob, Annika, Eng Seng, Danya, Tommy, Will, Jackie, Jian and Stevie; and the awesome teaching assistants: Rafat, Kelly and Jack; and the amazing devoted professors of the ME-COURSE. To all of the other instructors and directors from the engineering and design schools who helped me with the information gathering and to THE CENTER for hosting me as a visiting scholar during the time I stayed in the Silicon Valley area.
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1. INTRODUCTION: WELCOME TO THE VALLEY OF INNOVATION

1.1 MY CONTEXT: THE EYES OF ANTHROPOLOGY, THE HANDS OF DESIGN

"... such an exploratory journey, where you did not quite know what the answer was but there was an important amount of trust that if you follow the leads and your sense you will get to the answer like in hindsight would look obvious, but you wouldn’t know what you were designing on day one." – Instructor

The design and anthropological instruction, I have undertaken throughout my professional and university career have trained me to deal with the ambiguity of real world problem solving. They have allowed me to face these problems as a journey, and as much I have had highs and lows. They are like chaotic systems where you can see patterns, but it is hard to predict an outcome. Yet, because of my varied experiences, I thought I was prepared enough to work with the gap between sterile theoretical models and messy real-life phenomena. As I embarked upon more than an eight-month ethnographic journey, I soon realized that working within this gap was easier said than done. People are not easy to study. Culture is multifaceted. Teams are complex. There is more to say about engineering design education and teamwork than what I had expected.

This is why I decided to tell the story, the whole story of the visible and invisible things that were happening among the specific context of design engineering education in Silicon Valley. An untold story combining the world of anthropology, which provides the eyes to understand and observe phenomena, and the world of engineering design, which lends the hands to those eyes. The fieldwork that precedes this account became an embodiment of the interests I always had on design, multidisciplinary education, visualization and culturally literate methods.

To understand how and why I depicted this story in the manner I did in the pages that follow, it will be useful to understand where this research drive came from; and the context that gives meaning to my interest on teamwork. The general answer to this comes from the way I’ve experienced teamwork during my life. I wore many hats pertaining to teams from a variety of organizations and institutions. I did it as a student, as a team member, as a professional designer and later as an educator. Teams meet and they basically communicate, clearly, but they do so with a purpose (or at least they try), which is usually decision-making. However, decision-making is often based on incomplete information or idiosyncrasy, at least when going through the process of designing something. I knew there was something intrinsic about the use of visual instruments in the decision-making process, when they were pulled out once and again in this context. It was very common to come to a meeting where a slideshow, a drawing, a visual printed diagram or other graphic artifacts came to play a major role. These visual instruments were used to bridge the gap among the team members, and operated as a shared pattern among diverse contexts, environments and even countries. Just think about it: I bet you have been in that situation too even if you
were not engaged in the design process. Is there a universal pattern, or does it differ depending on the group and context?

Being a researcher, I started entertaining the idea that individuals where creating a type of visual lingua franca to communicate within teams. This became a sort of hypothesis. Why was this happening? How was it happening? What were the exact patterns? Was it common? These were not answered by the disciplines of design and anthropology, neither of which have provided long-term observational evidence that could help me understand the key issues embedded in the use of visual artifacts that seemed to be crucial (at least exceedingly common) to teamwork. If working in teams is a typical way to work in design, it becomes a relevant topic of study for design teaching. Grasping the dynamics of teamwork can certainly enlighten the way we train the future design professionals in academia.

The business world has not been oblivious to the importance of team dynamics, of course, and has borrowed substantially from methods and modalities first created in the classroom. There has been a significant amount of scholarship in the realm of organizational studies. However, this academic area usually explores the work of task-oriented teams in companies, and is not necessarily focused on the way individuals approach team negotiation in educational settings or at least there are not many (if any) long-term explorations. The fact is that educational settings should be relevant, not only to impact the design curricula in relation to the way we make the students engage in groups, but because these students will become integral members of the workforce in industry. Are they prepared to do so? How do we prepare them? How does this training influence the way they will perform in the future? It becomes important to understand which are the subtleties that precede the workplace in order to take action.

This was the moment when I decided to theorize from practice and went to observe how things were happening in the raw in a particular educational setting. Focused on engaging in a longitudinal research, I searched for an institution that provided me with the possibility to engage in a long-term observation, which is no easy task. You need groups working on long-term, committed projects, and most importantly, groups that are willing to be observed. The school of engineering at a private research university provided these conditions. I could witness how the design process learning and deployment occurred. It was a once in a lifetime chance to observe the way task-oriented teams interacted while doing design, how the ideas infiltrated by their academic training clashed and how they negotiated settlements. Thanks to the program's budget and orientation, the physical space and conditions provided a living lab (Følstad 2008) structure, where I could witness each moment of the process.

1.2 MAPS ARE USED TO NAVIGATE, THIS ONE IS YOURS

"Writing a book would give me a chance to share what I had learned, and help to further a cause I share with a number of others: to keep ethnography intact as a clearly identifiable style of research, rather than watch it become just another synonym for qualitative research in general" (Wolcott 2010:87).
So now that you know the overall context, my own research context, I can give you a more detailed map to navigate this dissertation. It is never easy to start an account. Overall when there is so much to tell.

The chapters that follow will be a peek into the culture of engineering-design students at PRADBORD, which is the pseudonym I gave to a well-known university in the Silicon Valley area. This is a story to share (1) *How the design process instruction takes place in an iconic and so-called innovative engineering-design program*, (2) *how academic training and culture influences and conditions the negotiation dynamics among teams of students*, and (3) *how exchanges and settlements are performed through the use of boundary objects and trading zones*. Each of these specific terms will be defined throughout the account.

I researched a particular community of practice, called the ME-COURSE. This basically a first year graduate course on engineering design that entails a teaching team and thirty-two students arranged in nine teams. During eight months I saw the students nearly every day, for more than ten hours where I would *hang out* and closely witness the processes they were going through. I worked closely with five of those task-oriented teams of graduate mechanical engineering students, and kept contact and did a less detailed work with the other four teams.

All nine teams were not only immersed in one, but in a series of multilayered organizational cultures that aggregate imposing a set of beliefs, mantras and specific ways to do things. The following narrative focuses on the teams, but also covers the multidimensional ecosystem that affects the design engineering practice and learning of these students. This is why the research also follows another iconic course unit in the core program in order to map all the levels of meaning possible. Being a designer myself, the story to tell might seem a little familiar. Nonetheless, I was recognized as a sort of *professional stranger* in that environment. I was addressed as the designer, as the researcher, as the instructor and sometimes even as a friend. All these roles helped me to navigate during the nearly one year that the data collection process took place, and the more than one year that it took me to write about it.

Being a designer, I am biased to action and externalization of knowledge in the mode of visuals, products or other form of perceptible embodiment. The following figure (Figure 1.1) shows the roadmap to navigate this ethnographic account.
If your main interest were the innovation on the creation and application of visual methods, I would recommend you to jump directly to Chapter 3: Reviewing the Methodology: a Unique Take from a Design Anthropologist. This might be the most revealing and useful chapter of all as it shows how I embraced anthropological methods from a design standpoint. This chapter can help in advancing the research done on the design process but understanding the cross-disciplinarity of ethnographic methods and the way that design can make a contribution to fundamental research overall in the phases of data collection, analysis and display of information. It is in my belief that there is more to be done in the area of synthesis and data reduction. As a disclaimer, this document is constrained in format by the boundaries of an electronic thesis dissertation guide. So you might not see the potential of visual methods displayed in this version of the dissertation.

Chapter 2: The Theory Behind the Quest: Mapping the Meanings behind the Engineering-Design Process, Team Innovation and Visual Engagements will start by unveiling the theoretical assumptions and literary background that are the pillars to this research quest. This will build common ground between me the author, and you, the audience. It seeks to bring clarity to the understanding of elusive terminology and large concepts such as: design process, multidiscipline, boundary objects, visual thinking, and others that if not grounded in a particular framework, can become a demeanor to understanding.

Chapter 4: Picture Perfect: The Mystique, The Hammock and the Thirst for Innovation will look to detail my first encounters in the field, particularly in the course unit I worked with. This chapter is a thorough description of the specific ME-COURSE community. It depicts the specific factors influencing the way people behave, how the instructional dynamics take place, how the cultural ecosystem affects this community of practice and all of the decisions that may affect the way teams face their product.
innovation projects. It is basically a description of the setting, a still picture that will help you to understand the scenario where action takes place.

**Chapter 5: The Picture in Motion: Making sense of Team Interaction** looks at the collected data from the ME-COURSE community. The chapter seeks to tease out patterns on mechanics, team dynamics, conflict and points of negotiation in the process. This section is relevant as it portrays the patterns observed in the task oriented teams of design engineers at PRADBORD. The final segment in this chapter finishes by talking about the significance of the data analyzed. These insights that can be taken into assessing curricula in the engineering design education that emphasizes the work in task oriented teams, the pursuit for innovation and the ability for the students to recombine their information in meaningful ways.

**Chapter 6: A Final Word: Takeaways for Handling Diversity in Design Education** finishes by teasing out the final learning outcomes from this dissertation. These might be useful to understand some of the insights, good and bad practices from the instruction that takes place in the ME-COURSE. In addition, this chapter points out the potential of thinking about negotiation in education as a lens for understanding and promoting the collective creativity of teams and recombinant innovation.

**1.3 THE LARGER RESEARCH SITE: AN ICONIC PLACE FOR INNOVATION TO FLOURISH**

**1.3.1 THE UNIVERSITY AS THE OVERALL RESEARCH SITE**

It is not really necessary to drive 3,000 miles to immerse yourself in another culture. For me, it was in the opposite coast from where I was fulfilling my PhD, where I could find a community with the perfect conditions for my research to take place. “This is Constanza, a designer-designer...not like us” (i.e. an engineer-designer), said one of the engineering researchers as soon as I arrived to THE CENTER, as I will refer to the research center that hosted me as a visiting scholar. This was part of the Mechanical Engineering School and there I would base my work. Even though I was grateful for their invitation, this early labeling and tone put me on alert. Historically, there has been a perceived difference between designers and engineers. However, it seemed there was a local political issue that I would need to understand. I shall go into that later in order to explain the local friction between some engineer-designers and the Design College (DC) belonging to the same university.

PRADBORD, as I am going to refer to my research site, is a well-known university in northern California, fairly close to Silicon Valley. And even though this university holds diverse ethnicities in its student body, the majority of the undergraduate pupils who are not Caucasian identify themselves in polls as “American” (Asian American, Hispanic American, African American, etc.). According to this universities' common data set for 2011-2012, the number of international students in the undergraduate program is less than a third of the amount of international students admitted in the graduate programs.
Given that PRADBORD is highly ranked in national and international rankings, these numbers are not a surprise.

The international presence was evident for me when meeting the members of THE CENTER. There, the majority of the individuals on site, and related to it, where from northern Europe. This could be attributed to the focus of THE CENTER in studying the design process or because of the leader’s joint appointments with universities in that area. Even though most of them had an experimental approach towards human processes, they usually labeled themselves as different from other more technical oriented engineers. “We are very crazy here,” one of the leaders indicated as soon as I arrived. Coming from a more purist design background, nothing seemed too crazy for me there. But considering their profession’s parameters, the excellence of engineers in resolving technical and technological problems with a very positivist approach, they could be considered unusual.

This was not the first time I had worked with engineers, or the first time I visited PRADBORD. I had been there some months ago in a short teaching appointment for a workshop. My memories of the visual impact that the spaces generated in me were fresh. In addition, this place has been relatively present in mainstream media related to design engineering and innovation. So I had also been exposed to the coolness and vibe related to this campus in the Bay Area.

1.3.2 THE CULTURE EMBEDDED IN ARCHITECTURE, INTERIOR DESIGN AND URBAN PLANNING

The coolness of the campus is majorly influenced by the architecture, interior design, and urban planning. Regarding the latter, the campus has been planned to be mainly for pedestrians, golf carts and bicycle riders. There are only a couple of streets left for cars to go through, but the majority of car traffic goes through the perimeter of the campus. Smaller streets are destined for the transportation of supplies or public buses that run on a schedule and are free for any riders. Nonetheless, a huge amount of the students, professors and staff have opted to ride bikes.

The reason for this proliferation of bikes on campus is because as the distances get to be too large to get from point A to point B (often the case on a campus of this size), the use and ownership of a bike greatly improves your mobility. Riding a bike, as opposed to driving a car, gives a perceived sense of freedom and democracy to the university members. Bikes can be financially accessible through a second hand internal market (which mostly works through a protected online posting) and a bike rental. This results a large number of professors and students alike riding bikes around campus. The downside of this is that first time bicycle riders get frequently in accidents, as they are clueless of the explicit and implicit rules of transit related to riding a bike.

But even there is a sense of democracy due to the urban planning there is also a non-democratic side to the way this university works. It is hard to say that there is an egalitarian feeling when it comes to
the high tuition rates that undergraduates have to face. For example, in its November 2012 Education Edition, the Washington Post Magazine points out the excessive amounts law schools charge in this country. According to the magazine, the amount regarding school tuition, fees and living expenses of this university is even more than other higher education establishments like Columbia, NYU, Harvard and Yale. Nonetheless, it's fair to say that the rates are lower than a few others, but they are still in the top tier of the United States. It might also be fair to say that a good amount of students are able to find jobs around the valley, and fulfill their loan payments due to the high salaries in the area, but that is everyone's reality.

Nonetheless its contradictions, PRADBORD stands out architectonically from other universities in the same trier, overall the ones in the east coast. Instead of emulating the gothic style of European universities like Oxford or Cambridge, PRADBORD's architecture embraces a more modern Spanish like style. This can be considered usual for the state of California, its climate and Mexican heritage. Nevertheless, within the context of high-end universities, it seems pretty exceptional. The clay roof tiles are present in the major buildings and give a red color to the ceiling line. However, in the last years, there has been a disruption in the architecture style by the involvement of building construction with an inclination to materials like glass, steel and uncovered cement. Still, the conversation between these styles is still perceived as harmonic to the ordinary eye. Some examples to these new constructions are the ones belonging to the pristine schools like medicine, engineering and the basic sciences. The financial model embraces the financial aid of some kind benefactor who will usually give the name to the building.

But cool buildings and a pedestrian orientation are not the only keys to achieve the *campus cool vibe*. In campus housing converts this place in a living environment. There are people all day, every day and it is not rare to see that lights are on in the student buildings no matter the hour. Undergraduate and graduate housing are located in different areas of the estimated 8,000 acres.

Graduate housing usually comprises a set of houses constructed around small gardens or plazas with gates of a short height that give access to everybody to the main court. It is common to see parents and kids share their afternoons enjoying the usual good weather of the Bay Area. An American looking suburban design that has been referred by its inhabitants like *The Truman Show*. On the other hand, the undergraduate housing is spread throughout the campus. Undergraduate students usually share dining and other leisure spaces. Both of the housing structures afford the interaction among students after schoolwork. It's common that students mingle there and get to know each other in situations that are not totally academically related. This situation pays off considering that according to their website, the amount of undergraduate students is around ninety six percent. On the other hand, the number of

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1 *The Truman show is a movie starring Jim Carey that portrays a perfectly staged suburban life in the United States.*

2 *Geek is a term from slang that refers to individuals that are usually odd or interested in things like computers or*
graduate students that live on campus is about fifty seven percent and even a thirty percent of faculty individuals have decided to live in the housing area. Most of the students are constantly interacting which will more likely perpetuate the sense of belonging to this community and the enactment of culture.

But even though there is a larger sense of belonging to the university enabled by the overall spatial definition, there is also a sense of belonging to a particular school. If the student chooses to, his or her life can be built around the campus area where his or her school is located. For example, if you are a graduate student in engineering you don’t ever have go to the area where the school of law is, unless you want to. Due to the time-consuming coursework and teamwork activities in some of the engineering programs, this is a reality for many of the students. Maybe they will go through the medical school and hospital because it is easier to access from that side of campus, but that doesn’t mean that they will go inside the school building or even meet the pupils. In this sense, because of the conditions, the idea of belonging to a school seems to be stronger than belonging to the university as a whole. Both coexist, but it is just a question of allocating time. “And there is just so much time”, one of the graduate students mentions.

1.3.3 DISCIPLINARY EXCHANGE

But time is not the only variable in the way the students relate to their school. Apart from some particular multidisciplinary endeavors (which I later define), the schools are segregated spatially and architecturally. Thick walls separate departments and schools from one another. Still, encounters of diverse disciplinary perspectives are randomly provided by: dining facilities, coffee shops and open working spaces with tables for sitting and power outlets. These are typically present in the most recent buildings. Conversely, the disciplinary segmentation was, and still is present (here as anywhere else). As Mitch, one of the engineering instructors indicated: “people here can be protective of their disciplines”. And there are several examples of this. Mitch explains, that when he was a graduate student in mechanical engineering (over 20 years ago), his professors didn’t take very well to the idea that students would take courses in other programs. He was “frowned upon” for doing it and was even addressed as “nuts” by his peers. Academic tribes differentiate physically from each other by maintaining their own delimited space.

Mitch was a pioneer. At the time, nobody in engineering could see any benefit on taking classes somewhere else. He did it anyways, and assures that there is still an informal culture of hanging out in courses that are not part of your departmental program. Students would sit in other classes just to acquire knowledge that was out of their curricula requirements. They knew that some of that could be useful or at least interesting for their own practice. Suddenly, outsiders coming from the close by Silicon Valley industries and in campus research centers started doing the same. So at the time, there was a non-
stated and organic cross-pollination of individuals grabbing information from other fields and injecting some of their own. Even though some of the instructors I interviewed assured that today academic departments in the university are more flexible on this issue, it is still the endeavor of some. At least a group of individuals has a broad understanding of the benefits that acquiring knowledge from other programs can bring. Overall, what the liberal arts can offer. This group is getting larger and it is aligning with the message delivered by the president on how creativity is one of the main drives at PRADBORD. In addition, physically attending other departmental courses is not the only way that cross-pollination among disciplinary tribes occurs. Lately there has been an extensive offering of online courses at this university. Some of them are even free of charge. They allow students, and non-students, to take courses outside their area of practice and to get involved with other disciplines. This online instruction obviously has shortcomings, but that the phenomenon is taking place is just a fact.

1.3.4 THE DESIGN COLLEGE BUILDING

Even though cross-pollination is occurring doesn’t mean that every student is jumping from a discipline to another or constantly mingling with students coming from different knowledge perspectives. With the intense coursework that students face in their program, it can be hard and expensive to extend their time in university just for learning something that is not required for the fulfillment of their degree. This is why the idea of particular schools taking this as a major effort becomes game changing. One of these is the Design College (DC). This doesn’t provide academic degrees and is built as a multidisciplinary endeavor. The construction of its building was financed by a benefactor and its architectural layout and distribution obeys their objective of facilitating disciplinary exchange.

The design college building was recently renovated (the program has been changed 4 times from its campus location), and this space seeks to be a prototype for evolving the collaborative process within. The school began with the use of “non precious" materials, so that these can be moved, torn or changed depending on what sort of activities are going on within. That is why the benches, seats and stools are deliberately made uncomfortable. They use cheap materials and have nothing ergonomic about them. This structure, with its aesthetic of impermanence, embodies the ethos of the school. According to one of the founders, this openness "has been a foundation for the expression of our cultural values". They have made the strategic orientation of this educational establishment physically visible through its architecture and design.

The signature architecture is identifiable by others coming into the unbounded spaces. The two-story building has few walls; lots of large glass windows and uncovered materials (like cement) make the place look modern and broad. It really looks different than any other space in this university. The creators’ stated goal for the space is to enhance collaboration, and for the students to move around this is
why most of the spaces are multiuse. This reinforces the idea that the environment is a way to amplify the organization’s work, and they are emphatic that their alumni create their future working spaces under the same values experienced in the DC.

But the design college doesn’t inhabit this space in solitude. The building is shared with a section of the Mechanical Engineers who share some of the same principles related to space and organizational culture. Apart from sharing the multiuse classrooms, it is on the second floor that the MEs conduct the emblematic ME-COURSE I worked with. THE FLAT is a studio space with no walls for divisions. Unlike the multiuse studios, this one is just destined to just the ME-COURSE. The space is only accessible to the students enrolled in the course through the use of a plastic identification card. The sensor reads it using RFID (Radio Frequency Identity) technology, similar technology that you find in buses and metro networks. This keeps the belongings of the students safe and allows them to come in and out whenever they want to. This fosters a more open, collaborative process among the students by giving them a “home” for their ideas to grow. These are “special features” when we compare this classroom to others in and out the university. And this is because, as stated by the instructors of the design and mechanical engineering schools, this space is a prototype for educational purposes. As an icon of innovation in education, THE FLAT deserves to be described in detail. But this will happen later in the account, where I touch upon the data collected while studying the ME-COURSE community.

Apart from the spaces being education prototypes, the schools of engineering and design loudly claim to be extremely innovative. Due to this, it is not rare to spot groups of tourists or education tourists coming from Asian, Latin American or European countries to observe and copy the model promoted here. Sometimes these tourists are invited to witness or participate in a course that the students are taking. These situations can be uncomfortable for some of the students, as it does not occur just once or twice a semester but nearly once a week (depending on the course). These frequent visits divided the students’ opinions. For some, it is definitely awkward. As one of the students mentioned, “the guy guiding doesn’t even know what we do in this course.” He described one such trip where a delegation from Portugal came in their studio room to observe the physical layout where their course took place. They did it while students were in the space, so it can be a little disturbing for their privacy. For these visits, the students are normally not asked for consent. Everyone that has a key access to the room can bring people in, and that includes other entities and instructors that work indirectly with the course. On the other hand, another student understood why these groups of people came to see their working space, stating, “PRADBORD has a special way of teaching, and this is the only way to really get to see it.”
1.3.5 THE COOL GEEK VIBE

Educational tourists come and go. There is not an extended relationship with the students. There is minimal exchange with them (if any). Some of the students may understand this situation as being part of a reality show. As a participant witnessing all of this during eight months, I felt that the number of one-time visitors could be considered a little intrusive. But as mentioned before, not everybody was bothered by this fact. Here, individuals want to be recognized and discovered. They want to show that they have cool ideas and they want to brag about their forward thinking environment. Here, being a geek\(^2\) becomes valuable. Some of the student’s role models include: the deceased Steve Jobs, Mark Zuckerberg or the guys from Google. This spirit made it easier to understand why this course cultivates a sort of rock star vibe. Case in point, when I offered individuals for anonymity in this ethnographic project, only one of the individuals involved didn’t want me to reveal their identity in the final account. This was interesting to me, because in my experience most people choose to keep their identity a secret.

1.3.6 BECOMING AN INNOVATION ICON: A CENTRALIZED EFFORT

But is it really innovative in every aspect? Don’t all leading universities claim to be innovative? I would say it depends on your point of view. Its public relations (PR) apparatus does a lot in boosting this idea and disseminating the message to different circles around the world. It seems a central effort. Although also, as some of the students indicated, if you come from programs that are more traditional, for example in engineering, this program will look innovative and overall different. And this is not solely due to the way they do engineering, but also evident in the way professors dress, how classes are delivered, and the freedom perceived in the open spaces. The coolness factor that attracts students from all over the country and the world is embedded in the way uniqueness is promoted. For me, coming from a design program during my undergraduate studies and a design and engineering instruction experience, it didn’t seem too different to what I have gone through. Yet again, it all depends in your comparison standards.

1.3.7 DO YOU BELIEVE THE HYPE?

For individuals arriving to this loud rock star geek culture, there are usually two ways to go. Either they rub the idea of creativity or innovation on the foreigner’s face, or they are critical of the image it espouses. As one alumni revealed: “we didn’t believe the hype.” She was talking about her particular experience with some of her classmates. They were the kind of individuals that were judicious of the whole message that the university was, in some way, imposing. On the other hand, some of individuals immersed in a two-year program under such a strong so-called innovative culture are too young or

\(^{2}\) Geek is a term from slang that refers to individuals that are usually odd or interested in things like computers or other hobbies of that sort.
inexperienced. Therefore, they might not have enough time to be critical or just conscious about what they’ve learned. In this situation they are at risk of becoming dogmatic preachers of what they’ve been told. They are able to recite what they learned as if it was a mantra or inimical truth. Which is not just about wearing a labeled t-shirt, but becoming part of a *cult*. Some instructors are aware of this fact. And as the students, they are perpetuators of it, or silent detractors.

Particularly, as I will explain in detail later in this account, the individuals in the product design program in engineering tend to be more skeptical to just embrace an *imposed* mantra. This program is different to the one that provides the ME-COURSE. These students have necessarily been recruited having a previous working experience. They have seen reality, some of them have been outside the Silicon Valley area (the conditions provided in the Bay Area are inherently different from what happens in the rest of the world), and know that the rest of the world does not work in the same fashion. They recognize that what they are taught will not bring instant success, or that they are necessarily directly applicable to all disciplines, which is the hype that some of the visitors are sold. And this is what a group of instructors mention as the potential Achilles heel of PRADBORD: arrogance. According to some instructors, the biggest problem is that some of the students or occasional participants of workshops believe that after going through a crash course, they can go out and apply whatever they have learned in companies with instant effect.

### 1.3.8 IMMERSED IN THE ECOSYSTEM OF SILICON VALLEY

The truth is that the idea of copying a particular model might be jeopardized by the misunderstanding of the particular conditions that afford their innovation model to go through. Copy pasting might not be the answer when trying to emulate such a complex ecosystem or what some individuals from the Valley have metaphorically called a Rainforest (Hwang and Horowitt 2012). There are several multisystem relations within the components of the Valley, and even some untargeted ingredients might make it irreplaceable. Why irreplaceable? There have been several attempts to create the Silicon Valley conditions worldwide. Most of these attempts have been unsuccessful. As stated by one of the venture capitalists I met, the ecosystem is hard to replicate. According to him it might have to do with the immigration component of the West Coast plus a huge set of variables, such as the mix of startups, venture capitalists, tech-savvy schools and high-tech innovative companies like PARC, Apple, IBM or Cisco. He also added that there may be some other behavioral or human components that can’t be tracked completely that might help push the valley into further innovation. But I am not going to wade into too far into the deep end of this issue, as it could become another story of its own.

Due to their close proximity, the growth of this university and the Valley are very closely intertwined. Graduate and undergraduate students come to work or intern for the companies in the area
in droves. Professors or part-time instructors usually consult, partner or directly work with some of the industries located in the valley, and a whole host of startup companies are funded or recruit this university’s alumni. This symbiotic relationship has created numerous success stories like Apple, Facebook (once they moved to the Bay Area), Google and LinkedIn (within others), that have been recognized the world over and impacted young individuals enormously. With the advances in mass and social media, those stories travel not only around the United States but also around the world. These success stories have become a driver for future professionals interested in creating the next big thing. The entrepreneurial culture permeates not only in the engineering-design related programs but everywhere in campus. Computer sciences, business areas and medical sciences have also been subsumed in this trend.

The monetary benefits of these innovations are manifest. Some students and instructors indicate that money is a driver for their professional decisions and activities. Whereas some of the engineering students were shamelessly proud of this, others would find it as a normal evolution to their practice. This has become a part of their identity, and being money-driven here does not have a negative connotation. It is something cool. “Like the whole fact that is in Silicon Valley, the whole startup, entrepreneurial mentality kind of thing is really cool”, one of the students indicated. The idea of teaching in a more applied way, according to Mitch, is to “privilege the practical application of knowledge to make money.” He emphasizes that it is not the only driver, but it is one of the most present. Mitch indicates that for students pitching becomes part of their daily script. And it is consequent with their environment were learning to sell your ideas can be a must. That’s why the storytelling technique has become so popular for every discipline. There is a constant need to translate technology or entrepreneurial ideas in a business language way, and knowing how to talk to venture capitalists is of great import to the student body.

1.3.9 ENGINEERING DESIGN PROGRAMS AND THE LINK TO CONSULTANCIES

The Silicon Valley entrepreneurial culture influences the engineering-design programs in other ways. And these are very direct. Instructors and students are aware that “some consultancies dictate content”. To illustrate what this means, I will compare two different approaches by professors teaching the same course. Their experiences as consultants shape their respective pedagogies.

When teaching the design process, and particularly human-centered design strategies, one of them believes that this should be a subjective individual journey that the student should learn to manage. It is a more empowering teaching philosophy. This is the owner of a small consultancy with big projects and steady clients. The other, who owns a very important consultancy in the area, teaches it is an objective, right or wrong process. The latter suggests that students shouldn’t be told all the secrets of what is done in applied consultant work. If students are serious about this practice and want to learn
more, he opines, they can intern in his consultancy. A very master-apprentice instructional philosophy, that has a direct outcome related to his company.

So the flavor of the design process taught depends not only on the instructor, but also on the qualities of the industry this person belongs too. Today, the predefined design process (the idea of a right or wrong process) is mainly the way undergraduate students are taught human-centered design strategy skills in the engineering-design program. For undergraduate students in engineering at PRADBORD these kinds of courses are a minimum requirement and they are part of the basic skills that a product designer needs in order to be successful in industry.

1.3.10 THE UNIVERSITY AND THE CASH FLOW

The relationship between the university and Silicon Valley is not just intellectual. PRADBORD benefits significantly from the funding that flows from the Valley. This comes mainly in the form of student projects, research funding, internships, benefactors and (what I call) educational touring. Particularly, two of the courses in engineering design that I witnessed worked with funding from a whole host of international companies. In one of the courses, the university charged over a thousand dollars just for companies to participate. Add to that all the expenses for student travel from the US to places like Norway, China and Colombia, and the cost of the program can really begin to add up. This will be detailed later in the description when I immerse you, the audience, in the world of the ME-COURSE.

The participating companies seek state-of-the-art knowledge coming from smart, daring students recruited through the program (and that come from all over the world) that are given a set of tools that this university has labeled as innovative and different from other traditional programs in engineering. So this is a symbiotic relationship that benefits both the companies, and particularly the students who are smart and fortunate enough to be admitted in these programs.

It is important to add that this is not just a relationship created in the school of engineering, but it is present in labs all around campus where the research and development (R&D) from the companies is outsourced to the university.

1.4 AN ETHNOGRAPHIC ACCOUNT FOR ENGINEERING DESIGN

Below are some general statements that will help to explain my views on anthropology and design as an area of study, and what to expect in this account.

1.4.1 DESIGN LACKING A SHARED RESEARCH IDENTITY

“Designing’ is as elusive a word as ‘technology’. Its meaning shifts with speaker, listener and with context” (Bucciarelli 159:1998).
Lately, there has been a more formal attempt towards a thorough understanding of the design process. During the last fifteen years the way research on design has been undertaken has begun to change, and it seems to have arisen from the need for more contextually rich ways for understanding the natural ways the design activity takes place (McDonnell and Lloyd 2009). On one hand, following a post-positivist tradition, there has been a formal acknowledgment of semi-experimental (I emphasize “semi” because it involves human interaction, which is not 100% controllable) lab setting studies in a series of journals pertaining to design, engineering, psychology and business. On the other hand, there have been some attempts to have more context-sensitive approaches. In either situation, most of the datasets on embodiments of the design process analyzed come from using professional design practitioners as subjects. Few of them work of students.

The truth is that neither the lab-controlled experimental approach nor the more context-sensitive approaches are better or worse. The issue with the myriad methods used to uncover the design procedures is the inability to have standardized methods to in the search of a common truth or epistemology. Even though there are attempts to theorize, these are not fully shared by the design community and thereof non-disseminated.

We might write off this lack of measurable criteria and theories by saying that design is a young discipline. And as such, it lacks a common research identity. Design has only existed in the realm of application, so there was no need to theorize over its practice. In my opinion, some introspection can be of significant importance and advancement in the field. Nonetheless, this unframed epistemological condition, portrayed in Figure 1.2, can be beneficial in today’s new disciplinary context.

![Figure 1.2 Design as a Permeable Knowledge System](image-url)
As I see it, this can enable design to become a platform for multidisciplinary innovation. Its or fuzzy theoretical condition creates a permeable epistemological knowledge system that is open to exchanges. As opposed to what we think of a gated community, its limits are diffused or at least open to exchange with the exterior. So for me it is a community of practice that can lend its infrastructure to other disciplinary tribes. This is why other disciplines can come in and use design’s applied knowledge and strategies. On the other hand, designers allow themselves to come out of their own disciplinary boundaries and use tools and ideas coming from other fields like sociology, psychology, anthropology, economics and medicine within others. Designers are not stigmatized for doing so. There is no punishment to get out of the silo because this one is permeable. And even though this can be considered ideologically promiscuous this makes designers great drivers for multidisciplinary collaboration.

In summary, Design is a pragmatic epistemological system that fosters the idea of “hooking up” with different disciplines to make sense of its world. If a system or idea is not closed it is a structure that is not completely stable. It is subjected, over time or over different conditions, to change. And this is a reality in nature, in biology and other systems. An unclosed structure becomes permeable, affording exchanges around its open or boundaries. This is an idea in progress (or a state of the art idea) and as such not totally clear. But it is an assumption I would like to make while addressing the analysis of my ethnographic dataset.

1.4.2 WORKING FROM DESIGN-ANTHROPOLOGY

"I believe we have always used the eyes of an anthropologist, and the hands of a designer...” (John Sherry, Intel, at EPIC panel 2012, Savannah).

The combination of design and anthropology has not been around for that long, at least not formally. It has mostly taken place in the applied world. And this has to do mainly with the inclusion and adaptation of ethnographic research methods in design consultancies. As comments from Elizabeth “Dori” Tunstall, the Associate Dean of Swinburne University Faculty of Design (which has one of the first programs on design anthropology) on DesignTAXI.com reflect, the combination is successful as it provides a way to get a deep understanding that later aids in translating the theoretical into real experiences for individuals that they can later review and negotiate (Xu 2012). So it is basically using the eyes of an anthropologist (using the methods, strategies and theories) and generating tangible responses through the hands of design.

But my specific research interest pulled me away from the pragmatism that embodies the design profession. I am not interested in developing a tangible product or artifact. In this thesis, I am not trying to propose a solution to the ethnographic information collected but to portray a process. That process is depicted under an anthropological strategy of building disciplinary research on design. I am looking to
theorize on design practice and education by using an anthropological approach. To be honest, when looking at the literary resources of research in academic knowledge, I was overwhelmed with the amount of other disciplinary approaches that I could use to face my research questions. Their nature is highly context-sensitive so other disciplinary approaches from the social sciences appeared to be appropriate to resolve inquiries regarding multidisciplinary visual negotiations in teams, objects for translation and the design process. Nonetheless, ethnography in the realm of anthropology and it’s bias towards culture seemed to be the most suitable for my work.

In summary, this thesis will portray a more theoretically interested work on design- anthropology. And it will be context sensitive in order to tackle my queries on behaviors and social aspects happening naturally in a particular team of engineering-design students.

1.4.3 FILLING THE GAP IN RESEARCH DEVOTED TO DESIGN

"Ethnography is an emergent interdisciplinary phenomenon. Its authority and rhetoric have spread to many fields where ‘culture’ is a newly problematic object of description and critique" (Clifford and Marcus 1986:3).

I am not the first individual to perform research on design practice. One of the biggest compendiums on design research, edited by McDonnell and Lloyd (2009), showcases some approaches that have been used to analyze design praxis in context. Some of the ones listed are: "interaction analysis, computational linguistics, viewpoint methodologies, semiotics, ethnography, functional linguistics, cognitive ethnography, and discourse analysis" (Ibid 2009:2). The qualitative or ethnographic research that is referenced, are similar to what Buccarielli (1994) or Dougherty (1992) have published. These ethnographic quests are mostly undertaken in the context of industries or firms.

On the other hand, McDonnell and Lloyd’s compendium contains also some more experimental approaches like the ones portrayed in Plattner, Meinel and Leifer’s Springer series on Understanding Innovation (2012). These are a compilation of different papers that are usually a short-term evidence-based approach to the study of design activity. In contrast with the work done in companies, this showcases graduate, undergraduate and sometimes even international students as participants.

Yet nearly all of these studies, for me, lack a sufficient period of contextual observation or make an analysis out of context of a lab setting where variables are controlled. They usually record a limited number of design meetings in order to sample a larger process. Interviews and other qualitative forms of research could be embraced in these studies as a form of triangulation. But there is usually a non-longitudinal following in the form of contextual observation. Due to this fact, there is an understandable inability for the researchers to fully immerse themselves in the culture of the engineer designers they are working with.
In summary, in these studies there is a lack of context-sensitive research that (1) portrays the work of design activity of students, which for me it’s relevant because of a series of issues regarding academic training and lack of professional experience; and (2) observes the larger process in time and in it’s own environment. It is in my intention to close that gap.

1.4.4 THE IMPORTANCE OF WITNESSING FULL PROCESS CYCLES

"... Or perhaps what was involved was what Renato Rosaldo once called in a discussion of what makes anthropological ethnography distinctive, ‘deep hanging out” (Clifford 1996:5).

For me, not engaging in a long term or deep hanging out, term coined by anthropologist Renato Rosaldo, while researching the design process is a glaring gap. It is not that ethnography or anthropological research is the only answer to study the way the process takes place. But it is appropriate when we consider that “all design activity is ultimately social in nature” (Meinel and Leifer 2012:xv). If processes in design are inherently social, we should be able to understand the social and cultural rules among which design activity is taking place. Social processes are usually extremely sensitive to time and to the evolving situations they are subjected to. There is usually a need to be deeply immersed in a culture for a longer period of time in order to understand the rules and evolutions of relationships and the components that define a culture. The downside of not staying in the field long enough is that anecdotal behavior or situations may be confused with cultural rules or usual behavior.

In the same line, fieldwork is time sensitive. It is a process that is not mechanistic and controlled as other more positivist research strategies. The ethnographer can’t be completely detached and is becomes an instrument and interpreter of the reality he or she witnesses. Through time and involvement, the researcher "comes to terms with a culture" (Van Maanen 1998:117). This journey starts before we enter the research site and continues long after we leave it.

Even though I was studying engineer designers, who could be said that is a tribe to which I belong, the true story is that the long eight months of immersion were really key to understand the ME-COURSE community. To truly get to know a cultural specific thought world can be a never-ending story. There are particularities that flourish occasionally and realizations that come into play when different layers of meaning start to build up. But this needs time to bake. Qualitative research is an aggregation of information, and the more you stay in the field, the more likely you are to understand the mechanisms that are taking place. There are just too many variables. This is like drawing a map of the culture and the interpretive capacity of the researcher depends on what he or she can annotate and learn over time.

In summary, there is a hole in design research related to the long-term immersion of the ethnographer in the field. Processes are time sensitive and qualitative research is usually about aggregated information that can only be associated when the investigator spends enough time in the
field. This is why eight months of full immersion becomes a considerable amount of time to close this hole.

1.4.5 WHAT NOT TO EXPECT FROM THIS RESEARCH

"Such work requires an intensive personal involvement, an abandonment of traditional scientific control, an improvisational style to meet situations not of the researcher's making and an ability to learn from a long series of mistakes. The language of the received view of science just doesn’t fit the details of the research process very well if you are doing ethnography" (Agar 1986:12).

As Margaret Mead (1953) once said and Wolcott (2010) restated, the anthropological way to represent information is not to generalize over a universe or population “the heart of ethnography is singularity” (Ibid 2010:17). For ethnographic research, the beauty is in the details. So please, do not expect for this account to be a set of rules that can be applied to a diverse group of students. This research is culturally bounded to the conditions of the locations and the people in the system. Nonetheless, this does not mean that the insights of this research won’t be useful for advancing literature in education, design, multidisciplinary studies or teamwork. Do not understand this research as the sole truth on the processes witnessed. “‘ Cultures’ do not hold still for their portraits. Attempts to make them do so always involve simplification and exclusion, selection of a temporal focus, the construction of a particular self-other relationship, and the imposition or negotiation of a power relationship” (Clifford and Marcus 1986:9). So this does not just mean that the research process should be time sensitive, but also that the representations of this bounded culture should be open to further expansion and change.

In summary, this ethnographic research will be focused on studying the singularity of a culturally bounded community of practice and it is not intending to be a representation that can be generalized to a larger universe.

1.4.6 STORIES: A MULTIDISCIPLINARY ORIENTED FORM OF RESEARCH REPRESENTATION

"Stories, by their ability to condense, exemplify and evoke a world are as valid a device for transmitting cultural understanding as any other researcher-produced concoction. The fact that they can do so without recourse to disciplinary hedges makes them in some ways very appealing, since they can be read and appreciated by a general audience" (Van Maanen 1998:119).

The representation form of ethnographic fieldwork is usually a written (verbal) ethnographic account. There are diverse styles, modes and tones of how this could be undertaken. As Van Maanen (1998) points out, these accounts are usually shaped by the tradition and disciplines from which they are launched. This is why it is important to restate that this research has been launched from a design anthropology perspective, involving interest in the design process but a reviewing through the lens of anthropological knowledge. In addition, there is also the inclusion of design tools in the processes of data
collection and final account. So design is not only the subject of research, but also the means by how visual anthropological methods are embraced throughout the fieldwork and representation.

Even though my particular way to tackle the research will be detailed in a further chapter dedicated to methodology, it becomes important to alert the audience that there is a bias to the visual in the ways the environment, rituals, and the social behaviors will be depicted. Culture is not really visible until it is represented in a form of a document or experience to the audience. And that is the purpose of telling this story.

Stories have been for centuries a way for humans to portray reality, to imagine futures and to pass some message from generation to generation. And the reason that stories continue to be the main form of transferring crucial information is because "we're wired to turn to story to teach us the way of the world" (Cron 2012:2). That means, we are cognitively wired. No wonder why storytelling is present in our academic papers, publications or other forms of scientific portraits.

Now, even though we are all as humans wired for stories the truth is that narratives can be intended to address a particularly disciplinary audience and to leave others out through the use of disciplinary-specific terminology. This jargon can become a form of exclusion, but also a way to define the adherence to a particular academic interest group. In my case, and considering that I am working in the intersection between different disciplines interested in certain flanks of the topic in research, I seek a path of inclusiveness.

The key for having a story that appeals to everyone has to do with the reduction of jargon to draw an intelligible map of a bounded cultural point of view. My goal for this research is to explore the processes teams of design-engineering undergo under the attention of different fields regarding education, design, visualization, engineering-design, anthropology, design-anthropology and organizational sciences within others. I don't dream big. I know I am not Darwin who had the ability to put something as complex as the evolution theory in the minds of the general public. Yet, during this story I will humbly try to portray what I witnessed during eight months of working with teams of engineering students in terms of negotiation, visualization, academic training and innovation in the design process. Hopefully, in a disciplinary jargon reduced way, that may sound colloquial and not too scientific, I will open the door for other disciplines to access the knowledge I grasped.

2. THE THEORY BEHIND THE QUEST: MAPPING THE MEANINGS BEHIND THE ENGINEERING-DESIGN PROCESS, TEAM INNOVATION AND VISUAL ENGAGEMENTS

"It is the process of design, in which diverse parts of the 'given-world' of the scientist and the 'made-world' of the engineer are reformed and assembled into something the likes of which Nature had not dreamed, that divorces engineering from science and marries it to art" (Petroski 1992:8).
This ethnography is on engineering-, design- and innovation-driven teams of students. But as simple and straightforward as it sounds, the complexities in the contemporary relationship between these disciplinary worlds can be overwhelming. My goal in this section is to give the reader a simple, theory-driven route map to understand the social way the design process is carried out in these particular engineering teams and how they intuitively use their visual mind to find a common ground.

2.1 ENGINEERING AND DESIGN MARRIED UNDER A NEW CONTEXT

2.1.1 DESIGN AND ENGINEERING

“From the point of view of modern sciences, design is nothing, but from the point of view of engineering, design is everything. It represents the purposive adaptation of means to reach a preconceived end, the very essence of engineering” (Layton as quoted in Ferguson 1997:1).

Design, as others have mentioned, is the “soul of engineering” (Joel Moses, former dean at MIT, as quoted in Petroski 2011:66). Design is the way (engineering) thought becomes reality through the act of making. In the same way that architecture was once linked with engineering, design has been an essential part of both practices. This is one reason why there are design schools born from an architecture and/or an engineering tradition. Whether today the common focus of engineering education is a more scientific/mathematical-based instruction and architecture is a more qualitative artistic one, both rely heavily on the design process. The truth for me, and for this account, is what others have indicated: Design and engineering are practically synonymous, as the former is crucial to the latter.

Engineering design is embodied in the learning process embraced in solving an ill-defined problem that does not have only one possible correct answer. This is the process I looked closely at. It is a process that has been in the public eye recently as a means for innovation.

2.1.2 DESIGN AS A STRATEGIC TOOL FOR INNOVATION

Re-evaluation of design as a strategic tool seems to have started several decades ago when some business strategists envisioned design as the key for tactical differentiation in markets. Today, those strategies not only address the embellishment of an artifact, but also the process behind defining meaningful stages for services, systems and experiences. This redefined way to apply the design process is what has many schools and universities redefining their MBA programs and other professional degrees to embrace innovation, in addition to some K-12 instruction and other kinds of organizations.

2.1.3 DESIGN AT A CROSSROADS

There have been serious attempts to make design a systematic discipline. In the States, it started with individuals like Henry Dreyfuss on ergonomics in the ’50s, with Horst Rittel’s work in the ’60s at
Berkeley and Bruce Archer at RCA. Then *user-centered* approaches emerged in the Bay Area from Xerox PARC (Palo Alto Research Center), one of the biggest exponents of this trend. Today it seems design is in one of its most evident pivot points as an enabler of innovation and multidisciplinary work in modern organizations. Fast paced advances in technology and organic growth of communication systems have resulted in a kind of micro-segmented global network. So now, problems have become more and more *ill-defined* and multi-layered.

### 2.1.4 Design and Systems Thinking

This means that the problems that design is facing today are usually not as circumscribed and simple as they used to be. They are not just creating a concept or a stylistic artifact. They need to be addressed in a different way, with a different set of tools. Today, designers are not tasked with improving something, the technicalities of hardware or the interactions behind a computer screen. Rather, they are working in redefining things as real-time social interactions, e.g., service design.

Tackling these complexities require a flexible process and intangible abilities to synthesize the diversity of variables involved. This is why some contemporary designers have been embracing the idea of *systems thinking* and systematic method-based processes. Under this lens, they understand that problems are interdependent to each other and within themselves. They have patterns of their own and changes in behavior. Their variables are interconnected and it might be difficult to see the multiple relations they are subjected to. These systemic problems are *non-linear*, so putting the problem into a proper context and explain in words can be difficult due to the inherent complexity of modern processes. From a *systems thinking* point of view, these ill-defined problems are “more than the sum of its parts” (Meadows 2009:11), but it is dealing with this ambiguity that today’s practitioners and academics are struggling to explain.

### 2.1.5 Design’s Inherent Ability to Work with Ambiguity

Some designers may argue that methodology is a strainer for creativity, but as experience has shown me, the use of methods and *explicit knowledge* (Polanyi 1967, Polanyi 1969, Collins 2010) help the interaction among teams. As never before, they could be able to predict a certain quality in the research and solutions. This new way to see design enhances its ability to work with the ambiguity of unrestricted challenges but also to define a process that other stakeholders can rely upon.

With the new design tools and methods for working with social interactions, designers are not to fear *wicked* concerns. Not only because this new view on design embraces a “no-fear-to-error” mindset and opts for iteration of the solutions, but also because it provides the ability to synthesize large amounts
of information coming from something that is undefined. And that is what makes it particularly suitable to process and work with the amount of variables that exist in a complex systemic predicament.

So the new design philosophy (newer to engineering than to other forms of design) does not shy away from ambiguity. In addition, modern forms of instruction in engineering design have understood the value of teaching students to deal with uncertainty in order to face real life issues. Today the use of real world challenges, which are often convoluted, is more frequent in the classrooms. Moreover, there is factual data that shows it improves students “capacity of problem solving” (Yildirim, Schuman and Besterfield-Sacre 2010).

2.1.6 DESIGN AND THE POWER OF SYNTHESIS

Those real life efforts can be solved through design’s project-based education. Particularly, design is focused on making ideas tangible and finding the truth on the creation process. It is in this creation process that learning occurs, and where knowledge can be recombinied to achieve more creative and appropriate solutions. This process has smoothly transcended the design discipline (if there ever was one). In my view, it is because design has an unframed academic condition. There is little agreement on design’s theoretical boundedness. But this is not necessarily a bad thing. This makes it a permeable epistemological knowledge system that has the potential to enable multidisciplinary exchanges. Why is this openness important? It could hypothetically improve the likelihood for innovation to take place.

2.2 TOGETHER BUT NOT SHAKEN: THE ROLE OF MULTIPLE PERSPECTIVES IN INNOVATION

“Two foundational beliefs motivate this increase in interest in interdisciplinarity: first, that finding effective solutions to complex problems requires collaboration by faculty from multiple disciplines; second, that faculty interchange across disciplines promotes creativity and hence increases the pace at which knowledge can move forward” (Strober 2010:4).

Something as equally difficult to define as design is to define innovation. Innovation can be described in different ways yet is frequently referred to as an act of change. For the purpose of this research, I subscribed to one perspective: Solutions that are creative are constructed through the recombination of existing or old ideas (Amabile 1988, Van de Ven 1986, Stark 2010, Hargadon 2003). Structures that are not stable provide the opportunity for innovation to happen, as the individuals have the space to improvise (Weick 1998), to reinterpret particular practices, to give the space for mistakes to happen (Ibid 1995) and augmenting the range of associativity of resources that are not normally coupled. Furthermore, innovation can be related with creativity, the novel way to resolve a particular issue or problem. And that novel way can come from the way an individual recombindes his/her own information or how he/she does it in relation to others.
In the first typology, and from a cognitive point of view, the concept of creativity is linked to insights (Sternberg 2009). To develop an insight, a creative way of solving a *fuzzy problem*, data on imaging of neural activity in FMRI (Functional Magnetic Resonance Imaging) has showed the involvement of memory processing (Luo and Niki 2003). So there might be a relation that involves the retrieval of old information and saving new information when facing an insightful problem. Accordingly, there is a combination of the old and the new.

In the second typology, Hargadon & Bechky (2006) propose a model of innovation where problem solving is addressed by *interaction as a group* as opposed to just one individual. Their position proposes that the creative process is strengthened by the recombination of past experiences that can lead to new insights. In this model, individuals reframe their experiences through social interactions, shifting the nature of creative processes from individuals to teams. For them, creativity embedded in innovation is not a persistent condition in an organization. It is a *social construction* afforded by the context and the components exchanging information during key instances. Their research findings give me the foundation to state that innovation can be generated in orchestrated instances. Therefore, the method used to approach a particular problem is determined by the particular conditions the group is confronting. This could be called the *recombination of knowledge*.

Perhaps you are now asking yourself: How is the method structured? Is it through the use of multidiscipline or interdiscipline? What is the difference between the two anyway? Let me give a simple example to explain the difference between multidiscipline and interdiscipline. *Multidiscipline* plays a vital role in the recombination of information. So what is multidiscipline? Crack open several eggs in a bowl. They are all together, but you can still figure out which was egg number one and which was egg number two. Their whites may be mixed, but their yolks remain separate. *Multidiscipline* functions in the same way, each discipline keeps their epistemological differences, but they can be together, thinking and working as a group without losing their identity. Interdiscipline is when you take the same eggs and whisk them with a fork, blending them completely into one substance. Of course now it is impossible to tell one egg from another. Therefore, *multidiscipline* does embrace the differences in academic silos, but it is interested in bridging them for a certain purpose. Interdiscipline looks to mix them without leaving them to be distinct from one another.

*Multidiscipline* is the one that should afford the recombination of knowledge that leads to innovation. Just imagine, in multidisciplinary conditions internal information is recombined when an individual is faced with new situations undertaken with other individuals coming from external disciplinary tribes. There he/she is able to process his/her own information in different ways because he/she is exposed to different ideas and ways to see things. Then just imagine, all the individuals coming together as a team. In a multidisciplinary environment their knowledge is mixed, but they continue to
retain their epistemological differences. In my opinion this method helps to foster innovation and creation.

So based on my working definition of innovation, multidisciplinary interchanges serve to achieve recombination of information, as it promotes the coming together of different memories coming from experiences embedded in defined cultural contexts that wouldn’t normally interact. So this interchange between disciplines provides the possibility to reinterpret methods and methodologies in novel ways, giving space for groundbreaking strategies to rise through disciplinary interaction. No wonder why grants, foundations and government agencies promote this process (Strober 2010). *Dissonance*, which entails the clash of diverse value conceptions (Stark 2010), can foster a fruitful condition for innovation, but it can be a mess if it is not orchestrated. Paradoxically, there should be method to madness.

2.3 SETTLING THROUGH BOUNDARY OBJECTS AND TRADING ZONES TO ORCHESTRATE DISCIPLINARY DIVERSITY

“But it turns out that talking across disciplines is as difficult as talking to someone from another culture” (Strober 2010:4).

2.3.1 ENCULTURATION AND TRUTH IN DISCIPLINARY TRIBES

But how can we involve method to orchestrate dissonance? At first glance, orchestrated dissonance seems like an oxymoron. Differences in the way we perceive truth can be a major obstacle when you are in need to achieve consensus in order to move forward in a certain task. And those differences, when they are based in the relative perception of truth, can complicate the process towards reaching an agreement.

Major differences come from ascribing to the epistemological beliefs that the disciplinary training perpetuates. Becher and Trowler (2001) theorize over the idea that subscribing to a particular disciplinary knowledge implies a particular form of enculturation into a defined *academic tribe*. Enculturation entails an active learning process among individuals that transfer and construct a system of meaning that is shared (Lassiter 2006). Your *disciplinary truth* might not match the one of your colleagues, and that is where discussion (and friction) takes place.

2.3.2 THE HUMAN LIMITATIONS

There are several issues with disciplinary enculturation that prevent successful multidisciplinary exchanges to happen. One of them is how the context affords the flexibility of reinterpreting knowledge. For example, how confined is one discipline to its academic department? Can they transcend it? Are the academic territories suited to overlap? Are there incentives to collaborate with other tribes?
The other issues depend on the individual’s ability or willingness to suspend judgment in order to enable the influence of other cognitive territories or cultural values. A barrier preventing this to happen is functional fixedness (German and Barrett 2005). As German and Barrett showed through their studies, there is inefficiency derived from the inability of subjects to engender an uncommon function because they are predisposed to a typical way to do things. Methods, methodologies and other forms of discussion are rooted in habits of cognizance. Therefore, your mind might not be too open to recombine or change the way you do things. Another limitation is the existence of essentially contested terminologies (Gallie 1956). It is not always easy to indicate which is the best meaning ascribed to a certain term. It is relative to which is your disciplinary standpoint.

2.3.3 NO CONSENSUS BUT TEMPORAL SETTLEMENTS

How to bridge and orchestrate the disagreement coming from the disparities in multidisciplinary exchanges? Or even sub disciplines? Remember, if our aim is recombinant innovation, the disciplinary boundaries need to be maintained. We want individuals to interact, to have healthy friction, but we don’t want their identity to dissolve. This situation might imply the need to settle temporal agreements for the sake of achieving a common activity and not necessarily reach consensus. As Stark (2010) explains, in order to be productive and constructive, opposing groups must discuss with rival structures submitting statements that are reasonable for their own contexts. Yet, if agreement is not reached, the risk of achieving nothing is imminent. Nonetheless, it is not necessary to achieve an enduring consensus, just a temporary one.

There are different strategies to reach temporary settlements. One of them is context. For example, if the research context is problem-oriented as opposed to knowledge-pursuit, collaboration is more likely (Strober 2010, Thompson Klein 1990, Becher and Trowler 2001). It is more likely to see MDR (multidisciplinary research) embodiments in centers that are devoted to tackle a particular issue like health or education, which more readily cross diverse disciplinary tribes. This is because there is a need to constitute a new epistemic community (Thompson Klein 1990) that is specific to the problem. Another way is to afford the existence of trading zones (Galison 1999), which are communication spaces where negotiation can take place. Lastly, the existence of boundary objects (BO) that identifiable objects that bridge the exchange and facilitates communication among diverse groups. In doing so they can cross the borders of communities of practice but they are able to retain their identity in diverse settings (Bowker & Star 1999). When BOs first were defined by Star and Griesemer (1989) they were described as flexible artifacts that could live in the intersection of different worlds without losing their identity.

Rossini and Porter (1979) identified four main strategies that groups use to come together in interdisciplinary research (IDR): 1) integration through a leader; 2) negotiation among experts; 3) group
learning; and 4) modeling. These can also be useful strategies in attaining multidisciplinary endeavors. For me, the last two—group learning and modeling—present the most potential for engineering design and engineering design education. They entail the training to enhance group learning through the design process as a trading zone and the skill to work with visual models as BOs. How do we prepare our students for this challenge?

2.4 MY CHALLENGE

How is disciplinary culture enacted in a particular labeled innovative academic environment? How does knowledge and beliefs on ways of doing things navigate the organizational structure? Can engineer-designers in the first year of a graduate program be considered a homogenous disciplinary tribe? Which is the role of the design process instilled in the way the teams interact? Which are the most important points of negotiation during the design process? Is there conflict? What are the possible explanations for teams having discrepancies during intense interaction? How do engineering design teams come into settlements or agreements in order to go forward in their tasks? Are there any ways that students find to bridge the gaps separating their understanding? The answer to these questions may be of use for the design or assessment of curricula in engineering and design, and more generally for any other discipline that seeks to train their students on the benefits of work in a multidisciplinary paradigm.

However, as ethnographic work evolved, I found myself in the need to rethink my data collection methods in order to get visual grasp of a very dynamic innovative culture. I needed to make things as invisible as interactions, visible in order to be able to generate a meaningful analysis. I had to apply recombination innovation in the ways I would apply the methods. Anthropology and design together, using a multidisciplinary approach offered a whole set of possibilities in the way to recombine and apply tools for data collection in ethnographic work. This is what I explore in the next chapter regarding the methods.

2.5 CONCLUSION

Design and Engineering in this account are considered synonymous. Design seems to be at a turning point where it seeks to attack issues that are ill-defined and ambiguous in nature. Designers do not shy away from this complexity. To tackle this complexity, designers must redefine the tools and systems thinking used to address modern issues with myriad factors. Even though multidisciplinary systems thinking might be more difficult to work within, it ultimately allows design to become an enabler for innovation, and has the potential to enhance problem-solving. It is a setting where diverse specialties and disciplines and individuals are needed to solve major problems in unbounded areas like health, education, complex technologies, etc. We are in need to question and rethink boundaries in order
recombine the information. This is one of the ways to create novel ways to solve these major, ill-defined problems.

However, for recombining their knowledge, individuals don’t need to totally mix or change their personal identities or epistemological truths. This is what multidisciplinary research is all about. They should maintain their own boundaries but create zones that can serve as an area to exchange knowledge and work towards a task. Objects that allow interchange to happen can inhabit these mediating areas. These objects and areas seem to be present in the design process. This is why it becomes relevant as a case of study that can be interesting for multidisciplinary research, education or for teamwork knowledge in organizational studies.

Under these parameters, design tools and idiosyncrasy could facilitate achieving settlements among these different entities. The attributes of design skills and process could be the ones that allow multidisciplinary engagements without necessarily reaching consensus.

3. REVIEWING THE METHODOLOGY: A UNIQUE TAKE FROM A DESIGN ANTHROPOLOGIST

“... [Culture] is a phenomenon general enough and distinctive enough to suggest that what we are seeing is not just another redrawing of the cultural map - the moving of a few disputed borders, the marking of some more picturesque mountain lakes-but an alteration of the principles of mapping. Something is happening to the way we think about the way we think” (Geertz 1983:20).

3.1 REDRAWING THE MAP WITHIN THE INTERSECTION OF DESIGN AND ANTHROPOLOGY

3.1.1 WHY METHODS ARE NOT CONSESIGNED TO THE APPENDIX SECTION

Generally speaking, in an ethnographic account the methods section is thrown back in the Appendix. They normally portray the ethnographer’s research experience in the field. The methods are not usually the “meat” or the takeaway that may have pushed the reader to take this ethnographic story off the shelf or download it from a library database. In my case, however, one of the most important takeaways for the discipline of design and anthropology (and obviously to them in combination) could be the approaches taken on methods. Not on all of them, but especially on those related to the visual. This is why I have chosen not to relegate this chapter to the back where the bibliography rests, but to present it here in order to create a conversation to build on theory derived from praxis in design. This section will explain the theory behind my own design-anthropology take on methods and their application. It intends to build on what has been written on visual research and my own experience with a visual bias.

It was not easy to launch this research endeavor from a multidisciplinary platform. And this was even harder considering that disciplinary maps are constantly changing. As with every state-of-the-art practice, the boundaries of a design-anthropology approach may be yet negotiated. The map is blurred and navigating within that area can become a blindfolded journey. But isn’t this what design is all
about—exploration and learning while doing? Likewise, anthropology is accustomed to dealing with ambiguous and open-ended human-derived questions. So these two disciplines seem, in their nature, pretty well suited to face the challenge of reframing the intersection within design and anthropological knowledge.

3.1.2 IN A STATE OF FLUX: THE RELATIONSHIP BETWEEN DESIGN AND ANTHROPOLOGY

There might be an explanation to the constant change of this relationship. According to Tunstall, in her article “Design and Anthropological Theory: Transdisciplinary Intersections in Ethical Design Praxis”, the engagement of design and anthropology in the applied world has been more formally accountable since about 25 years ago (Tunstall n.d.). It is important to highlight the fact that it is an engagement mostly undertaken in the applied world, as Wasson states such in her iconic article: “Ethnography in the Field of Design” (2000). What I am interested in portraying in this chapter is a fairly new kind of relationship that goes further than applied research, into fundamental disciplinary research. Apparently, the latter is in a state of flux, as there is uncertainty in a changing environment where rules and conventions are not yet set. Hence, there is a whole new disciplinary map to redraw.

3.2 THE INTERSECTION BETWEEN DESIGN AND ANTHROPOLOGY

3.2.1 THE VISUAL OVERLAP

Visual approaches might be the most obvious overlap within design and anthropological practice. Even though outsiders to the discipline usually think on representation in anthropology like a written-word form of data and representation, there is a whole area of anthropological thinking that dedicates itself to visual research. On the other hand, design has always been a pictorial driven community of practice. This involves academic subgroups like: architecture, engineering, graphic and product design.

![Figure 3.1 Intersection Between Design and Anthropology](image-url)
3.2.2 EVERYBODY IS WIRED TO BE VISUAL

“Through an elegant chain of visual reasoning and with characteristic of sardonic bluntness, Galileo, writing from Florence in August 1612, converts empirical observation into focused evidence supporting conclusions. His argument unfolds the raw data (‘what the eye of the forehead’ registers) into a luminous explanation of mechanism (what the eye of the mind envisions, a deeply visual logic that produced precise insights far beyond those achieved by others who had also observed sunspots in the early 1600s’ (Tufte 1990:19).

Like Galileo’s studies embody in the quote, visual research appeals to a wide array of disciplines. Lawyers use visuals today as evidence in a courthouse and statisticians use graphics to portray differences in large sets of data. It might be a natural human instinct to rely on visual displays as forms of evidence. We do it when we use maps, a GPS to guide our route, or even when we are navigating on the Internet. Today with the immediacy of communication, globalization, social networking and continuous advances in technologies, the world seems like a large and complex structure with non-linear processes, interacting systems and interactions and with a variety of interwoven elements. Amidst the layers and dissonance, sometimes we must, like cartographers, make abstract representations in order to organize and navigate it.

3.2.3 IN ACADEMIA WORDS ARE “MORE CORRECT” THAN VISUAL LANGUAGE

These visual strategies have been overly utilized to address audiences outside academia. Like stories, they appeal to everyone. However, academia is a political battlefield where hard, usually positivist theorists, feel that truth only comes in one form, written in words or numbers. Journals and other forms of peer review documents can be against the use (or overuse) of visual displays in their publications. Mainstream literature suggests the superiority of using linguistic methods as a “more scientific” form of representation or display. Lindsay, from the Artificial Intelligence (AI) field, suggests that linguistic methods enjoy an “aura of correctness” (Lindsay 2002:30) as the form of reasoning. This has also affected education. As Ferguson (1977) assures, there has been an abandonment of non-verbal knowledge in engineering schools (in my understanding, engineering schools also contemplate the formation of designers), in demeanor of a more scientific or “hard thinking” (Ibid 1977:834) approach.

However, there are practitioners and theorists in the area of design (and engineering design) and anthropology that support and disseminate the idea of visual work among their own academic tribes. Visual anthropologist Sarah Pink believes that the world of behavioral sciences is dominated by the written word and that written ethnographic works are seen as “a superior medium of ethnographic representation” (Pink 2007:2). There are situations, however, where visuals are more effective to convey a point, and the use of language may not even be needed (Lindsay 2002).
3.2.4 THE DISCONNECTION OF VISUAL THEORY AMONG DIFFERENT DISCIPLINES

The ability to define theories from a multidisciplinary perspective is fraught with difficulty due to their amorphous nature. Hence, attempts to define theories on visualization for its use by diverse disciplines inevitably stumble into silo-specific jargon. There is a need to find a common shared ground in this matter, at least to work in the realm of design and anthropology.

How do we find common ground when there are different disciplines coming into play? Tunstall (n.d) portrays ethnography as a transdisciplinary strategy. Transdisciplinary means “that one that is at once between the disciplines, across the different disciplines, and beyond all disciplines” (Nicolescu 2002:110). In this perspective visual approaches can also be transdisciplinary as they can transcend disciplinary boundaries. They do not obey to a disciplinary structure, but to various at once, or to no one. They become a holistic reality in themselves.

For the moment, it seems cumbersome to work in defining a sole transdisciplinary theory of visual strategies. Yet, it becomes a first milestone to do it from a multidisciplinary standpoint. It is in my interest to bridge the gap between how visuals can be addressed in design when combined with anthropological theory by putting forward my research journey as an example. It is also in my interest to portray an exemplar of how visual artifacts, BOs or representational devices (Diggins and Tolmie 2003) can be used in theory construction and as an embodiment of evidence.

3.2.5 LITERATURE AND THEORIES OF THE VISUAL IN CONSTANT CHANGE

“These design strategies are surprisingly widespread, albeit little appreciated, and occur quite independently of the content of the data” (Tufté 1990:23).

Designers of any stripe are familiar with visual artifacts (also called visual creations). Thanks to the new media and diverse semi-automated software tools, there has been a wide dissemination of design strategies to massive audiences. Nonetheless, the literature related to visual artifacts embeds a major bias towards action. Books usually comprise recipes—how-to, the do’s and don’ts on the use of typography, color, design grids or graphic layouts, etc. Thus, there is a more recipe-like approach to visual literature. Don’t get me wrong. This is NOT a bad thing. Yet this is not enough to construct core theoretical statements that become the pillars of a shared visual theory among designers and their sub-specialties. These texts might be practical for the practitioner, but is insufficient for finding a deeper understanding.

It is important to understand that because of the advances in technology, research on visual cognition and other components of visual research have been evolving at a fast pace, so this research is also in a state of flux. Within this context, theorists from diverse disciplinary tribes like cognition, geography, information sciences, communications, computer sciences and design emerge. They have
come forward with ideas that are closer to a visual way to make sense of the world. Still, this idea of visual epistemologies seems very young. Even though design should be one of the precursors in defining the trajectory of this form of thinking, it is not a sole leader. There are many, and from diverse academic areas. Let’s remember, design is still struggling to define its personality in a theoretically-driven world of disciplines. As mentioned before, the fact that it is an open system of knowledge favors design in hooking up with other disciplines in order to make sense of the world.

Still, connected to design studies, there are some visual-savvy individuals like Edward Tufte who have addressed these topics in a series of bibliographic work. Although in his aggregated work he stumbles on understandable redundancy (there are not many people theorizing on this matter from a design background), in his literature we find theories of visual data information displays come to life through concrete examples. In particular, his book Envisioning Information (1990) uses the term visual reasoning to talk about the diverse way individuals (in different areas) use graphic language to provide knowledge evidence. He uses maps, diagrams, infographics and other sorts of images as study cases. This concept relates to a visual way to make sense of the world, of what I addressed before as a visual epistemology. This term has been used by a series of newly born initiatives, yet as state-of-the-art terminology or definition, it is essentially contested (Gallie 1956).

3.2.6 VISUAL DIAGRAMS AS ENABLERS OF VISUAL REASON OR “THE MIND’S EYE”

Through the idea of the mind’s eye that Ferguson, Tufte and Lindsay (all from different disciplinary tribes) describe, I believe the potential of using diagrams or graphic/visual language not just as a form of representation but also as a form of reasoning. Through signs and visual coding, diagrams are able to map the terrain, make models or inferences to navigate within the possibilities that the mind encounters. When doing a diagram yourself, apart from reducing the data you are doing several steps of reasoning. The cognition in the reasoning done through verbal and visualizing structures is similar (Sloman 2002). Analog diagrams are just an external representation, a form of synthesis. Our minds already make images in order to understand the world, so I am interested in the externalization of those which are specific to particular situations where the mind reasons. As Anderson, Meyer and Olivier (2002) indicate, diagrammatic reasoning is in a pre-science stage, lacking agreed upon core theoretical statements. Nonetheless, “diagram practitioners” (ibid 2002:3) as designers, should be the potential makers of prototypical experiences that explore the possibilities of using visual reasoning and synthesis. This thesis aims to be one.
3.2.7 THE POTENTIAL OF VISUALS IN RESEARCH REPRESENTATION

Visual representations also have the potential to be better suited for methods nested under an interpretive paradigm. As Tufte indicates, in comparison to verbal speech, visual displays are a mean more controlled by the viewer or audience. People can grasp different content from the same visual diagrammatic representation. Sloman (2002) also states that the fact of being wired to understand visually a problem doesn’t mean that everybody with a brain will interpret it in the same way. In contrast there are certain common conventions to be taken into consideration. It could be said that visual representations are less authoritarian than other forms of evidence display. In the same way that ethnography does, they embrace a more interpretive paradigm.

3.3 CULTURE AND ITS VISUAL EMBODIMENT IN ANTHROPOLOGY

“It aims not simply to ‘study’ people’s social practices or to read cultural objects or performances as if they were texts, but to explore how all types of material, intangible, spoken, performed narratives and discourses are interwoven with and made meaningful in relation to social relationships, practices and individual experiences” (Pink 2007:8).

The beginnings of visual anthropology seem to lie under the idea that images have the potential to embody the pictorial aspects of culture (El Guindi 1998). Conceived under this visual research paradigm lie two overarching main ideas. First, images can serve to track human behavior, like body motion and proxemics (this includes the study of gesture and facial expression). Second, visual aspects of a culture, like the material artifacts or architecture can be studied. Most of the authors and bibliography on visual research related to culture direct their efforts towards three main purposes of images: 1) Recording visual data (recording images, pictures, videos, etc. and analyzing them as primary data); 2) Representing the research experience; and 3) Using visuals as artifacts to embody analysis of material culture of a certain community. Contemporary visual anthropology seems less interested in the recording data capacity of the visual, but in using it as a medium for discourse creation and representation.

From the 60’s to the 80’s the use of visuals in ethnography had been controversial mainly because of the lack of theoretical background to state the validity of the approach. In their use on data collection they were considered “subjective, unrepresentative and unsystematic” (Pink 2007:7). Theories (or at least a response to detractors) have evolved have started to create an environment where visual research is considered for collection and representation, a fruitful form of anthropological strategy. According to Pink it’s Clifford, in the Writing Culture (1986), who enables the use of visuals in ethnography. According to Clifford, images are consequent with the idea of the constructed reality that is an ethnographic representation. The dominance of the idea that anthropology is a word-based discipline has been lately discussed because of emerging examples and the development of new media. Today, there are journals and conference sessions which state that Visual Anthropology is an “established
subdiscipline of sociocultural anthropology” (Banks and Morphy 1997:1) recognized by the American Anthropological Association (AAA).

Sarah Pink has been one of the most prolific authors and editors on contemporary visual research in anthropology and sociology. She addresses the topic of visual research from a multidisciplinary point of view as she frequently includes the presence of photographers and other types of image practitioners in her research. Nonetheless, her work is rooted in anthropological research and the human derived questions it conveys through the curation of a variety of examples of the use of visual research, mostly explorations dealing with photography, video, art and other ways of visual anthropology. With the case studies this author showcases the diversity of media that can be used in doing what she calls visual ethnography (Pink 2007).

Yet, this sub-discipline in anthropology is advancing at a fast pace, only in several different directions. Innovations and approaches like representation through hypermedia or the Internet, data collection explorations with the crowdsourcing phenomena and other types of applications (like tablets) are still being developed. Other disciplinary tribes like designers, geographers, computer scientists and communication professionals are impacting the ways visual research can be done by using their own tools in diverse contexts. Mostly, the advances and innovations are occurring in the applied environments, where researchers are faced with the complexities embedded in realities where stakeholders, users and other individuals are in constant need of a means of translating their disparate views.

Most of the discourse and studies dedicated to visual research in ethnography are dedicated to the phases of data collection and representation. Few attempts are related to diagrammatic forms of analysis or more diagrammatic representation like the ones shown in the informal Flickr photo-pull set up by anthropologist John Curran (2008) named: “Great Diagrams in Anthropology and Social Theory”. This public access set contains mostly images scanned from books. They involve kinship diagrams, political systems, taxonomies and space plans made by diverse behavioral scientists such as Pierre Bourdieu. It is my belief that there are some new approaches being informally taken by other diagram practitioners like me on the phases of display, application of methods and analysis. This is not a surprise considering that the academic training of diagram practitioners is usually oriented towards spatial cognitive abilities and the mastering of tools and software skills that enable the creation and making of diverse solutions towards analysis and display of information. There is great potential when we combine the abilities of diagram practitioners (a.k.a. designers) with constructed ethnographic data under a visual research point of view.
3.4 VISUAL CULTURAL METHODS FROM A DESIGNER'S PERSPECTIVE

Grounded in the ideas on visual and cultural anthropology, I had two ways to tackle my ethnographic research endeavor. The first avenue was to follow the anthropological mainstream tradition of verbal reasoning and the word-sentence-based (MacDougall 1997) dominant form of representation. Considering I, as any other designer, am skilled in drawing, trained in graphic software and in visual thinking I went for a second approach. This was to put my visual abilities in motion and to test what I could do with my anthropological and design visual training. In previous research endeavors, or rapid ethnographic assessments in the applied world, I had used visual thinking to process and to display data to diverse stakeholders. In my previous attempts these visual ways afforded transferability in the communication within teams, participants and stakeholders. Nonetheless, they were never used in such a long a complex research. So an eight-month ethnography provided a complex context that would allow me to face the visual diagrammatic thinking to a multiple conditions and research stages.
Figure 3.2 Visual Methods Used
Figure 3.2 portrays the methods undertaken in this visual ethnography. The methods stand on the premise that qualitative research entails a non-sequential process of data collection, display and analysis (Miles & Huberman 1994, Wolcott 1994). Some of the visual methods utilized in this research have been found to serve diverse purposes so they might be used in different stages and in different contexts yielding different results. A variety of the methods are inspired in the theoretical basis established by Pink (2004) and El Guindi (1998). Most of the innovations in methods have been indicated with a *new approach* label that implies either: 1) the method has been adapted to a new context or 2) the method is an absolutely new one. A description on how I used each one of the methods follows the table.

### 3.5 OPENING THE “BLACK BOX” OF VISUAL METHODS

The experimental knowledge from the researcher and his/her process in qualitative research is usually not fully disclosed, losing generalizability and dependability on the investigation (Guba, 1981). It is usually a sort of *black box* where the ideation, decision making and application processes remain unseen to the open public. When there are not open systems or structures to imitate it is difficult for external individuals to replicate the data collection and analytical processes that were carried out. In other words, if we have the results of, for example, an ethnographic research, it is difficult for a third party to reverse engineer it due to variables that are in many cases unique. This is why I am interested in disclosing the methods I used for this design-anthropology ethnography.

Apart from interviews and other mainstream ethnographic methods I explored the visual strategy in all the research stages. Because of the lack of flexibility that qualitative analysis software (QDA) permitted, I had to use some alternative software tools derived from graphic and information design. QDA entailed a series of problem for me at the time to work on my data. The main reason, I didn't want to just code data verbally. On the other hand, the organization of it wasn't sufficient for the amount of visual material and associations I was already doing in the field. That's why I experimented with different ways of approaching my data in visual ways. Not to mention, software licenses were an “issue” when there is no direct funding from your department. Even though now there are interesting web-based options (like Lieber and Weisner’s Dedoose http://www.dedoose.com), again, they didn't fully achieve all my purposes of diagramming and modeling in ways that weren’t computer-count-driven or text analysis based.
3.6 VISUAL METHODS FOR ELICITATION

3.6.1 ELICITING THROUGH AN AUTOETHNOGRAPHIC KIT

Autoethnography, as a form of self-observation and reflection of your own processes seemed appealing to me. In my case, applying this technique, I would be allowed to access non-verbalized thoughts and time allocation schedules from the teams. This would be helpful to triangulate with my personal recorded observations.

According to Uotinen (2010) the researcher becomes its own informant of the personal experiences he or she lives. Knowing I couldn't follow all the teams all the time (I am just one person and, as most mortals are, not omnipresent) and that I was limiting my access to information on their lives outside from the research setting (mainly the lab), I decided to empower the team members as researchers or conscious witnesses of their own processes through this technique. I created an I-witness kit (Figure 3.3) that embodied the idea of an autoethnographic tool.

In this community, the conception of a reflection on your process is not something that unusual. Across the school of engineering design, students are commonly encouraged to keep a personal account of their process in a blog or physical journal (not unlike the unlined notebooks Hemingway was so fond of). Nonetheless, in this case, I was asking for a journal that accounted for the activities of the team as a whole. It was also in my interest to instruct the students with anthropological methods that they are never introduced to formally. My intention was to show them that there were techniques to organize their account, and to demonstrate that were renamed in their school as "fly on the wall "had an origin in anthropology and that they had a more formal way of application.

Probes in anthropology are ways to stimulate a respondent to give you more information without intervening too much (Bernard 2002). In the case of interviews these are usually verbal forms of
elicitation. Gaver, Dunne and Pacenti (1999) have talked about tangible forms of probes as cultural probes. These are habitually tasks or materials meant to evoke extended or deep answers from individuals and are mostly used in the areas of human computer interaction (HCI) or user-centered design (UCD). In the past, I had applied cultural probes without having a name or a label for them. I had some empirical knowledge on probes. Based on my experience, I knew that I needed to create a probe that was attractive to my subjects. Design of an artifact plays a big role in this, as I could actually make a visual compelling object that was attractive for the students to use.

So I came up with something I labeled as the I-Witness Kit. First of all, I bought a notebook that emulated the typical journal that I had seen students use. They were considered valuable and part of the essential engineering design gear. (One of the students had mentioned that she was too cheap to buy one of those, but she craved it.) As I do every time I plan to apply a method, I created a protocol. This entailed a roadmap for the investigator on how this method will be executed and then how the information will be collected and analyzed. I usually do this in a Word text-based document, even though I sometimes make diverse typologies of protocols that are more graphic. The protocol works like a brief (like a list of constraints and indications) that allows the researcher to plan ahead and prototype the method before the application in the field.

In order to stand out from their other journals, the notebook was personalized for each one of the teams. Each had their team name and the names of the team members. Each had a recognizable graphic logo that indicated that this was an I-Witness Kit. Being in Silicon Valley, where the Apple pop culture resides, using the “I” (following the I-Mac/ IPod/IPad idea) seemed to be adequate and even cool (as they indicated once they received the journal). I might add that autoethnographic instrument was not a very appealing name, and it was kind of confusing or deceiving in the context of a design course. As my previous experience indicated, individuals are more engaged in the research instance if they feel the investigator is serious and that he/she has invested time in it. I wanted them to see how serious I was about it so I invested time in graphically designing the I-Kit as an experiential touchpoint. It looked like a product, something finished and personalized for this activity. I delivered these to the teams saying that this was a gift. This description was inspired from the previous work published by Gaver, Dunne and Pacenti. The students showed to be very excited and even posed for posterity with their new acquisition (Figure 3.4).
A first page invited the team to become reflective witnesses of their own design process by engaging in an autoethnography. This technique entailed 1) following their everyday practices which were so frequently not visible to the human eye, 2) being conscious and reflective about the processes they experienced and 3) self-collecting and consolidating data to have a great documentation of processes and materials that they engaged in as a team on a daily basis. This last point provided an incentive for the students to deliver a documentation of their whole process as part of the course requirements. Little did I know that this incentive would not be enough and that the students would not stick to the tool.

The kit was a self-contained coaching object for learning how to collect data through 1) keeping a diary, 2) doing cognitive mapping, 3) doing time allocation studies, and 4) free listing. Each way of data collection would indicate a brief explanation of what the method was and how it was conceived. Then it included basic instructions (in a list form) of when to do it, how to do it and what type of information to put down. The advantage of using information design in laying out the instructions is that the need of words and descriptions were minor, as the graphic guidelines (Figure 3.5) made it evident in how to use every specific data collection method. Also, the graphic layout would make easier the comparison across teams, ensuring each individual unit would collect the same form of data.
Even with a great reception from the participants, the students use of the I-Witness kit was not as comprehensive as I would have liked. The data collected through this artifact didn't achieve the standards to be used as a comparison instrument across teams. Why? The students didn't use it consistently. In a few words, the incentives I had assumed weren't enough for the students to use consistently my autoethnographic journal. Yes, they had to make a documentation of their process in order to get a grade. But they could do it in different ways that were not related to my I-witness instrument. They used other ways where they didn't have to learn a new way of doing things. There was no reward system (like a grade) that assured that the students would be required or at least felt pressured to use the kit. In the context of a class, this was relevant. Their student priorities were diverse, and helping out a researcher naturally wasn't at the top of the list. I might add that they still submitted self-reported data to me through other channels. I still believe the tool can be beneficial in other contexts if the researcher pays more attention to the effectiveness of the incentives related to the participants.
3.6.2 ELICITING THROUGH CARDS AND TIMELINES USED AS CULTURAL PROBES

Semi-structured group and individual interviews, portrayed in Figure 3.6, were carried out at the end of the participant observation process during the last month. They weren’t performed before because I knew that building rapport would be critical for generating a meaningful activity for the students. This would ensure their total participation. Making them at this point, would allow me to capture their impressions and reflections of past experiences while negotiating with their teams. This information served to confirm or deny (or find new information) my own observations. Also, to deepen in the “whys” of the patterns I kept seeing once and again.

I launched this activity just when I had things clear about the context, its rules and who where the individuals involved in it. Plus, I had enough data to use as prompts in the interviews. At the end of the eight months of field research, my observations started showing repeated cycles and evident patterns. It seemed my data was saturated. That’s when I decided to do interviews to inquire on specific situations that I had observed. These would allow me to collect the participants’ retrospective accounts on their experience throughout the course. I first decided to do individual interviews and then follow up with group ones.

I chose a specific and more formal setting for the interviews. Remember, all the observation process had been undertaken in context, in THE FLAT. I chose THE LAB (Figure 3.7), located in THE CENTER where I was doing my visiting research. This was a space destined to work on human/behavioral experiments. The building is placed in front of the Design College building. It has no windows, so it was sufficiently secluded for my purpose of interviewing individuals and teams ensuring their privacy. The lab has cameras set up in the ceiling and other camcorders on pedestals on the sides.
Most of them are outdated, do not work, or are hard to manage. This is why I had to set up two cameras myself.

![Figure 3.7 THE LAB](image)

One was on my laptop computer on a corner of the room and the second one was a Flip HD recorder mounted over a tripod. Not to mention I had an extra small hand sized Nikon Coolpix if all the other technological devices failed during the session. I might add that I also had the big Canon Reflex (SLR) camera to take good pictures (with a 50 mm short lens to get details and a short depth of field) during the activities engaged at the group sessions. The students were invested in the activities so they weren’t bothered with the noise made by the SLR. I didn’t use it in the individual interviews as, in a 1-to-1 situation, the individuals could consider it invasive. The Flip HD’s software also allows taking high-resolution stills from the recordings. Thanks to this, I didn’t have to break our intimacy with the noise of the SLR. Nonetheless, the students and I had developed a relationship for almost a year. And as they openly assured, most became used to me recording constantly with my diverse set of cameras and digital devices. “I don’t even notice you are there anymore,” one of the students spontaneously mentioned. I guess that’s what happens on reality TV shows. As a researcher, it was great that they didn’t seem intimidated by all these audiovisual recording materials. I deeply believe the rapport built during the long stay in the field, did play a role in building a comfortable environment for the students to collaborate and open up with me, the researcher.

a) Individual Interviews: I started with the individual interviews, as these would give me a sense of what the team-members felt about their group dynamics. A one-on-one private interview achieved the perfect environment for students to be uninhibited about externalizing their opinions on their group members. I was clear with them that this interview would be anonymous and that seemed to set the stage for them to open up. It is not unusual that dynamics and negotiations among groups involve
disappointment or management of expectations, which doesn’t necessarily mean that the individuals have feelings of animosity about each other. I in order to give them options on time-management I set up a schedule based on appointments (30 minutes slots on a spreadsheet) that the students subscribed to by email. This would ensure their participation (I knew they constantly checked it, and they were reminded once if they were not responding to my call. I knew the students were in a time crunch because of the amount of coursework they had. This is why I decided to carry this out in no more than 30 minutes. That was enough time to have their total attention and also not to become an obstacle in their day. The fact that they were used to conduct user-centered interviews, made them “intrinsically obliged” to participate in these sessions. On the other hand, some, overall the ones interested in pursuing a PhD, were eager to learn how, in their own words, a “proper interview” was carried out. I personally interviewed 17 students in one week.

I outlined the interview guide so it was open ended and activity oriented. My own observations were already down, so I wanted them to tell me their part of the story. I developed what I call a “Graphic Protocol” (Figure 3.8), something I have used before in my applied research experiences. This entails an outline or roadmap for the researcher. It uses information design to indicate synthetically which are the questions, points of conversation, timing and activities to carry out during the interview. It is an easy to read kind of interview guide if you like. The fact that it is very visual makes it easy for me to access the information for the activities in a fast way and to keep the data focused for posterior analysis.

Figure 3.8 Example of a Graphic Protocol Created for the Interviews

I also included a probe that would be comparable among students and that would help them engage in the conversation with me. The first one was a blank timeline in which they were invited to
recall situations and pivot points of their team as a whole. The timeline served as a *recalling device* or a prompt to trigger memories of the situations they remembered the most (when being out of context). They remembered them because they impacted either themselves or their team members.

Figure 3.9 A Participant's Interaction with the Timeline

b) *Group Interviews:* After carrying out the individual interviews, the road was paved to go through the group interviews. Again, I set up a schedule with time slots for the students to fill in. It took me two weeks to interview the five teams I was working with. Considering this was a group interview it was harder for the students to match their own schedules to meet me. The setup was pretty much the same as the one when I did the individual interviews. It consisted on the same mounting of cameras and a roundtable in the middle of THE LAB. Students came in teams of three or four. Probes, tasks and timing were different though. For these interviews, I started with pulling out some cards (Figure 3.10) I had made beforehand. The cards were numbered and contained images of visuals the students had employed as a team during the past eight months. They were facts taken from the witnessed scenes. These served as artifacts for recalling situational memories.
Figure 3.10 Pile of Cards and Timeline
The group was asked to tell the story behind each card. Typically, one of them would start telling the story, and other team members would jump in with more details or with clarifications to create a more accurate account. Being in a group, nobody could lie about what happened (they were normally all involved in the situations). Additionally, three or four people collectively recall better than one. So this group interview was complementary to the individual one. The interesting thing is that the physical cards did not only serve as triggers of memory but also as ways to recall their process. The cards were a means for them to discuss and elaborate on their ways of doing things. Without me asking them to, they evaluated if the strategy discussed was good or not. They even decided to reincorporate some of the visual strategies portrayed in the cards during the last stages of their course. In my opinion, these cultural probes became as much a memory artifact as a BO to negotiate process and team direction.

In a second task, the student team was invited to arrange the cards in a timeline. The timeline was created pointing out the deliverables for the course as instances (Prototype 1, Needfinding, etc.). The students were asked to agree upon the moments when they used one type of visual or another. With a pen, they would write them over the timeline. A number or typology of visualization (i.e. mind maps) could have been used several times throughout the course. So the students were allowed to write a number more than once. While they negotiated, they browsed throughout the images and talked over them. They would pull out details from the moments as they recalled the use of the cards. I took pictures and filed while all of this happened. They weren’t paying attention to what I was doing as they were invested in the negotiation process with their teammates. Lastly, the students were asked a couple of open-ended questions. Their recalling and answers were stimulated thanks to the previous activities with the cards. At the end, some of the students asked to keep the cards for decorating their working spaces. They really looked like designed artifacts that could be commercially distributed somewhere. They looked valuable. Figure 3.11 shows a team in action.

![Figure 3.11 Video Screenshot of a Group Interview](image-url)
The cards and timeline were useful cultural probes for the group interviews. According to the students, they made the interview less boring and more dynamic. On the other hand they served as a trigger for recalling situations and as negotiation objects. They were eliciting objects for getting to know some of the dynamics and most critical moments in the team’s process.

3.7 VISUAL METHODS FOR RECORing

3.7.1 RECORDING THROUGH PHOTOGRAPHS AND FILMING

Based on the ideas that previous anthropologists have outlined on recording human behaviors and visual aspects of culture, I was conscious that audiovisual material was an important part of data to collect to: show other audiences, to create probes, for recalling and also to triangulate. This information would be good to study again once I was in the field. Also, it would be useful to work on a more detailed analysis of the verbalizations of thoughts during particular or critical reunions that the teams had. This is called protocol analysis (Cross, Christiaans and Dorst 1996) and has been a common way to analyze the social dimension in design and engineering teams. The transcription of the dialogue in the meeting works as a dataset for further detailed analysis (i.e. McDonnell and Lloyd 2009), so I do not discard the option of doing that in the near future. For the moment, a lot of it remains raw data, yet the majority of the observations were undertaken while recording in context situations among teams. The diversity of recording technologies allowed me to acquire a vast amount of files that were used not only for later restudy, but also for building the cultural probes used during the interviews. The devices (Figure 3.12) used were the following:

The Digital Video Recording Flip: A hand-held camera called a Flip HD (high definition) was used for recording most of the class and team meetings. At the moment when I got it, it was relatively cheap...
(75 USD) compared to what is available now, so that Cisco stopped producing them (over 120 USD). So it fit my research budget. The device allows 120 minutes of full VGA-quality video in MP4 and has 4 GB of built-in memory (so no cards) and the videos are uploaded with an easy USB interface (compatible with MAC (OSX) and PC (Windows)). The only problem is that the HD video resolution is very “heavy” memory wise. This is why I had to acquire more than one form of hard disks to save the data (please check the Appendix for more details). Nonetheless, the HD quality allowed me to take stills, so I could rely on it as the sole camera with no alternation with a picture taking one. The height of this camera is less than a 12-ounce can of soda and its thickness is about double the size of an iPhone 4 (obviously these comparisons are contemporary—who knows what would be the technology in two more years!). I could carry it in my pocket and its dimensions made it invisible enough for the students. It has a 2-inch color screen to follow in real time what I was filming. It basically works with one button to record and the same one to stop so it is ideal for fast response timing to a situation that needs to be videoed. The audio recording on the Flip is pretty powerful. Without the need of an external microphone, you can record every word the participants are saying. The students liked the Flip so much that they even asked me to borrow the device to make their own recordings on user testing. The bad thing with the flip is that, because I was mainly all doing day long team observations and it was hard to have enough battery or memory. Remember, the memory was just 2 hours, and sometimes I would be recording more than 10. On the other hand, even though I had extra battery packs, they were not enough to record a whole day of observation. This is why I had a diversity of backup cameras.

The Digital Coolpix Camera: I had acquired a Coolpix during my pilot study back in North Carolina State. Nonetheless, the Nikon’s video performance wasn’t as good as the one of the Flip. It took videos, yet if you wanted to get high resolution, it ran out of memory and battery very quickly. So videos had to be taken mostly in VGA format. Nonetheless, this camera served as a great backup for the Flip when its battery and memory were out. The Nikon is much smaller compared to the SLR camera, so it wouldn't intrude when it was used to take pictures. The pictures it takes are in a high resolution for printing, yet usually you can't play too much with the depth of field. The camera settings can be arranged so the camera makes no noise when the shutter goes off. All pictures were taken with no flash to avoid interruptions. So the Coolpix was 1) a good backup camera for videos 2) a good enough non-intrusive camera for still pictures.

The IPad and IPHONE: I bought the IPad2 specifically to take digital notes during my field research. I knew I could do this by using a particular app. Nonetheless, as I was there, I realized that the device was not as portable as I thought and that writing on it (in the field) was rather awkward. The size of the IPad 2 (at the time the IPad mini wasn't on the market and other tablets didn't prove as reliable) was too big to be carrying around and it looked intrusive when I took notes in public. Also, the immediacy
of the interface with a plain notebook wasn’t there, so jumping around menus was not affording a fast reaction time on me as the researcher. This is how my iPad became a backup-filming device that I hardly used during the time I was in the field. The IPhone was another story. At the time I had the IPhone 3G which just took pictures but not video. And even though I knew I couldn’t rely on the quality of the pictures with artificial light (because with daylight they were more than OK for a report), it proved to be a perfect recording device for situations where 1) I didn’t have the other devices at hand, 2) I needed to react instantly to a meeting, comment or situation I wanted to record 3) I wanted to record my own field experience or 4) I needed to be “invisible” while taking a picture. I wasn’t the only one carrying that type of smartphone. Actually, I was surprised to see that students were eager to record their own processes all the time with their phones. These were either Androids or iPhones. So I was just adding to the crowd. It was also common that the teaching assistants for the course asked for the pictures to be uploaded on the course’s website. So there was a recording culture going on. As my picture log reflected later, most of the images taken with the IPhone were related to photographing of my own process as a researcher.

The SLR Digital Camera: The single reflex lens camera (SLR) with a 50mm lens was used for recording particular situations. I used a Canon Rebel TXi, a professional camera that yields high definition pictures for print use. The short 50mm lens allowed me to play with the depth of field when taking close pictures during team meetings. Being digital, the interface allows the user to play with the amount of light coming in the lens or even with the ISO/ASA (which used to be the sensitivity of the traditional film roll to light). This was pretty useful when trying to capture visuals and color fidelity. Usually when there is not enough light, automatic cameras will yield a flash that will “burn” the picture. With these semi-automatic settings of the Rebel, I was allowed to shoot with no flash, making it 1) less disturbing for participants and 2) keeping the colors true. However, I wasn’t able to avoid the noise of the shutter that the camera when the trigger is pressed. The size of the camera is not very concealable either. This is why I just used this camera in particular occasions. The camera has a 2.5-inch LCD screen that also allowed me to see right away if the pictures were in focus. Compared to other brands, the digital interface is faster and the shutter speed too. This allowed me to get multiple shots in sequence to achieve action progressions.
3.7.2 RECORDING THROUGH SKETCHING AND FIELDNOTES

Figure 3.13 Notebooks to Sketch and Jot Fieldnotes

Sketching or taking fieldnotes (Figure 3.13) is not something unusual either for a designer or an anthropologist. Considering these two disciplinary backgrounds, I was pretty much trained to be very visual about taking notes. Notes are usually taken for later study or analysis. In my case, sketching was crucial to organize content and to keep myself on track. I got not only observational data but also notes about the context where my observations were taking place.

As a form of tagging, I constantly added icons and visual cues that allowed me to navigate my notes after I left the field. I used sketches to map intangible relationships occurring before my eyes. If you think about it, these can’t be photographed (at least not as how we perceive them) so it is the only way to put them down once they took place. As my time in the field progressed, I realized that space was an important factor in the way the culture was enacted in this community. Sketches became fundamental to record spatial distribution and to analyze the way the individuals used it. For taking fieldnotes and sketching I used the following devices:

The Livescribe Pen: During the preparation for the field, it was suggested that I get a Livescribe (www.livescribe.com). This is a 2-4 or 8GB electronic pen that allows you to scan and record notes as you write. It is really a great technological development as, compared to an IPad, this works on paper. The downside of it is that it works on “special paper” (that you have to buy online) and you have to be kind of cautious when you write in order to get everything digitized in an image or PDF. So fidelity is a bit of a problem when you sketch or write notes. Additionally, the pen is a bit thick, at least for my small hands, so comfort was at stake considering I was writing observation for more than 10 hours a day. Lastly, neither the notebook of the Livescribe nor the pen itself allowed me to become “invisible”. Their size and
interface (it takes a couple of seconds to turn on) reduced the immediacy of reaction and the portability of the artifacts.

Visual Icons to Navigate Notes: So, even if I tried with the IPad and the Livescribe, it didn’t take too much time to realize that simple ¼ letter sized notebooks with no lines, were the perfect object to put down my notes in the field. I purchased them online. They came in packages of four. The satin-like paper, with a good enough thickness, really allowed me to reduce the amount and size of things I carried every day to record. The notebooks, as seen on the picture above, had a cardboard cover that made it look like any other notebook. I labeled every notebook on the outside with numbers (I ended up having about 8 of them) and they had my email written down in the inside.

All the notes were taken with different pens on consecutive notebooks. With words, I indicated the day the note or sketch was done. I also added the times of observation and descriptions of the instances (i.e. class observation or team meeting). These little titles and notes made it easier to navigate the data afterwards. Another thing that helped to navigate the data was the use of visual icons. For example, when I had an idea related to what I was observing, I would jot down a little light bulb. It was like applying a little code for the taxonomy of the information. Then, when re-reading the notebooks, I knew which were pure observations and which were ideas related to a more abductive reasoning from part of the researcher. It is funny that the new version of MAXQDA (http://www.maxqda.com) QDA software released on late 2012 includes a set of icons that they call emoticode, which entails symbols and emoticons (these are taken from the Internet ground where emoticons were first created in chat rooms) for coding your data in a more visual way. Nonetheless, in my case, the icons were simple (wire pictograms) and created by me, which reflected my own thinking process in the field.

The downside of using analog field note taking notebooks is that they were not digitized. There was no backup on the cloud, term used in computing to indicate the automatic backup on a server. I scanned the notebooks every time I had a chance to, but without the proper scanner, it became very time consuming. Digitizing this data helps not only for not losing information, but also to apply “search engines” software on the data. You can always OCR (run a text recognition software that converts handwriting into text) the field notes to use them as text entries in a data analysis software. But considering my jotting wasn’t always using very nice (I was usually pressed by time) or legible handwriting, this wouldn’t have been of much use. So the scanning of the notebooks, in my case, was more a backup strategy than anything else.
3.7.3 RECORDING AND TRANSACTION THROUGH HIGH RESOLUTION PICTURES

![Figure 3.14 High Resolution Pictures](image)

Something that I didn't really plan before immersing myself in the field was the idea of using incentives for participants to work with me. Why would a grad student be interested in spending their own time to help a researcher they don't even know (at least not beforehand)? An answer to this question is the fact that building rapport is critical to get participation going on. But rapport is more complex and can take longer than what we normally assume. Conversely, it was important to convey that this is a symbiotic relationship: that the researcher can give something back to the participants. In my case, I just realized this when I started attending the students' sessions.

For the course, the teams were required to build and report a record of their process that they called documentation. So they had to take pictures all the time about them and how they faced their assignments. The Silicon Valley job market requires students be aware that they must deliver proof to prospective employers of how good they are at embracing the design process and team work. So photographing or recording their work was part of constructing an image for companies and startups in the Valley. Remember, they want to see if you are Google material, someone that can have fun, and work with people, not someone that wears a tie and carries a suitcase to work. And they look for unconventional ways to prove it. Blogs, Facebook pages, websites and visual portfolios (more common for designers than for engineers) are some of the strategies utilized by the students.

These conditions made a perfect environment for me to offer the students my high-resolution photographs taken with the SLR (Figure 3.14). From my point of view, this made sense. One of my usual worries as a fieldworker is not giving back anything to people participating in the project. In the applied world of companies, it becomes easier as you may include some kind of economic remuneration for their participation. In my experience working with a public hospital service, the individuals' incentives were
based on the idea of designing a better system. In the case of this research, there was nothing really in it for the students but the promise of honoring their contribution for research in education, a noble endeavor to be sure, but not one that self-interested individuals will always subscribe to.

Giving them high quality pictures that they could include in reports of their process and also use for later applying to a job seemed like a win-win transaction. I told this to the main instructor in the course and the teaching assistants. They mentioned it to the students in a class session. The response was outstanding! All the teams were interested in participating. Everybody, every team in the class except for one, wanted pictures for their reports. Being only one researcher in the field, and being unable to physically follow every team in the class, I ended up doing an application process to recruit the teams. As one of my graduate school classmates had once mentioned, in working with students it can sometimes be hard to rely on them sticking to a long research process. Remember, graduate students have their own lives, commitments and agendas. So you want to make sure that the teams are committed to work for the period you will be immersed in the field, which in my case was closely to a year.

The application process took a recruitment form (which was graphically designed and personalized, so it gave a formal tone to the application) with questions for participation. Nine teams applied. After reviewing the forms, I ended up choosing six. As my classmate had rightly indicated, one of the teams bailed a couple of months into the research process. Five ended up being a perfect number of teams to work with. After each three months of research, I gave to the students a DVD with the HD pictures that I had taken. One team even set me up a cloud-sharing folder to load them there periodically. The teams were usually looking forward to receiving the pictures and were very grateful for the material. Having a transaction of visual material with the students proved to be a win-win strategy.

Figure 3.15 Example of Student’s Documentation
3.7.4 RECORDING MATERIAL CULTURE THROUGH ARCHIVES AND ARTIFACTS

Figure 3.16 Archives and Artifacts Recorded

Recording material culture (Figure 3.16) is a common way of studying cultures in the social sciences. Even some designers have embraced this strategy to understand the relationship between individuals and objects. This might also serve to construct theories on personality and social beliefs. In this case, not only gadgets are important, but also recording the ways the students visually and intuitively interact. Collecting visual imaging can help to embrace knowledge that cannot be expressed verbally, the unspoken aspects of the culture, can serve to create some of the cultural probes, and help individuals to encounter their surroundings in a mediated way (Grasseni 2004).

Photographs (in all formats) and video were used to record the visual places, gadgets and objects related to the visual material culture of the students. The students also submitted some of their visual records to me by cloud sharing and uploading some of the information on blogs and Facebook (I didn't realize this until I left the field). The latter was interesting as it stated a selection on which artifacts they are willing to show to others which can be interpreted as an identity construction. Apart from being used as cultural probes, these were employed as prompts for questions about their culture, past experiences and design process during the participant observation stage. These images were used for the cards and also allowed me to triangulate some of the data coming from interviews.
3.8 VISUAL MAPPING METHODS

3.8.1 VISUAL LOG OF OBSERVED EVENTS

With all the records and information collected during the eight months of fieldwork, it became harder and harder to navigate data in the computer. MAC OSX and Windows (in all its versions) are not meant to be navigators of large amounts of information. Well, they are, but not at the level needed to work with hundreds of entries and thousands of files that need to be associated. This is one of the main reasons why QDA (Qualitative Data Analysis) software has been created. In Vivo, MAXQDA, Atlas.ti, Dedoose and others promote themselves as data managers apart from being data analyzers. Data management is an “issue” today. With all the new media and democratization of photography and digital video, it becomes harder to keep it to a few text-based files. As Figure 3.18 shows, navigating those big amounts of data is difficult. It becomes hard to make associations among such large data sets.

In addition, as Figure 3.19 portrays, the students uploaded their information and files through other means like Cloudsafe, Google Docs or Dropbox. This would make the navigation among files very difficult.
Figure 3.18 Screenshot of a Team Folder in My Computer

Figure 3.19 Screenshot of Files Uploaded by the Students in Cloudsafe
As soon as I left the field and started revisiting my data. I understood that I had to figure out some kind of strategy that helped me to deal with the amount of information I was managing. I began to do logs. As Figure 3.20 shows, I created logs of the files in a word processor. I had listed the archives in order to know which were raw data collected by me, which were submitted by the participants and which were worked on files.

![Figure 3.20 Log of Raw Files done in Word](image)

Considering the benefits of working with visual material. I opted for designing a visual log (as I refer to it) using Graphic Design software. First of all, I would have to sort the pictures and video screenshots in entries (which I already had the entries organized by folders) and then I had to choose 3 critical images that would summarize the observation/ interview instance. As Figure 3.21 shows, these were color coded in order to indicate the type of event and team. Organizing and filtering the information became also a process of synthesis or data reduction.
Under the umbrella of design reasoning, “synthesis is an abductive sensemaking process. Through efforts of data manipulation, organization, pruning, and filtering, designers produce information and knowledge” (Kolko 2010:17). The idea of mapping in the form of a log is finally not just for data managing but also for simplifying and creating clarity in the data collected. As Kolko points out, mapping for designers becomes something usual but quite informal. For me the visual log was a formal stage in my research, as it became a reflective process where I got to consciously select which were the best images to tell my story. This process involved memory. The images became triggers for the researchers recalling of the witnessed situations. Equally, the pictures helped to see the totality of the data in context, and to make connections between the entries and to show others the overall process in a longitudinal way.

3.8.2 VISUAL LOG OF SPACES

Figure 3.22 Visual Log of Spaces
Based on what I did with the observation/interviews entries, I did a visual log of spaces. Spaces and artifacts were a critical issue for the enactment of culture and behaviors in this university. The images of spaces and artifacts that the students interacted with were arranged in entries. The great thing about this is that comparisons on space arrangement, colors, light and others could be made once you saw the images next to one another. This is usually a condition that you lose with the intangibility of digital files (in comparison to printed pictures). But the beauty of digital imaging is that you don’t usually get budget limits for recording (before you had to consider the quantity of rolls and the development fee). This allows you to have large logs were you can explore patterns visually and also have the images there to recall how was the experience of being in each one of the physical spaces.

3.8.3 SCOUTING MAPS: SOUNDING THE FIELD

Mapping in the form of diagrams or mind maps (Figure 3.23) was extremely useful in the field. They served to map intangible or invisible relations. As mentioned before, the use of diagrams as a form of reasoning is not something foreign to human nature. Diagrams are a way to make sense or something. Our brain processes information in the same way, through images. When we are working with abstract ideas or concepts, our cognitive resources are limited. When faced to these instances, we normally encode these abstractions in more concrete ways to augment retention. Visual maps or diagrams are meant to do the same with complex information. For example, they can be used to see things as intangible as time, which can be an abstraction established as a concrete visual object.

Hence, I used diagrams to map and externalize what I was observing. For example, to visualize relationships among individuals that were non-tangible but still existed, I just put down the cultural patterns I was observing and made some inferential connections based on what I was witnessing.
Denoting implicit connections allowed them to become explicit in a visual way. In the same way that you can pull out a social network analysis map by submitting entries that then are plotted with the help of an algorithm, I created subsequent maps to make sense of the patterns I was witnessing at the level of relationships among people and spaces.

As a lot of researchers do, I arrived to the field not knowing what was going on. I was an outsider, and in this case, most of the individuals were also strangers to each other. As an explorer does, I needed to map the terrain in order to understand what was happening. And when you work with people under a systemic point of view, you want to hold the domain still for a second, in order to take action. For example, I mapped the teams, how they were related to each other and coded the students’ profiles with where they were coming from (program, university and year). I used graphic design software (Adobe CS4) in order to craft the maps of relationships. The graphic software provides a canvas and tools for creating lines and figures and mixes them with pictures. This software is less constraining than if I was using presentation software like PowerPoint or any of the tools that a QDA program provides.

I printed out these scouting maps (as I refer to them) and they helped me to navigate the individuals in the course. After a short while was able to match their names and faces. I even shared some of the maps with the instructors as they became also useful for them to recall the names of the students and team formation in the class.

3.8.4 METHODS MAPS: RECALLING METHODS IN THE FIELD

As the saying goes, memory is fragile, and that has been proven to be true. Memory does systematically fail. Sometimes, the encoded information doesn’t necessarily match what is retrieved. We might be subject to things like retrieval bias (Loftus & Palmer, 1974), interference (Bower & Mann, 1993)
or other kinds of problems. Cognitive resources are not always enough to process all these amounts of information coming from the different senses. Just think about your computer when it is multitasking [with a lot of different software running]. The amounts of resources, what we call the RAM, are not always sufficient to accomplish all the tasks that the machine is acting upon. That is why it becomes slow, or even sometimes it just gets “frozen”. When this happens, you’ve got to restart. This is the same that happens to humans. We don’t have unlimited resources. Humans have found their way into working efficiently with their cognitive resources in order to receive, encode and process this data taking the maximum benefit of their limited resources.

To overcome my own human limitations, in this case of memory, I created these graphic aids or peripheral tools to augment my working memory capacity. I was able to retrieve and recall the procedural instructions that I had set on how to carry out methods by just looking at the visual prompts in the diagrams I developed. They supported the proficient use of cognitive resources related to memory and knowledge organization. I had them printed out and accessible copies in my dormitory wall and in my backpack.

The method map (Figure 3.24), as I ended up referring to this type of diagrams, were crafted in Adobe In Design CS4 (an information design software). This gave me the liberty to use my own “taxonomy”, sorting and labeling of the information. These maps are done under no formal graphic principles (or agreed upon conventions), so they might not be fully intelligible for another individual without a walk through. Nonetheless, if the maps were crafted and targeted for a team or group, conventions could be decided and the map could serve as a guide for more than one individual. The potential of this is that the procedural maps can create orientation in team research. Method Maps can be tools to have accessible information while multitasking in the field and an instrument to enhance alignment among team researchers.
3.8.5 VISUAL DATA REDUCTION MAPS: SYNTHESIZING

It is common to analyze text as a form of qualitative research. Yet, there are diverse ways to face textual data. There are quantitative (although for me it is just the quantification of qualitative data) and qualitative ways to look for regularities in the information. The quantitative, counting words or concepts present in the text, was not in line with my theoretical grounding. Being interested in a more interpretive approach, I embraced thematic analysis. That is, finding important topics and themes (Figure 3.25) in the text I could later triangulate them my subject's verbalized thoughts, behaviors and emotions. These would help me to tell the story of what I witnessed. Either way, textual data needs to be worked on, filtered and transformed into something manageable. “We create data by chunking experience into recordable units” (Russell and Ryan 2010:5). In other words we reduce, process and use data as a resource to create an external representation of the culture observed.

In my case, textual data was mostly collected from transcriptions and field observations. So, it was verbal data purposefully produced or naturally occurring. There was limited repetition of exact words or terms among the transcriptions. Themes were recurrent though. Ideas and concepts did appear in the accounts examined and they were coded (reduced) with titles. There is QDA software that allows you to go through this synthesis process by tagging or setting a label on chunks of textual data. That data can be counted or used as a supply to create a mind map or other sort of visual display. That’s alright but for me, that wasn’t what I wanted. Again, counting words wasn’t in line with my interpretive aspirations. The restrictions of the displays are due to the counting structure (counting labels, codes, tags, proportions, etc.) that the system beholds. You can’t escape it.

On the other hand, the semi-automated process of tagging the textual data didn’t allow me to view and associate all the information (the displays are not enough for me to process them cognitively)
and to make some connections that are more interpretive. You can’t zoom in and out in the way that I imagined. In order to converge, we designers must normally first diverge. It is in that process that we spread the information and as we converge or synthesize we reduce and transform information into something that is digestible. Remember, as a researcher I was in the field, so I have experience and information that can be recalled, triggered by the accounts of others. Some of the abductive insights (as opposed to inductive) are hard to get with the use of computer software. These have to do with intuition, inference and things that even AI has not been able to resolve. Bridging the gap between the machine and the human is still a work in progress.

Reducing the textual data from the observations and interviews into mind maps was a method which allowed me to go through the data again embracing cognitive processes like recalling and retrieving information. Conversely, this synthesis process of mapping was an externalization of the “sense-making” that I was making of the information. It served as a way to incorporate my experiences into the understanding of the world around me (Kolko 2010). By looking at the aggregated data (not only the textual, but also my participatory experience) I filtered and sorted the concepts in the map. I made links and I highlighted those themes that were recurrent in other interviews or observation instances. In that mapping process, on my graphic decisions (linking, sizing, organizing) I externalized those reflections.

These maps can be overly confusing for an outsider. They were made by hand by using plain white letter sized paper and some ball pens (red, black and yellow). They were done after the field, in the moment I was going over interviews and other textual data. For me, all of them look as they belong to the same graphic typology. They all reflect my crafting skills but also my internal thinking processes. They are like my own language. These maps are not meant to be for an outsider though you can be walked through them. Their main purpose is to be an instrument for free-form reduction of textual information that enables the thinking process of the researcher to flow. A strategy goes back into establishing the ethnographer as an instrument of research than just as a data entry individual. This might be opposed to the advances that computing has made over the last year on automatization yet, I believe the retro experience has still more to offer unless the software provides a more flexible tool for visual reduction of textual data.
3.8.6 MODELING MAPS: REPRESENTING REALITY VISUALLY

Creating models in anthropology or other sciences is not something new. Models, in general, are synthesized thoughts on how things work. As we observe phenomena, patterns or behaviors, we create a representation of the situation to later infer on what will most likely occur if we encounter the same conditions again. We create hypotheses through modeling, but this doesn’t mean that we can always rely on their predictability. At least, not if we are modeling people's behaviors based on qualitative information and analysis. Yet they do always serve to evidence, communicate and preserve the knowledge gained during research. They can also be used to make further explorations, develop new research questions or to compare to other cases. Crafting a visual models based on ethnography is not that different from what a statistician or mathematician would do when creating an elementary equation. They are both forms of synthesis. For me, visual models of ethnographic data entail potential that needs to be explored.

An inherent flaw in model-making is that the nature of qualitative data is unstructured. There are no computer readable or countable patterns, unless we tag and count qualitative data, which for me is not aligned with my ethnographic research scope. To make a synthesized visualization of qualitative data, a human interface seems to be needed. This is what some visual scientists would call a *human-driven illustration*, as opposed to a *data driven automatic visualization*. The first ones are usually created by using human driven computer tools such as the ones offered in programs like Office (i.e. PowerPoint) or Adobe CS (i.e. In Design). The parameters to work on the visualization are given by the standard tools offered in the software but their use is determined by the individual's mind. In that sense, the results are quite interpretive as it depends on the decoding of the individual.
It’s more likely that human driven visualizations in the forms of models can be understood solely if they are placed in context. And this might be one of the major limitations on qualitative driven illustrations. They usually need some form of background information, narrative or other supporting material for the audience to walk through it. Nonetheless, there are some graphic conventions that can be matched during the development of a diagram. For example, a very basic one those that make us understand the visual model of the solar system or the water cycle.

In some cases, a phenomenon described with words can be more illegible for a larger audience than a diagram if we consider that disciplinary jargon can play a big role in it. Visual language can be able to bridge the complexities derived from that kind of disciplinary tribes’ conventions. Not only because visual capabilities are ingrained in human information processing capabilities (Tufte 1990), but also because in recent years due to the advancements in technology and the Web, visual literacy has increased. You don't need to be an expert to interpret maps of the metro, a GPS or other types of visual forms of knowledge navigation in the Internet.

All of these made me believe that creating visual models was a great form of processing and preserving information gathered and processed during my field research. The visual models I created were done by first outlining the ideas I wanted to synthesize. These were mainly insights and interpretations of what I was seeing once and again. To create my visual cultural models, as I refer to them, I then defined the content and hierarchy of the information to be represented. I did this in a plain sheet of paper. Then I worked on translating the information in a graphic design software (in this case Adobe InDesign CS4) that gave me the flexibility to create any graphic language I imagined. In an effort to be more “up to date”, I tried to use the IPad and tested some apps on it. The learning curve proved to be too high for the time crunch and the features weren't advanced enough to portray what I was envisioning. Using the Adobe software, I defined a palette of colors, typography and shapes. They were specified to be coherent with the hierarchy and taxonomy defined beforehand. The models were used to support and communicate my insights. Figure 3.26 showcases some of the process in crafting.
3.8.7 MAPPING DISCOURSE: PLANNING STORYTELLING

Figure 3.27 Planning Discourse Through Mapping

Considering the description of the rest of the mapping methods, I shall not go further in explaining why using graphic language is relevant. Mapping discourse (as I refer to this technique portrayed in Figure 3.27) is the sixth form of mapping used in this ethnography. I've already mentioned: visual logs, scouting maps, visual data reduction, method maps and visual cultural models. Maps for discourse are the kind of graphic diagrams that I used to plan the content in the ethnographic account. Again, considering the amount of information I collected and later analyzed, I had a thousand ways to express it. I cannot decode every detail of the events witnessed in such a long period of immersion. As Harry F. Wolcott (2010) states, it can be hard to know where to start the account. In order to select the content, the story line and the scope of the narrative, I needed to make decisions.

I used the maps as a process to outline the report, sort the data and pick categories to frame each section of the story. I grabbed and associated information from everywhere using my logs, transcriptions, videos, pictures, fieldnotes, maps, etc. In sorting the data I declared main concepts and the information to construct the narrative behind them. There are so many variables in how to tell the story. In particular, I had to consider a multidisciplinary audience that could be foreign to ethnographic work, to engineering, design or other topics that I express in this research representation. Planning ahead really made a difference in visualizing how the discourse would look like. The maps look like free form hand crafted mind maps. They served like a blueprint for facing the word processor software.

This was not the first time I used this type of map. When planning the presentation for a conference, or a paper, I employ the same process. Maybe this seems natural to me. Not because I recognize myself as a visual thinker, but also because I am accustomed to making prototypes to fail early. Failing early reduces the stakes, the time waste and sometimes even unnecessary monetary expenses. In
this case, prototyping the narrative in the form of maps proved that premise true. On paper, I could erase, reconsider, add and rearticulate the content. Then, when writing the information in the word processor, I would go through a second process of evaluation. In summary, I went through two cognitive procedures that guaranteed a fruitful use of my time. I might add that having a blueprint also reduced the anxiety of facing myself to a blank page in the computer. At least I had something, one map per chapter (if not more) and one map of the whole.

3.9 VISUAL METHODS ON NEW MEDIA

3.9.1 ONLINE RECORDING: THE VISUAL DIMENSION OF LIVING ONLINE

![Figure 3.28 The Students’ Lives Posted on Facebook](image)

Before getting to the field, I had considered new media, like the one showcased in Figure 3.28, but I never thought the level of penetration would be at the extent of what I witnessed during my field research. The average age difference between the students and I was around ten years. They grew up with the Internet and cell phones; I didn’t. As I arrived to the field I was overwhelmed by the way the students had incorporated things like cloud computing and social networks in their lives. The dimension of “living online” added another layer of information to collect. It also made it possible to understand what did the students want to portray to others.

Without even expecting it, some of the teams were sharing their online folders in Google Docs, Cloudshare or Dropbox with me (they even asked me for permission). All of these are forms of online storage and sharing open source (except for Cloudshare) platforms. Apart from providing storage space, Google Docs was used by the students to work online (as a team) on documents like texts, presentations or spread sheets. The interesting thing is that they are allowed to chat while they are working so remote collaboration is possible. I had access to some of these chats and documents.
Another form of reporting online were social networks. Platforms like Facebook, the Wiki from the course or even the personal blogs of the team members were another tier of material to collect. I didn’t access the participant’s Facebook account (I didn’t accept the friend requests) until I left the field. Once I left, I realized that they posted pictures and perceptions of their teamwork online and shared it with their own communities. We have to remember that some of the students are living far from their homes, which are either across the country or in other countries. As an international student myself I understood their need to communicate with their known ones. Nonetheless, I believe that age plays a role in what they are “used to” publish about their public life online. On the other hand, they are building an online identity, so that is also a critical factor in the selection of the information they post in the social networks. I used the pictures, videos and documents collected online just as another source of information to make sense of the culture I was depicting.

3.9.2 I-RECORDING: SELF REPORTING THROUGH TECH GADGETS

Students not only used the cloud computing or social online networks. There were a bunch of technological gadgets, visible in Figure 3.29; that made their way into the students’ daily lives. It is relevant to consider that this is a specific private school where access to these instruments might be more likely than in other educational establishments or situations. The context also plays a big role, with these students being used to working with these gadgets on a day-to-day basis. The fact that Silicon Valley is just next-door, as I addressed in Chapter 1, might impact the way the students see themselves and certainly their aspirations. The culture of this school of design, and when I say design I am referring indistinctively to design and engineering, embraces a reflective creative process. Students are encouraged to record and think about the way they tackle design problems.
I never thought there would be so many technological gadgets present in the classroom. Perhaps because the iPad and other smart tablets were released just a couple of years ago, the app world has been releasing instruments that can be used by students to fulfill the needs of their digital lives. For example, one group of the individuals felt more comfortable working on their tablets with a touch and digital interface than with a paper notebook. For me, it is hard to consider the iPad as a replacement for the analog pad. “In this way it is easier to post the information later on the blog” one student indicated. And it made sense as the data was produced, digitized and uploaded on a couple of clicks. With a tablet stylus and a particular app (NoteShelf), they would scribble down, jot and make sketches that would be directly posted on their blogs or wiki sites. The following image is an example of a student’s upload on her public blog.

![Figure 3.30 Screenshots of a Student’s Blog](image)

Another form of self-reported data from the students was a series of pictures and videos about their processes that, as Figure 3.30 shows, were shared online. All these forms of self-reported data taken with technological artifacts and new media were collected and added to the rest of the data analyzed as another dimension of observation. Some individuals would call this part of a netnography. In my case, I feel it was just a small part of my ethnographic data collection process. This data was collected in the form of screenshots in order to keep the fidelity of the organization that students used to present this information online.

### 3.10 CONCLUSION

This ethnographic fieldwork comes extensively from the intersection between design and anthropology. That intersection seems to be visual. As widespread as the potential of the visual are in diverse disciplines, however, visual theories and literature are in a state of flux. Generally speaking, there
are non-shared commitments to the study of the visual literacy, and this is majorly due to the constant and rapid changes in technology.

This dissertation provided the grounding to envision, examine and apply and diverse visual strategies while mixing the views of anthropology and design. Considering cognitive psychology and the field of computer sciences was also a must in crafting and applying the methods. The results in improving or at least tackling the phases of data collection, analysis and representation proved successful to me. I was able to collect enormous amounts of diverse data, to manage and synthesize it in meaningful ways, and to tease it out for representation of a cultural reality.


4.1 IMMERSION

“Ethnography is specific. It is local and particular – particular people in places at a particular time. It is grounded in instances of specific observed behavior. It is about somebody, not about everybody” (Wolcott 2010:92).

4.1.1 THE ME-COURSE, A WELL DEFINED COMMUNITY

The study of the other is certainly relative to the boundaries you define in a social map. And in this case the boundaries were clear to me. Studying this community is related to what has been described as the research on local knowledge (Geertz 1983), the study of academic tribes (Becher 1994) or epistemic cultures (Knorr-Cetina 1999). In this case, it can also be related to the complexity in the study of organizational culture. As in organizations, in this study, there is not just one thought world coming into play. There are several of them entailing the valley, the university, the school and the individuals grouped under this community. These are relevant variables when talking about product design or innovation.
As Dougherty (1992) points out, Fleck (1979) once indicated that the organizational context could be the one that impedes the development of novel knowledge, the ability to collaborate or even obstructs innovators from imagining new social forms. The community I observed is embedded in an ecosystem (Figure 4.1) where individual behaviors, social, cultural and environmental factors come into play. This is why routines, modes of thought, communication strategies, information exchange and physical space are relevant to understand at different levels. They are things that potentially afford, inhibit or modify the way negotiations take place among team-members in this class. These are certainly things that can help us understand how to deal with task-oriented teams in the future.

The class of thirty-two students I worked with seemed to engage in the design process in a particular way with a common goal and shared beliefs on process and communal values. They used a specific way to talk about things and they work with a relatively similar body of knowledge prompted by the lectures and material instructed by their professors. Their identity is not only supported by these factors, but on the identity that they market to the outside world through their public relations (PR). They are certainly a distinctive group of individuals. For me, they entail a community as they are identifiable and like no other. Nonetheless, the fact that this is a community doesn’t contradict the fact that, in relation to their disciplinary beliefs, is a micro segmented one.

4.1.2 THE FIRST ENCOUNTER

The first day, I arrived to the class when the academic quarter started. It was around noon on a sunny day in September. After a few explanations of the teaching team on what was going to happen throughout the year, I was introduced to this community as a researcher from THE CENTER. This implied that I was just from across the street, in that building they recognized. A brief explanation of the symbiosis between THE CENTER and the course followed. There was a tradition at THE CENTER focusing research on the design process and innovation in engineering education. Usually, published or not, these results usually impacted the ME-COURSE’s curricula.

This course, as some instructors of the Design College indicated, was made deliberately to prototype education. For them, I would just witness the course for their own benefit. This should make my entry and access to the students easier. I belonged to something they knew about, and that they considered their own. The labels that followed were designer, anthropologist and Fulbright PhD scholar. For them, that was the summary to who I was. And even though Dr. Penn (the pseudonym with which I will refer to the head instructor in this course) seemed enthusiastic about this fact in front of the students, he seemed to behave at the beginning, towards me with some mild skepticism.

All the individuals were congregated together in one classroom. All eyes fixated on me for a second, but that was all. It seemed that none of the students really cared about me. Not even the two
professors or the three teaching assistants (TAs) seemed to be worried about my presence. I was “just another” witness to their class, as one of them indicated, nothing more than an uncritical recorder instead of the serious design-anthropologist I was introducing myself as. This kind of helped at the beginning to gain access to revealing information. Of course in that moment they didn’t fully realize that I wasn’t an educational tourist like so many they had seen come and go throughout the course. I was here to stay and to make the most “dedicated record” of the teams, as one of the instructors later told me. This would be key in earning their trust and respect.

4.1.3 THE OUTSIDER/INSIDER

“Hi, my name is Constanza, I don’t know if I have personally introduced myself to you guys”.

“Well”, says one of the students “We’ve seen you around”, “you’re the one studying us”.

“Well, I am observing in a similar way as you will do with your users. I will be observing you guys and taking records so any time you want pictures or videos of yourselves just let me know”.

“Oh Cool!” they enthusiastically indicated. I believe one barrier is down. – (Excerpt from the fieldnotes).

Given that the course is comprised of engineers and designers, and given my educational and work background, some anthropologists may indicate that I am basically a native studying my own culture. However, the truth is I don’t really know if I could say I can be part of this delimited culture, subculture or community. I don’t know if I belonged to this microculture (Wolcott 2010) that lives in their studio classroom, THE FLAT. I was certainly an outsider with a disciplinary grasp on what was going on in the social structures pertaining this community.

Arriving to this setting I was obviously not culture-free. My character and personal reactions derived from my previous experiences played a role in the way that I immersed myself in this culture. Having taught in Engineering and Design Schools, and having worked in both areas professionally were key to understanding the jargon and priorities at my arrival, and to negotiate my entrance and stay with the gatekeepers. The directors of the center, I belonged to as a visiting scholar, even indicated that this long-term course was a “perfect fit” for my research.

On the one hand, I unconsciously did comparisons with my own firsthand experience, but I consciously kept myself from being judgmental. On the other hand, I did identify with the design students and that enabled me to quickly empathize with the pupils. I knew from my past experiences what some of their academic and professional concerns and frustrations they could face. That helped me to considered time and stress whenever I approached them. My learning curve to behaving in the native’s standards was rather a small one. In a very short time, I became invisible.
4.2 A SAMPLE OF THE SILICON VALLEY CULTURE IN AN EDUCATIONAL SETTING

4.2.1 THE ME-COURSE: AN ICON AMONG THE ENGINEERING SCHOOL

“Please let me get into this class!” – Gayle, ME-COURSE student

Even though I would introduce myself to the students later individually, witnessing the first day of class felt awkward. I was worried when I realized that building a relationship with these individuals could be harder than I thought. At first glance, they felt cold. Soon I would learn that the students were nervous because, in that moment, they were part of the application process to get one of the few vacancies the course offered, which were scarce considering the amount of individuals that aspired to take it. “Way too many people showed up on the first day,” Gayle said. The stakes were high. “The reason I came here was to take the ME-COURSE, I knew about it through friends that had come here before,” Tommy passionately indicated; and it is because this course truly raises passions. No wonder why. With an extensive budget, great PR, successful alumni, a “quirky” vibe, and an alternative way (today maybe more mainstream than before) to embrace engineering and design, this course accomplishes the standards of students wanting to integrate the job market in the Silicon Valley area.

4.2.2 THE FLAT: THE PHYSICAL CONTEXT WHERE PEOPLE COME TOGETHER

“I’m kind of interested in like a startup. That’s one of the reasons why I came here. Also like the whole fact that is in Silicon Valley, the whole startup, entrepreneurial mentality kind of thing is really cool. And I definitely wanted to get more into that” – David, ME-COURSE graduate student.

Shock! There is a hammock. This is the first thing I realize on my first day when crossing the aisle from the traditional looking classroom towards the open studio space known as “THE FLAT”. Just think about it, far from the sea and far from a palm tree, there is a hammock standing in the middle of this room dedicated to academic training. The truth is that the hammock, as a cultural object holds meaning. It embodies the mentality of the course.

To understand this artifact, it’s necessary to peek into the larger culture. Considering the hammock in the context of Silicon Valley it actually makes sense. Just think about the so-called Web 2.0 culture, the Googleplex (Google’s headquarters in Mountain View, CA portrayed in Figure 4.2), Facebook Offices and the spaces where other creative startups or companies live. During my time in the area, and due to incredible contacts such as my roommate, who was “the lawyer” at the Survey Monkey (SM) startup, I got to visit the overgrown Google, the newly born (at the time) LinkedIn and obviously Survey Monkey in Palo Alto. Just as a quirky fact, the CEO of SM is married to the CEO of Facebook, so no wonder why the places look physically similar. Mindsets relate to each other and they are expressed physically in
the spaces they use. What I witnessed in THE FLAT was absolutely what you get when searching images of these places online.

Open spaces, undefined dress code, fridge full of free healthy snacks, recreation areas and yes, in some of them, hammocks as the ones shown in Figure 4.3. The idea of spaces forged for creativity is not new, but Silicon Valley has taken it seriously. As we know already, the culture of this university is greatly impacted by The Valley, and vice versa. The Design College and the ME-COURSE may be the most palpable evidence of this assertion. This symbiosis between the course and the SV culture is one of the reasons why graduate students come all the way from places like North Carolina, Boston, Texas, Pennsylvania or even Singapore.
Add to the hammock, the presence of sofas, couches, a foosball table, a Nintendo 64 console; a few rolling whiteboards (which they call Z boards), multiple TV screens, rolling seats (yes, everything here rolls), a fridge, coffeemaker and a small tool workshop for building physical prototypes. Some of the students add details of their own like an aquarium; others bring their desk lamps or pictures. They are encouraged by the instructors to personalize their working space for the time the course takes place. This is their home.

In the design education jargon, this space and system are as *in-residence* studios (Figure 4.4). This means that this is a defined space that students use exclusively for this course. Here, instructors assess the students by going towards the students’ space, not the other way around. This is opposed to the traditional educational model where a classroom space is used for several courses and where instruction or assessment is imparted in those multipurpose teaching area. In the conventional model, the students generally end up checking in class when they have to submit a class assignment. There is no sense of belonging, sense of owning a space or constant interaction from the students afforded by the spatial conditions.
It is relevant to mention that this untraditional spatial arrangement may only make sense in project-based learning, or studios where the class fulfills a common long-term overall goal. It is financially challenging that every course in the curricula acquires this typology of space for its exclusive use. In the in-residence ME FLAT at PRADBORD, the only ones who have card-access to the classroom are: students, teaching team (TT), and some authorized individuals including me because of the nature of my research. With their card, the students are allowed to leave and come back at any time they want to.

This is not the first time I see this spatial arrangement come in place in a contemporary educational setting. At North Carolina State’s College of Design, the in-residence studios are part of the teaching strategy. This is a very different model to what I was exposed to in my five years as a design student in Santiago de Chile. Not just because of a lack of budget, but also because it has never been a strategic decision in the application of the curricula. As one of the professors from the graphic design department at NC State denoted, this strategy not only makes the student to develop a sense of belonging and a group identity, but they also build other interesting educational relationships between one another. “We teach far less software because they are all here and they teach each other”. The advantages of in-residence studios for me seem to be substantial.

Nonetheless, the difference in budgets between a state university and a private high-end higher education school are evident. The artifacts (furniture, digital equipment, tools, etc.) this FLAT holds is substantially more expensive than a common in-residence classroom elsewhere. At NC State, students from graphic design usually have to bring in their own material, yet they do have access to common printers and to a tool shop (equipped with laser cutters and other prototyping instruments) shared with industrial designers. The ME-COURSE students at PRADBORD also have access to a machine shop, yet this
just adds to the tools they can access in their own classroom. Additionally, the spatial comfort provided by this extensive budget allows students to spend as much time as they want in this secluded space. This is an important factor for the students, who indicated that the face-to-face time is invaluable when doing a team project related to product design.

The TT defines working spaces for each team. These are provided with a desk or table, extremely comfortable ergonomic rolling chairs for each student, an LCD monitor with a CPU (fixed computer) to hook the laptops and a shelf with a built-in whiteboard. All the rest of the artifacts, including whiteboard markers, post-its and computing chips; are for common use. Still, regardless of the budget difference, both groups of students at NC State and at PRADBORD were passionate when talking about the opportunity to work in this spatial modality.

4.2.3 DESIGN SCHOOL AND ENGINEERING SCHOOL: TWO DIFFERENT DESIGN DEPARTMENTS

“How can you be creative and have engineering at the same time?” – Jacob, ME-COURSE student

As indicated in the introduction, THE FLAT shares the building with the Design College (DC). Nonetheless, it belongs to the School of Engineering, specifically to the Department of Mechanical Engineering (ME). Still, the open space of THE FLAT (one of two for graduate students) could be confused with being part of PRADBORD's DC. Being together in the same location and sharing a physical architectural identity makes any foreigner to relate them. THE FLAT and DC’s construction and interior design are based on the spatial principle that creative spaces are mobile, reinterpretable and afford collaboration. They are rooms that accommodate the situational interaction among students based on combining different experiences through the tools of design thinking (Figure 4.5).
The schools may be close to one another, share aesthetic characteristics and cooperate in some aspects. From what I witnessed, differences have been growing among the individuals of both departments. First of all, it is important to restate that the DC doesn’t provide academic degrees. Furthermore, the product design program and the mechanical engineering program, both from the ME department, began prior to the DC, and even some of their founders and leaders of the DC are graduates from the ME product design program.

“Twice as many U grad students want to take classes as are seats available. The lucky 500 students in the program augment their Master's degree studies in business, law, medicine, engineering and the arts by solving problems collaboratively and creatively, and immersing themselves in the methodology Kelley’s made famous... But there are no degrees - something Steve Jobs talked him out of” – Charlie Rose, 60 Minutes CBS News, Jan 6th 2013.

The DC has made itself famous worldwide. Recognized for its dedication and own way of viewing design thinking as a tool for innovating in real-life issues. A lot has to do with PR (various appearances of its founder in mainstream television and news shows and other types of media) and its ties with one particular design firm in Silicon Valley. Part of its recognition has to do with the great experience that the students from the School of Design go through and promote later to others. They just seem to love it and are fond of it. For a businessperson, a doctor, lawyer or social scientists, the courses they go through in the DC might be where they’ll have the most fun (in a classroom anyway) during their undergraduate years. Also, the alumni tell stories of success between those that have been trained there. The educational vision that the founders had has been certainly an innovation in multidisciplinary education. But has it been to design?
4.3 NOT EVERYTHING THAT SHINES IS GOLD: CRITIQUES TO THE WAY DESIGN IS TAUGHT

4.3.1 TRAPPED IN A “POST IT” CULTURE

It seems that designers worldwide could appreciate the efforts undertaken by the DC to place design on the map for other disciplines. They have been successful at that. Nonetheless, the lack of actualization of some courses, vision and rigor (from some instructors) have brought lately some critiques among students, instructors and the larger fragmented design community. As some designers have angrily alleged “Design is not post-its”. The use of post-its became the most visible of the methodologies the DC design program promoted. It has gone viral through the social networks, magazines, PR and media. These have become dangerously iconic for the Valley and the firms that claim to engage in innovative practices.

The truth is that this is just one of the many techniques they promote and it doesn’t summarize the whole process. It is used to put down ideas (write them in the post-its), and cluster (group and move around the post-its) them to usually craft an idea with that information. This technique doesn’t have any substance if you don’t do anything after applying it. “I go out and I put every thought and idea I had on the interview in post-its and I move them around, a lot. And that’s become an end in itself!” indicates Mitch, (the pseudonym of) an alumni who has been a design instructor here for a while. “I’ve seen them using it as this kind of activity where I can get really good at. I can seduce and it’s very impressive. Then I color code and cluster and put fancy names on things, but they never make anything after!” he adds. Some students see this as “something that will make their resume look better, and to be more competitive in the market.” This has certainly become a problem, and as Mitch tells me, some of the protagonists are aware of it and are trying to rethink the model, but he adds that there remains a “massive gap between analysis and synthesis.”

4.3.2 THE PERCEPTION IN LACKING RIGOR

Compared to the DC, the ME program’s PR work in a more low-key fashion. Even though it relies on it, their PR budget seems to be more targeted towards particular universities and companies. They are cited in peer review journals, they appear in specific podcasts and radio shows related to innovation and sometimes appear in some specific television programs. Their PR points towards a community that is more engaged in engineering, business and innovation. This lack of public showing off in pop culture and mainstream media may lead to confusion between the departmental differences of these design programs. External individuals may not realize the boundaries and usually confuse them. Obviously, both relate to design, but as I learned, they shouldn’t be muddled up.
Due to academic training, a portion of the engineers have a professional *superhero perception* of themselves. As others have indicated, *non-applied scientists* such as physicists could be the only ones able to question their supremacy. In this case, there is a stereotype of engineering versus other sciences that Petroski (1997) brings up when analyzing a famous altered picture where the Steinmetz and Einstein have been placed together. The picture shows a diminished, small electrical engineer versus a ‘tall, formal and self assured’ (ibid 1997:8) theoretical physicist, implying the rivalry that could exist. In this quasi-hierarchical world, do these mechanical engineers question designers in the same way they are questioned by theoretical scientists?

When I came to the ME department I was vocally labeled as the *designer-designer*. This meant that I was not an engineer-designer (forget about indicating my anthropologist side). Soon I would discover that it was not a good label to have. There was a perception that “next door designers” were messy on the application of methods and that they used their *(doubtfully reliable)* “designerly” *ways of knowing* (as some engineering instructor mentioned in a mocking tone). For the engineers of the CENTER, the courses weren’t academically rigorous. Of course, being a PhD in Design-Anthropology with an extensive academic formation I didn’t relate to this, but I understood where these tensions were coming from.

Specifically, the general belief from the Engineers is that DC trains their students without academic rigor, as it doesn’t intend to give an academic degree that has to fulfill measurable standards. They also didn’t usually publish in recognizable peer review journals. Remember, this school wasn’t conceived under these purposes. Nonetheless these factors brought tensions when some students started to choose courses due to their popularity but not because they were integral to the profession. The truth is that engineering and design sometimes can be considered synonymous (Petroski 1992) so this might be more like a sibling’s healthy rivalry going on in programs that are much alike but also different.

### 4.3.3 THE ARROGANCE EMBEDDED IN ACADEMIC TRAINING

Even though some engineers can be, in their minds, super powerful, all the design programs here are challenged by arrogance. Some of the students that take a couple of design courses at PRADBORD claim to be *designers*. They tend to believe they have the authority to talk and teach on design matters. In fact, it is not rare to find some of them adding the *design thinker label* to their LinkedIn profile after taking an introductory design course; but do a couple of three or four-month course allows you to label yourself as a designer? Maybe a course is just what you need if you are naturally good at it. Who knows? It’s hard to make a generalization on who deserves it and who doesn’t, but the truth of the matter is that you are not going to become a design guru by taking one or two funky design courses. Yet, it is a good label for your curriculum if you want to work in the business arena.
In the business area or not, this is one of the things that irritate some engineers and professional designers. The fact that there is lack of rigor in studying, labeling and practicing design in some parts of this environment is alarming, but is not solely the students' fault. Here is where the culture of the university also plays a role, as one professor told me: “the problem at PRADBORD is that we have difficulty with arrogance. We’ve created arrogant people who believe they can change the world. Which is not bad; I want to have people that think they can change the world, but the arrogant part is that they wanted to quit with the ability to do it. Or even have all the tools necessary to do it. Then they proselytize as where the arrogance allows them to go.” It is fair to mention that the proselytism and arrogance are also present in the larger engineering disciplinary culture. Nonetheless, it becomes relevant to acknowledge that these are perceptions coming within and outside this closed university community. Is this amount of arrogance getting out of control?

4.4 THE COURSE DYNAMICS: INSTRUCTION

4.4.1 THE NATURE OF THEIR PROJECT-BASED LEARNING: A LONG-TERM COMMITMENT

“We do projects that are sponsored by companies, but the companies don’t tell you what to design. The important thing here is to figure out things by yourself” – Dr. Penn during the first large group meeting.

When Dr. Penn introduces “this unusual” engineering course to the students he proudly indicates that it has been around since the 70's. This is maybe why its planning and execution can seem quite sophisticated for a traditional engineering education background. Nevertheless, there has been a lot of fine-tuning and research back and forth in the implemented strategies, and as some alumni indicated, it’s far from perfect, but it is as good as it gets in engineering education. This course prepares you to practice in the outside world. It is frequent that alumni of this course are involved during the three-academic quarter process. They stay close to the course either as assigned team mentors, expositors of their own experiences, and as success stories of what they did after with the skills they learned in the course or even as recruiters of students taking the course.

Being a three-quarter course implies not only a longer time to inculcate skills and a way of thought to the students. It also translates into a higher commitment from students to the projects they embrace as a team during this course. This is one of the longest courses and experiences that the students will have during their two or three year-graduate formation. Usually, at PRADBORD, design courses in engineering last one quarter and usually involve a collection of short projects. “I had never done something longer that three weeks”, says Emily who has been at U since her undergraduate and is taking a fifth year to fulfill an ME Master. Each quarter is about ten weeks. As students indicated, they usually "speeded" through the design process to solve three projects superficially. As they put it, this limited their
possibilities to deepen into purposeful team dynamics. “There was nothing in my portfolio I was really proud of,” said Danya another fifth year student. That's what encouraged her to take this specific course.

This long-term ME class offers pupils the opportunity to dive profoundly in the design process and resolve a real-life open-ended tasks provided by an actual corporation. Usually these companies are well known. The task assigned is usually related with another country (i.e. Germany, France or China) and in partnership with a team from a foreign engineering university there. “We hand-picked some that have a similar course philosophy and similar timing of the course,” Dr. Penn indicates. In this course, nothing is really left to chance. Figure 4.6 shows partnering teams working together.

![Figure 4.6 Working with Partnering Teams](image)

Students don't take chances either. When thinking about their future job market, this class provides an opportunity to add something substantial to their portfolio. They can become an interesting candidate when competing with others for a particular position. For a group of them, this is their first encounter with a business partner. They will learn and build future professional networks from it. This business relationship is embodied in the *corporate liaison*. This individual becomes one of their biggest stakeholders throughout the average thirty weeks (plus breaks) the project lasts. The corporations are required to pay a defined amount of money to participate in the course. As the instructors indicate to the students “the projects cost enough to the companies that they do care about the results.”

The money invested by the corporations is converted into a budget for the students to purchase material needed for prototyping (like hard disks, chips, hardware, etc.) and to the team's travelling expenses. The students designate someone in their team to be in charge of their financial plan, but they also receive help from an administrator hired for the course. Part of the budget is also used for financing weekly class gatherings. These, as portrayed in Figure 4.7, are usually organized around a topic like for example a *Pecha Kucha* (a short 20 second slide presentation) of students introducing themselves to the
rest of the class and around delicious food. Considering that most students live on campus, incentives are well matched. The attendance to these events is usually a 100%.

Figure 4.7 Weekly Gatherings in THE FLAT

4.4.2 THE SOCIAL STRUCTURE: TASK-ORIENTED TEAMS

To resolve the prompts given by the corporations, the students group in teams through a careful orchestration by the TT. The teaching team is composed of two senior professors (both doctorates and from an engineering formation) and three teaching assistants (TA). The latter have been carefully selected from students that went through the course the year before. This is critical, as the TAs are the ones that answer practical questions and who guide the teams with examples of their own experience portrayed in established lectures and informal conversations.
The thirty-two students configure themselves in nine teams after the first month in the course in a carefully defined process. This requires going through several hands-on activities that allow the students to get to know each other. Figures 4.8 and 4.9 portray a couple of these warm up activities for team building. Three or four students with diverse undergraduate preparation compose the teams. From those nine teams, eight wanted to work with me. I had to make them go through a process to finally select five, which was the maximum I could handle for working in a detailed way.

Unlike other engineering programs or courses, this teaching team knows these activities are relevant in breaking the ice during the first weeks and are crucial for the achievement of innovative solutions, a fact they highlight to the students. Through lectures and small talks, they constantly remind
them that they will be working, living and spending a lot of time with their teams throughout the three quarters. During one of the lectures, students even take a test on what a PhD researcher from THE CENTER addresses as *Teamology*. His questionnaire seems to measure some characteristics related to future team performance and resolving preferences.

![Figure 4.10 ME-COURSE's Organizational Diagram](image)

Additionally, they are invited to consider the wider network that will be immersed in during this course. “This is our network”, indicates Penn to the students, showing them graphic slides featuring seven projects, professors, academic partners, students and partnering corporations. He even introduces alumni coaches, but these are not as visible as the other partners later in the process I witnessed. Figure 4.10 is a basic diagram of how I perceived the organization of individuals around a particular project. The teaching-team also incites students to think about their role in this network.

However, the self-perceived roles of these students may be different. Even though this is a course in ME, students do come from different engineering *subdisciplinary cultures* like mechanical, electrical or bioengineering. Additionally, they come from product design, other countries, other universities and other cultural values. Team dynamics can be affected by these variables. They are very different among each other. Students do take this matter seriously. After selecting their teams for the whole project I ran into one of the team at the closest supermarket to campus, “We are enjoying some team building time!” If the professor says it is important, you must as well take the advice. “Dr. Penn has seen tons of projects,” and according to the students, that validates what he says.
4.4.3 EDUCATIONAL STRATEGIES

Throughout the duration of the course, Dr. Penn portrays his experience by showing historical exemplars of how projects succeed and stumble upon errors. This might prime the students to follow a certain direction, yet they are also a way to build self-confidence in the students. If others have made it successfully through the process, they will be able to make it too. Usually the exemplars showcase deliverables that past teams have submitted. These deliverables are either advances on prototype building, on the design process, project ideas, documentation or testing of a particular solution. The course has a pre-defined amount of deliverables that each team has to submit in order to receive an evaluation from TT. Additionally, the teams have to arrange and conduct consecutive meetings with their corporate partners, users or the partnering team from the partner university. All these tasks add up into a tight schedule that fits into what are called Large Group Meetings (LGM) and Small Group Meetings (SGM).

LGMs are usually lectures that happen often at the beginning of the first quarter. The class meets as a whole usually in the classroom in front of THE FLAT. This classroom looks like a traditional university space with seating and long undivided tables facing the front of a rectangular space. In the front, there is a connection to a projector that hangs from the ceiling. There is also CPU and a white screen that falls from the roof. During these sessions, the teams are primed with pre-defined lectures, to go through the same product design process. The lectures, usually a projected slideshow, involve particular exemplars of past projects or techniques that the instructors want the students to apply during their projects.

The LGMs are predefined in a shared Google Calendar that students can access to an always-updated version throughout the Wiki Site. Most of the instances are pre-defined (course experience from
previous years), but if the instructors feel that there is anything important to show to the whole class the schedule can be updated. The students are usually connected to Wi-Fi provided all around the campus. So even if there are last minute changes, they will usually be informed before arriving to the wrong place at the wrong time. This might seem irrelevant for some, but ME students here have tight schedules that they share between school, maybe an internship or part time job in a Lab or the Valley, and some extra curricular activity that might add some benefits to their CV. As they are hard on themselves, they have also high expectations on others, overall in the program. So these scheduling and updated communication strategies help to keep a healthy environment for these demanding individuals.

On the other hand there are SGMs. These are called “Desk Crits” (desk critiques) in other design environments’ jargon. The professors approach the students to give them feedback on their projects. In this case, the instructors or teaching team plan ahead to approach particular teams under a predefined schedule. Because the course happens twice a week (Tuesday and Thursdays), some of the teams’ projects may be critiqued either on the first or second session. During this session, usually the teams present developments on a particular deliverable. So the teacher’s feedback is either procedural or prototype based. For the SGMs, other teams are also invited to participate. Sometimes, the instructors will provide guidelines (paper slips, forms or structured methods) for the invitees to fill in. These will orchestrate the feedback from the participants to the critique so that the team can have a clear idea of what was said. Usually, these are crafted based on what the teaching teams have learned along the course or on the school’s pedagogic beliefs. Other handouts include guides for applying specific methods during the class. In summary, methods and techniques are imparted through large group lectures, slideshows and tailored conversations in smaller groups.
Figure 4.12 Example of a Handout
4.5 ENGINEERING DESIGN INSTRUCTION: THE DESIGN PROCESS

4.5.1 A NEW FORM OF ENGINEERING: THE MYSTIQUE BEHIND PROCESS

“It’s unlike any class I’ve taken before. A lot of classes I had taken were more problem set based, or things where they would teach you some kind of theoretical material and you replied in like homework. So resources were really easy to find and it wasn’t very challenging to figure out how to do something. Whereas here it’s like I want to do something new and I have no idea how to do it and it’s challenging to figure out how to do it! But I enjoy it because it’s always like learning something new” – Jason, graduate student at ME-COURSE.

Even though there is tension between the ME and DC programs, they do embrace the same major principles on the design process. They are closely related with the new form of education embraced historically by the founders of the design programs in engineering. Around fifty years ago, they started a joint program with the Art program. This emerged as a response to their observation that American engineers have changed during the Cold War. They had become good problem solvers, but reluctant to understand human problems. “So the founders felt that they had to bring back engineering to solving human needs,” says one of the directors. This is a distinct and iconic approach to engineering as it recognizes what liberal arts can bring, and that is a major shared pillar to their curricula. Students from the ME program recognize it, overall those who are just arriving and have a previous experience with other programs as a comparison point.

Every student that comes in the program is selected for a reason. Everything here starts with a thoughtful recruitment that is aligned with their educational beliefs. Since it began, this program searched for people with a twist in their personality. They are interested in students that are more likely to cross boundaries and ask different questions, “people that resist the boundaries the world puts on them.” And the inclination to have open-minded individuals doesn’t stop here. Being a combined program between art and engineering, it received applications of students with undergraduate studies in diverse areas. This diversity enhanced the predisposition towards trading off certain disciplinary boundaries. Working with diversity can be fruitful but is not always easy, and they know it. This is why their specific educational system relies in choreographing their interaction through four concrete beliefs that are the pillars of the curricula imparted in both programs. These are Process Mindedness, Human Centeredness, Bias to Action and Rapid Prototyping.

4.5.2 PROCESS MINDEDNESS: A LEAP OF FAITH

“I would say that the biggest component is that there is a belief that there is a process. So there is a process that can be articulated at a simple level and there are many variations possible for that process but if you follow that process it will do a few good things for you. And you will come up with at least a minimum level of creative solutions to a problem that you have had been defining” – Director of the DC.
Having a common process is key in joining the disciplines or sub-disciplines together. When we think about process, we usually have in mind an assembly line in an industrial background. Some education systems, like the average American K-12 education, have tried to emulate by teaching in an assembly line instruction (Rogoff 2011) fashion. Unlike manufacturing industries, the design process is not a set of linear stages and it is far from an assembly-line instruction. The design process (Figure 4.13) embraced here (and in other design programs also) is more like interconnected. It is not linear, though I had to make it sequential in order to make a representation for this dissertation. They iterate in cycles and swap between two major stages: diverging and converging.

![Figure 4.13 Adaptation of the Design Process Undertaken in the ME-COURSE](image)

These diverging and converging stages are useful when you face the problem typology that this program embraces. These engineers are not interested in solving technical and closed problems, at least not in their graduate programs. During their undergraduate studies they are taught the technical skills that an engineer needs to perform: thermodynamics, fluids, programming, etc. Yet, during the fulfillment masters, they seem to be more about what students call "higher level thinking". This starts with embracing an ambiguous real life inquiry. Compared to other programs in mechanical engineering, the boundaries of the problems that the students face are not defined and there is not one correct answer or way to get there. These are issues where you have to “figure out your way” with a specific toolset imparted by diverse forms of instruction.

The nature of the problem seeks to instill skills like leadership and entrepreneurship in order to make the students comfortable with ambiguity. The process works when problems are large and open-ended. The students refer to the nature of the problem as a “larger design space,” where they have enough intangible room to try out their ideas. The reason is simple. If the problem is closed and with rigid boundaries, the space for letting chance to play a role is limited. This process is based on the belief that
there needs to be enough room for experimentation. Having limited control over the factors and variable becomes a good thing as it might force the engineer to be more open and see things in different ways.

Even though it sounds very much like the traditional project-based teaching in design, it takes this form of instruction to another level. It differs from other design programs that are based on art and craftsmanship. In those, there is usually a master-apprentice model involving imitation and intuition (Poggenpohl 2009). In these more traditional atelier models there is a lot of tacit knowledge that needs to be absorbed and that can’t, usually, be questioned. Moreover, there is a lot of room for subjectivity in the instruction and evaluation. In contrast, these programs in engineering design promote a more individual oriented structure where the student takes authorship and consciousness about his/her own process. It is not about what the instructor wants or has in mind. Rather, it is based on information collected by the student with a set of techniques that are pre-defined and imparted in a more structured way (yet not always lecture-based). With that information, the student is able to define or redefine the boundaries and manage the variables to settle the issue or problem area. The instruction embraces one of the skills that authors from diverse areas applaud from designers, synthesis.

To draw the map on the issue students in a team go through stage-managed phases. They do through them in unison. They create, analyze and synthesize as a team of dancers following the same choreography. This planned or semi-planned interaction affords the students to work under the same cognitive modality. They are in the same thinking mode. On the contrary, if one student is creating while the other is synthesizing it’s most likely that they would have a hard time communicating. Their priorities and focus are different at that point. A staged process allows the group to diverge and converge at the same time, maximizing their team efforts in achieving a solution to a given problem. The process matches the purpose and intentions of the individuals in the team. “Sometimes you need a scalpel that cuts open, sometimes you need a flashlight that sheds the light”, says the director. These are different tools used at different times under the same team purposefulness.

Under this belief, the team constructs a common ground to enhance the conditions for creation and understanding. It could be said they share an ephemeral epistemology that lasts as much as the project. This helps the team avoid quarreling over the individual priorities in their own thought worlds, but to instead create a third thought world that becomes natural to all of them. As Rishabh, a graduate student said when encouraging his fellow skeptical partnering group, “Have faith in it. It’s a well-proven method.” Even though he is a newcomer to PRADBORD’s culture he trusts the process' long-term proof of success.

The downside of the process being successful is that it has become mainstream at least in the Valley. Can it be considered innovative? For the moment it seems static and more as a mantra that you can become blindly trapped in. When there is too much belief in the process, there can be rigidity, and as
psychologists German and Barrett (2005) well show in their research, you can become biased for response. You become fixed. So even though the process that was once conceived to afford creativity, it could potentially become a strainer to it.

4.5.3 EMPATHY: HUMAN CENTEREDNESS

There are other components in this process that make it distinctive from other design ways. This particular take on design incorporates the human as the major component. This can be related with the development of personal computing, the mouse and GUIs (Graphic User Interfaces) in the Valley area, especially at Xerox PARC (Palo Alto Research Center) and SRI (Stanford Research Institute). Suddenly, in a small amount of time, software became more important than hardware. The development of more empathetic solutions that didn't make users frustrated when using computers became relevant. Human-computer interactions were different than the evaluative approach that human factors had. Human factors just measured the results when the design was already finished. There was a need for another type of approach and people like Stu Card, in PARC, knew this. This is one of the key periods when designers and developers, overall in the Silicon Valley area, started timidly incorporating applied social science's methods for understanding what were the needs and goals of individuals when using their products. Their idea was to contribute in the first section of the design process, and not at the end when all the decisions were already defined. It has been said that those are the roots of interaction and empathetic design can be traced to this period (Moggridge 2007).

Interaction and empathy at PRADBORD is instructed under the name of Needfinding, which is a technique that is rooted in the social sciences (or that strips off methods from the social sciences, as some would counter). The rationale behind this technique that is also practiced in consultancies and companies around the United States is to find the needs that users have in order to design a novel or better product or service. However, do people really need things? This scope has certainly caused controversy. Instructors have been forced to change the Needfinding label of course into a “Design What”.

Whatever the name of the empathy drive course ends up being, the fact is that it is part of the undergraduate curricula, but in the Masters program it is an elective. In the ME-COURSE the students get basic training on Needfinding, but an important number of MEs and Product Design graduate students take it as a one-quarter elective. The skills taught have become a major asset for alumnae entering the job market. A handful of the students I worked with had already been offered a position, implying they had to instruct others in the company on these techniques. Even some of the instructors that have big consultancies in the area hire these graduates as interns or for a permanent position to serve the companies in Silicon Valley. No wonder why. With the Internet, fidelity of the consumer is constantly changing and companies started looking not only for differentiation, but for innovative strategies to win
the user’s heart. Even though I mentioned the criticism to the lack of evolution in the human-centered approach, there is also recognition on design couching decisions in human needs, perceptions and goals of individuals.

Still, working with human-based knowledge, is not an easy step for a discipline like engineering. It disrupts the traditionally positivist engineering idea of knowledge being perfect. As instructors indicate, some of the ME students have their doubts about working with imperfect knowledge such as a human derived one. It is hard for them to shift their attention from total control (of material fatigue, dimensions and structure) to human empathy. “So that sense of giving up your ego, to kind of see what is happening around you and suddenly you see the problem and the answer!” Yet, through the curriculum and a full immersion in a community that shares a strong belief in the human aspect of design, they finally tend to accept it. So even though the individuals in the program belong to a larger identity of engineering where the language of engineering is spoken, they have successfully developed an independent design culture around engineers that understand that they can’t control all human aspects.

4.5.4 BIAS TO ACTION: MAKING AS AN ACT OF INQUIRY

“But what it created is that because this program started with this handful of students. Two years between 15-18 students together in a very intense hands on space with a very strong culture that was transmitted from year to year it was essentially like joining a commune. You had a strong culture, you had a strong way of thinking and it was very, very different from the way design was taught at TU Delft, Royal College of Arts, RISD, CCA, Art Center. Very very different culture” - B an alumni and instructor.

Apart from interaction and process, these programs in engineering design rely upon a self-defined culture of making. Even though making might seem obvious for mechanical engineers, there has been a separation between instruction and construction during academia and training in academia. Students coming from ME undergraduate programs like Duke and BU, in the East Coast, and UCLA and USC in the West, felt this was the case. The mechanical engineering program at PRADBORD has always been vocally based on a hands-on culture. An approach that is more about constructing all the time rather than building things sporadically. This culture is enacted through the spaces where individuals interact and engage in the practice of design in engineering. These spaces, like THE FLAT described before, provide the tools for the students to be constantly crafting and learning by doing. They draw, construct and build prototypes to make their ideas tangible. It is not just using prototypes as a form of storytelling about future options. Here, the process of making becomes a larger form of inquiry in itself.

With passion, students describe how their ideas from the visual mind come to life in these common spaces. This is one of the most exciting things for newcomers. Maybe because it’s one of the major differences they see with other engineering programs. After some weeks, they realize that this is not about prototyping for creating a perfect artifact, but using the prototype as a synthesis of the ideas on
their mind and as a learning prompt. This teaching design philosophy is not about manufacturing beautiful objects, but to articulate solutions by exploring the problem space by visualizing and testing options. These are not beautiful prototypes, but they embrace a rather intended unbeautiful design.

Figure 4.14 Intensive Prototyping

4.5.5 CONCLUSION

The popular ME-COURSE at PRADBORD is a recognizable community, which I accessed thanks to my formal relation as a visiting researcher in the school of engineering. Being diversely experienced in the areas of design and engineering, I was able to immerse myself in the culture in a smooth way. From a total of nine teams, thirty-two students total, I worked closely with five teams. These teams worked in a defined physical space that embodies the relationship with Silicon Valley and their thirst for innovation.

The space is the ultimate representation of the innovative identity that the iconic ME course portrays to the exterior through PR and academic publication to tailored communities. This course is often confused as part of Design College program whose PR is loud and works largely in mainstream media. ME and DC are two different academic initiatives related to design. The ME course and graduate programs are dependent of the School of Mechanical Engineering. The design program is part of the Design College and it provides no academic degrees. Their purposes are different, and both schools have been popularly recognized as executing their own missions greatly.

Contrasting the good press and recognition in the mainstream of the Design College, there are major critiques to the execution of their program. These relate to the lack of rigor in instruction, the arrogance embedded in the academic training and their overuse of some techniques such as post-its. These are some of the reasons why mechanical engineering instructors and researchers may feel that the comparison of both programs is inaccurate.
The ME-COURSE embraces their distinctively instructional dynamics. This is one of the only courses that sets a long-term commitment of three academic quarters to a project. Usually, courses last only one quarter. The individuals are organized in orchestrated task oriented teams that have a major budget and responsibilities towards a corporate and an academic partner. Moreover, the course seeks to build on the educational research derived from investigators in partnering centers.

Even though the programs differ greatly in their major goals, they also share a common design process. The product design program forefathers largely envisioned a process with the purpose of bringing creativity into engineering, but the process has larger pillars to stand upon in order to build a distinctive culture of engineering, more adept at confronting the complexity of real life problems. These are process mindedness, empathy and bias to action. These procedural definitions can only take place in solving ambiguous problems where students need to find their own way and have enough room to experiment.

5. THE PICTURE IN MOTION: MAKING SENSE OF TEAM INTERACTION

5.1 TEAM NEGOTIATION IN EDUCATION

This dissertation aimed to study the way teams, in engineering design, interact with one another in an educational environment. That interaction is not always smooth when the time comes to decide on a particular course of action. Hence, the team must find a way to bridge the gap separating their respective thought worlds. Based on experience and my literary assessment I always presumed these bridges were visual. The following chapter seeks to tease out some of the patterns that I kept seeing again and again among the engineering design task-oriented teams I worked with, relating to the use of visual boundary objects and to the importance of trading zones in the negotiating process.

In order to tell this story, I first need to highlight some important details that became apparent while studying this particular community of practice in design. The ME-COURSE, at first glance, was a community of engineers. However, when zooming in and focusing on the individual members’ behaviors, this group was less homogenous in their disciplinary perspectives than would be expected. Being the first year of the graduate ME program, students came in with different views, skills, beliefs and disciplinary identities. As Figure 5.1 shows, they came from undergraduate degrees in mechanical engineering, bioengineering, product design, automotive design, and information technologies, among others. Additionally, they came from different university contexts and countries. According to the course’s records, in past years, other graduate students from very different disciplines like Education and Computer Sciences have also attended the course.
This diversity is not unintentional. As the directors and instructors of Mechanical Engineering and Design College indicate, the programs seek to recruit from disparate areas to enhance the diversity in the program. Today, PRADBORD is conscious that innovation can be achieved from recombining information and the value of different mindsets coming together. It seems that for these programs, the best way to do it is by assembling teams of different disciplinary backgrounds.

After the intense eight months of participant observations in the field, a complete year of online follow-up, audiovisual material and sorting out the data coming from the twenty-six semi-structured individual and group interviews, I realized that the students in this community didn’t share one defined disciplinary identity. It could be said that these are different sub-disciplines of engineering. However, there were important differences regarding the academic value system and epistemology that in this particular context became in some cases even contradictory. Even though there was a growing sense of belonging to the course and to the school, talking about them as belonging to the same discipline at this moment, in their first year, was not accurate.
This is a reality that is comparable to what happens in multidisciplinary engagements, maybe with a different intensity. Each entity in a team has thought worlds of their own, but they come together in order to tackle a particular project. Through the coming together, friction arises as the individuals try to convene in one shared strategy by trading off their disciplinary mindsets. In this case, being the first year, the students are usually protective of what they have been taught to believe is the “correct way” to do things. This is evident while observing the clashes and by the comments that their fellow team members have to say: “it’s frustrating as they are sort of reverting back to this very traditional strategy, but I feel if I can sympathize with them, that would have been the approach I would have taken before coming to PRADBORD.” This is a common refrain from someone entering a new community. There is a learning curve that is defined by the time it takes the individual to blend into his or her new community in order to come to terms with it.

In addition, something that drew my attention was the fact that the particular ME-COURSE process and curriculum exposed all of these micro segmented teams to intense negotiation due to the need to achieve a result in a constrained period of time. Even though humans’ every-day lives are full of transactions and exchanges amongst a whole host of actors, this particular negotiation process came to be more multifaceted than usual. After realizing these two important insights, I understood that I had to change the regular focus of negotiation. Rather than view it as a side effect of the creative process that takes place when designing something new, I approached the negotiation dynamics as critical for team survival. When negotiation is seen as a secondary issue or side effect, there is not much attention placed in the way those interactions are born, progress and die, or how tension brings team members together or divides them. It is not a common point of view in the research related to educational settings.

I consider it of great importance to bring attention to these dynamics in academia, where essential disciplinary behaviors are challenged or perpetuated. Today, there is not a real analytical framework in design that explores in detail the negotiation of students or the potential for team creativity coming from grouping diverse perspectives. The way ideas come from the minds of diverse individuals and then are translated into a shared context, where a team interacts, is overlooked in pedagogy today. There is no emphasis on how or where those ideas are discussed and negotiated and finally settled on. The lack of this framework makes it hard to plan ahead, adapt, criticize or improve the design process embraced by teams in academic settings.

Under a lens that values team creativity, diversity and negotiation in design education, there are two elements that are crucial: 1) emerging ephemeral trading zones among teams and 2) the mediation through boundary objects. In this case, because of the nature and ambiguity of the problem (the design project prompt) and the components of the process embraced, the boundary objects were mostly visual. These objects, as Star and Griesemer (1989) have indicated, could allow individuals to keep their own
identities, yet work together to reach settlements. Considering the rationale behind innovation that I expounded upon in the first chapters, these would increase the odds of combining and recombining old information in diverse and novel ways that could lead to creative solutions.

Around the fourth month, patterns on negotiation started to become visible. The conflicting views in the discussions were detectable in some key points related to the high intensity of decision-making, in the converging phases of the design process imposed by the course, and corroborated by the students throughout the interviews. Converging or synthesizing into one idea in design is not usually a big issue, unless there are a lot of options to decide about and there are multiple perspectives ascribing to their particular viewpoints. Negotiation gets complex when the exploratory or discovery phases (which in this curriculum are called divergent) in the design process yield great amounts of distributed information gathered by the members. These often-large amounts of information came from trying to solve an issue that was more open ended than a usual problem set in engineering. The students go out and collect information to make sense of the matter, and the information collected involved interviews, observations, archival and Internet-based research. This pattern is the nature of the instilled design process, a process that, unlike other more traditional engineering approaches, forces students to explore creatively and empathize with the human component in their project.

With this newfound understanding of this process, I decided to involve a more organizational point of view in the analysis, which is not surprising considering boundary objects were originally created under a more organizational studies umbrella. They were a substantial part of my research rationale. The issue with organizational investigation, however, is that it is mostly based on processes and interactions. These can be pretty invisible or tacit to the common eye and convoluted to explain with words. Here is where the visual lens of the researcher plays a significant role in making the invisible visible. The rationale of visual thinking was useful in order to make sense not only of the data, but also to test the benefits of working with visual oriented techniques that could be attributed to a designer.

5.2 MECHANICS BEHIND THE NEGOTIATION IN THE ME-COURSE TASK ORIENTED TEAMS

5.2.1 THE ROLE OF DELIVERABLES

"So last quarter there were so many deliverables! I felt it kind of inhibited our creativity. Cause we were like: "Next week this is due"... that week this other thing is due, this is due, we have to write up in a document ... we have to write up when we went to talk to someone. That takes time. And that limited our allocation, like time allocation for like being creative and going out and just doing stuff" - Jackie.

The mechanics in the negotiation process of the task-oriented teams is closely related to the deliverables programmed throughout the process that the course embraces (see Chapter 4 for a description of the process). Deliverables, or small sequential tasks with tangible outcomes that are part of a larger project, were of central importance to the teams and to the instructors. They are usually a
presentation, prototype or document that summarizes a section of the larger process. These instances are scheduled in order to: a) allow all teams of students to advance at a similar pace and orienting them in a particular cognitive state at the same time (i.e. being in divergent thinking mode versus being convergent); b) keep them on track, prompting them to converge (students are usually tempted to keep on diverging) and c) receive feedback from the TT and other stakeholders. The deliverables shown in Figure 5.2 mark the pace of the negotiations among teams. Note that they are transversal to the whole class and central to instruction.
Figure 5.2 Deliverables Shared By All of The Teams
Tasks organize the diverse students in the team to the same cognitive mindset. The nature of the task will either help the team to converge on a particular framework, or diverge and explore a problem together. In this context, the teams behave like an orchestrated troupe of dancers listening and moving to the same rhythm. All can move about in harmony by embracing a known choreography and anticipating the movements of their fellow team members. The only difference between converging and diverging will be the rhythm of the music. Deliverables are usually assessed with a grade that, in this competitive environment, has a strong impact in the students. The tasks could be labeled as: convergent, divergent and team building tasks.

Convergent tasks are those who force the students to think about one idea. Still, they are not limited to ensuring the completion of a particular assignment. Convergent tasks are more about learning than cognitive training. These assignments seek to be reflective of the students’ deep understanding of the design process and their creativity in resolving their particular project prompt. This task typology places the diverse students in the team in the same cognitive mindset of settling and deciding (as opposed to exploring). The students indicate that these assignments are the most difficult ones because of the amount of information they usually have to synthesize as a team. They have to decide altogether to pick one direction or idea in order to deliver a presentation, prototype or some kind of artifact required by the TT. “It’s been hard to converge, there is so much information and so many directions we could go... it’s actually really challenging to converge as a team and to, just go with an idea,” said Emily.

Divergent tasks are usually exploratory procedures, like brainstorming, where differed judgments are embraced, and throwing out crazy ideas is desirable. These are the ones that students feel more comfortable with. In this university culture, participation is embraced and constructiveness encouraged by the way the students navigate their interpersonal relationships. As opposed to converging, diverging does not imply choosing one idea over the other, or favoring one student’s opinion over others.

While divergent and convergent tasks are different, both tasks are related and complementary. There cannot be converging tasks (prototypes, ideas, artifacts, presentations) if there are no diverging tasks (brainstorming, human centered research, benchmarking), and some tasks will be convergent/divergent, whose aim is for the students to rethink their options or decisions they have made.

High stakes are involved in most of the convergent tasks because the students’ performance will be judged and assessed based on the results of the projects made. An example of a high stakes task is a prototype to test a project solution. That’s why they can be polemic and they can nurture conflict.

Other deliverables also comprise some low stakes tasks that give the students freedom to experiment without focusing so much in the success of the outcome. Examples of these are the warm up tasks like the construction of a paper robot, which interacts by using Arduinos. This task comes after the
long winter break and it looks to give space for the students to get used to working again after pausing for a long period of time. The fact that stakes are low (the project is not graded) empowers the students to have more freedom in making decisions or exploring ways to do things.

*Team building tasks* are those that are programmed throughout the course to enhance the relationship among teams. The team building tasks from the beginning of the course allow the students to mock up or practice the way the design process is undertaken. These tasks, like the design of a paper bike and a subsequent race, are low-stakes tasks, yet they provide an opportunity for students to experience the stress in converging, and have a taste of what negotiating with their team members can be. Then, later, when going through the process of defining their team, they can make informed decisions on whom to group with. The other team building tasks scattered throughout the project are meant to be constructive instances so that the students can focus on strengthening the human relationships among team members.

### 5.2.2 GOOD HOUSEKEEPING: MAINTAINING A HEALTHY TEAM RELATIONSHIP

“[Team Members] all get along really well, so that’s one thing that it’s like team chemistry that is like pretty important for a group project like this. So we, you know, communicate our thoughts pretty directly, you don’t have to worry about what the other guy might think, you just say what you want to do or what you need to be done” – Stevie.

“It’s been really good that I think we have become friends, and we can challenge each other without offending each other too much, at least, at this point. We haven’t had like any big fights or anything. It’s been a lot of talking through things, and sometimes late at night” – Emily.

“I like our team dynamics because we go out, not even when it is work required. We hang out, we play Uno a lot and I guess that was really healthy for our team. And we are not like scared to like joke on each other and make fun of each other. I guess it helped us to be open to new ideas during the exploration” – Jackie.

In the ME-COURSE, conflict is inevitable because of the common process and orchestrated deliverables (*shared external conditions*), but other major forces that come to play in negotiation that are related to the individuals in the team. These are what I call *internal conditions*, which I will refer to later in this chapter. Large amounts of exploratory data imply that there are too many decisions to be made and too many perspectives to homogenize, leading to friction. The silver lining of all of this tension, however, is that the dissonance affords recombinant innovation.

Periodic non-damaging conflict within the teams was not instantly apparent to the casual observer, but for me it began to appear a few weeks into the course. It usually manifested itself during long discussions occurring at late hours in THE FLAT, or in the form of subtle body language. I expected the friction, since I understood the ideological conceptions infused by the academic training of each particular individual in the teams. Contentiousness was usually not visible for the other teams in the ME-
COURSE, also to the TT. It was a team “issue” that everybody kept within their particular team, and when asked about it they would be very careful not to turn a minor disagreement into something larger. Having constructive conflict would not be possible without a positive disposition from the students to tradeoff and settle. For example:

“My ideas and her ideas would collide because I would think like an engineer [traditional engineer] and she would think like a designer [product designer], but then I would say yes, that’s what I’m here for, like understand the other perspective and I would just give in to what she says and see how it goes and most, most often it was well” – Rishabh.

The idea of having a healthy team relationship was important to the five teams I worked with closely. For nearly all of the students, the team building exercises were crucial for the survival and success of the team. The period where they had to select the individuals to work or not to work with was decisive to the way the team performed during the project development. Most of the students indicate it as a milestone in the process. They felt they had made an informed decision and most of them were satisfied with it. The first tasks of getting to know each other were important, and for some of them this was the hardest task.

I observed the teams actively trying to build camaraderie. Some of the students integrated some intentional techniques like playing Uno (a card game) or eating together periodically. Even in this positive interpersonal context, however, there was bound to be some social tension related to the interaction within the teams. Honestly, don’t all negotiations have a bit of tension? It seems unavoidable.

5.2.3 THE BENEFITS OF TEAMS’ FACE-TO-FACE TIME

“Like if I don’t see them [team partners] one day its weird. Like even on weekends. Like I see them all the time, which is great and like it helps us to like stay really up to date on this project but I don’t think that environment exists in other places” – Jason.

“We’re usually like all together when we do that. We don’t like “make decisions by email”. Um, generally it’s when we are all or as many of us as possible are gathered.” – Gayle

“I think we do all of our work in person actually. Or almost all of it” – Tommy.

Negotiations, unless otherwise intended, occur in THE FLAT, a defined space to work where they are able to meet at the times they are available. Availability is not something easy to achieve among these very busy graduate students. So some teams opted to meet up organically, whenever they are around. Others scheduled meetings with a very defined outline in order to take as much advantage as they can of their face-to-face time. The students indicated to me that physical meetings are irreplaceable, and can occur even in a more relaxed setting such as dining out. The face-to-face meetings give them an
opportunity to recombine ideas, challenge each other and settle on certain matters in a constructive way. It also benefits the bonding and the enhancement of interpersonal relationships.

However, increasing the frequency of face-to-face meetings does not necessarily yield absolute efficiency, and ensure that their plans to create or do something will succeed. Creative processes for these teams sometimes may take more time than they expect, and they are usually overwhelmed by that fact. It becomes difficult to plan ahead. As tasks need to be finished and deliverables delivered, the teams are forced to find their way to settle under a common idea. The truth is that the more instances the students have to meet, the more room and time they have for experimentation, and to let the cycles progress organically.

This face-to-face contact could not be replicated when working with the students and the international partners in China, Norway, Colombia or elsewhere. Remote working teams accomplish work through online technologies such as Skype or Chat rooms like Piraten Pad, GChat and Facebook. Even though technologies have made work across geopolitical barriers easier, for some of the students it is just not enough. Most of the teams regret not having been able to completely connect with the teams abroad. Even if they made their best effort in improving their work relationship with those teams, they usually felt disappointment for the lack of deep interaction and the complexities of trying to create a common language in an intangible context.

THE FLAT allows them to gather at any time they want to. With this they can create not only a routine, but a perpetuated dynamic where they know they will often see each other, and where they know they are available to approach any issue that arises with a specific deliverable or entire project. It is important to point out that this experience might not be replicable in other spaces where the individuals are not in-residence, do not live close to each other, or eventually have families to share their time with. In this case, the students are in a sort of “bubble”. (Recently, Yahoo’s executive vice president of people and development Jacqueline Rese announced that workers would no longer be able to work remotely, raising a huge controversy in mainstream media.) While the benefits of remote working are many, from what the students told me, being in close physical proximity to one another was truly irreplaceable.

5.2.4 DIVISION OF LABOR: OWNERSHIP AND ACCOUNTABILITY

“You figure out in a group, there was four of us, um, it was, three people just stepped up and said they would take ownership on certain things or like they would just start doing certain things. Um, so it wasn't very organized, but it flowed pretty well and the time frame was so short everyone just had to do everything. You just had to keep doing stuff. You do it, and then this next thing. And that's how it gets done” – Gayle.

Most of the teams at some point divide the discrete tasks related to the deliverables. Some do it regarding the strengths and skills that each of the team members has. These abilities can be related to
techniques for programming software or constructing circuits. These aptitudes are usually rooted in the undergraduate engineering curricula, and most of the students that have not undertaken it at PRADBORD, and who have focused on technical learning, manage them impeccably. When asked about his undergraduate training, one student indicated, "Well it seems to be a pretty standard mechanical engineering curriculum, you know fluids, thermo, um, static, dynamics, math, um, materials." On the other hand, those individuals with a product design background at PRADBORD are better prepared for assignments based on doing research and working with the human factor involved in the exploratory and testing phases. The recruitment of new graduate engineering students seems to take this into consideration so there seems to be no need to take time in teaching technicalities. During their graduate education students can focus on more "higher-level" (as they refer to it) thinking learning and sort out their technical obstacles by relying on their team members.

Usually the division of labor takes place in low stake tasks such as constructing a paper robot. These are more of a team-building warm up kind of task. Some of the team members will be in charge of the programming and others will just construct the external parts of it. In this situation reliance on other team members is crucial. "I need to know who I’m working with and that I trust them," says Jacob. Because of the lack of time, there is a need to delegate. Generally, the students take ownership of a task they believe they can be held accountable for, and other group members will do the same with something they feel they are more skilled for. This allows them to work more efficiently and enables everybody to have some responsibility and intellectual ownership on the overall deliverable.

But not every deliverable's labor can be distributed. And this is what usually happens with high-stakes tasks. These usually have a great impact on the way the project will be conducted and, ultimately, the results. Teams are aware that there are certain decisions that must be taken by the group as a whole. To settle on the direction that a particular prototype will take usually requires face-to-face time. This is evident when teams complain about the difficulties of online working with remote teams on Skype and having an even harder time negotiating due to language barriers or just to the lack of physical context to embrace a discussion.

5.2.5 INTERNAL CONDITIONS FOR CONFLICT AROUSAL IN TEAMS

Conflict arises among teams due to several reasons. Some of these are internal conditions, which are ingrained in the team’s DNA. The usual disagreements in the teams concern differences in the personalities of the team members. We have all either experienced or observed team members butting heads. Still, for this particular community, the major conflict arising from internal conditions is the difference in disciplinary training on the way a process should be carried out.
Process, in the case of this course, relates directly to the design process. As mentioned in the previous chapter, the design process embraced by this course is born from the specific cultural beliefs from the school and program. The forefathers of the program have carefully defined the way this process is taught and it seeks to be an alternative to “the typical” engineering design education. The idea of having more empathetic engineers, biased to action and process minded, permeates every bit of the way the disciplinary training occurs. However, not all of the students in the ME-COURSE are subjected to the same training on process during their undergraduate engineering studies. As they revealed during the interviews and observations, they have been taught in a more traditional spirit of solving problem sets, memorizing algorithms and equations or simply designing a positivist experiment to prove the effect of a variable.

Two flashpoints emerge from these differences: 1) a clash because of ingrained disciplinary beliefs on procedure and 2) a clash on what engineering is really about. In the first case, students from a more traditional engineering background are prompted to think that doing something innovative should be technology based. That is, having a great new code, a new sensor or other impressive kind of machinery. That is what an engineer with a traditional mindset would be inclined to think. But in PRADBORD the mindset is different. Having a process with an empathetic orientation, their overall inclination is not to solve anything from a technological standpoint. Doing something without a human oriented goal is not feasible in the context of this culture. Students that did their undergrad at PRADBORD will push other students to convert to the ways the university promotes. For example:

“First we started to think about this cool technology. And then it was like, oh cool! Let’s put it in a car. And then I kind of pushed them. I was like what is the need? Let’s go back and look. I don’t feel comfortable of like just doing something without a purpose” – Kaitlin.

The difference in training and disciplinary beliefs was not only noticed by students that were trained at PRADBORD. Some students migrating to this new kind of thinking on the design process in engineering could see the teams from other countries struggling to adopt this new perspective:

“I have seen German and Indian engineers and we are not really used to this way of method of working and I remember the Germans when they came here they were also very, I mean, pessimistic about this idea of like using post-it notes and writing things down and doing this and that. It doesn’t really fit well with the engineer mindset, right?” – Sapan.

As Sapan points out, the process of being empathetic and divergent is not the usual engineering mindset (or at least what is believed to be the traditional one). So it is not surprising that there is friction among students trying to promote these new empathetic techniques and others trying to understand why they can’t use the ones they had learned in the past.

Friction is also present in the beginning of this adoption process. Students from the traditional engineering mindset see design skills as soft skills. These skills are more people oriented and can be
related to what is taught in business management. The hard skills, like *technical abilities* for programming or for mathematical calculations, are the ones that traditional engineering naturally holds in higher esteem. Traditional engineering thinkers believe these hard skills are the sole prerequisite that leads to success. Oftentimes, these students addressed the soft skills in a pejorative way (using words like dumb or stupid), and told me that they don’t see the design-based team members as equals believing they received a less quality form of instruction.

“So I did a lot of programming as an undergrad. I feel bad cause I think the last two quarters I’ve gotten dumber technically. Just cause I haven’t done any math or any programming. And I don’t know if that was a good idea because like when I came I was like, you know, I’ll do the design thinking and I’ll go work on a design consultancy and it’ll be great. But I can’t just say I’m a design thinker” – Mike.

Given the dearth of any quantitative methods for these soft skills, the adoption of this new perspective on engineering takes time, and the students used to using this new human-oriented engineering lens know that. They are patient in allowing others to get comfortable with this new viewpoint on engineering practice. For example, one of the engineers in the program had this to say:

“I remember at the beginning they had people come in and talk about needs and like everyone was just like oh this is like really stupid or like this is really weird, like I don’t understand why this is important. And they were going through all the steps. And to me like that was, like I understood because when I first started last year like I was like oh, you could just totally make this up but there came a point when it clicked for me and like I understand that it takes time for it to kind of click with people. So I was patient but (laugh)” – Thomas.

Clashes because of these different viewpoints on what entails “good” disciplinary training can become a trap if the teams are not conscious about it. This doesn’t mean that one procedure is wrong and one is right, but one focuses on hard skills for positivist experimentation and the other into a more creativity and empathy oriented process for a more empirical form of design solutions experimentation. A simple analogy can be found in analyzing people's religious beliefs. In terms of religious beliefs, some people are more observant than others. The more observant the person is, the more reticent he or she is to consider the views of other faiths. In the engineering design paradigm, thankfully this conflict doesn’t usually end in a fight, but it makes it harder for students to get into settlements on how to progress in the process towards a certain task. A good example of this is someone that does not believe that they have arrived to “the correct idea” because they don’t have quantifiable information that proves that idea works better than others. His or her team members would advocate that this idea is solving a need detected by the information they have collected from their users, so it should be the “best guess for a correct idea”.

Due to the nature of these ambiguous design problems, there should be a variety of correct ideas and different ways to solve the same problem. It is just a question of having the most appropriate one for the complex context they are working in. As soon as they understand that, they usually settle and move forward.
5.2.6 EXTERNAL CONDITIONS FOR CONFLICT AROUSAL IN TEAMS

“At that point it was getting so late. But we do have time restraints and like we still have to produce like deliverables. And that was one thing I felt like other students, like sometimes don’t necessarily understand like as well. Like there are deliverables, you know, answering questions is important too but you’re not going find anything until you make it” – James.

Apart from the shared conditions related to the curricula imposed by the course, other external conditions for conflict arousal in teams have usually two origins: 1) time crunch imposed by the course schedule and 2) overly demanded students. These are usually combined. The imminent approach of a deadline to submit a particular deliverable or task stresses out these overly demanded students. There are things to be done, ideas to be thought out, and time is usually scarce. “I think the most stress that we ever had was last week right before the prototype was due. Because we were doing it like the night before and then we had to like finish it at 4 am and then they [teammates] had to do their problem set for class. And then like, we sort of took a 8 the next morning to test it for the whole day. And then it was due at 5 on that day. So we like finished testing it at four. So we, I guess we like, we wrote up our final thing like at 4 and it was due at 5. But I mean we got in and surprisingly now I don’t think I even was that stressed. Everyone was very tired,” indicates Tommy, one of the students.

Students never have “enough time” to complete their work and usually end up stretching the last minutes of the night before to accomplish their deliverable. Nighttime, when individuals are tired after a long workday at school or at some startup in nearby Silicon Valley, can be tiresome. Usually being tired cuts off patience and conflict is most likely to arise. Time is ticking and if the task is not accomplished the students will perceive it as a failure from their part. Tension coming from these tasks is likely to create discussion. Students feel the need to converge fast before the time is over. Some would complain that others need to get on board and stop exploring because they have to deliver something, and it better be what the TT is expecting from them.

5.3 RESOLVING CONFLICT AND NEGOTIATING CONTESTED IDEAS

5.3.1 POINTS FOR NEGOTIATION IN THE PROCESS AND TRADING ZONES

In processes related to creativity, it is very difficult to define a linear visual model of how these processes occur. They are usually simultaneous and iterative. Nonetheless, some major patterns of progressions can still be mapped if we isolate this complexity and reduce it towards a model that uses time as organizing criterion. That has been done in the past in research dedicated to the design process and it has yielded graphic depictions like the ones portrayed by Hugh Dubberly in “How Do You Design: A Compendium of Models”(2004).

In trying to build a taxonomy of graphic models dedicated to the design process, Mendel (2012) preliminarily identifies four recurrent stages present in the models of the design process: 1) discover, 2)
reframe, 3) envision and 4) create. I used these as a base, and I created an adapted version, adding information from the processes I’ve witnessed in this particular community, and that surprisingly homologues to others observed in the past ten years as a design practitioner and academic. Figure 5.3 shows the abstraction or model of the process I will be basing my analysis on.

The model shows a process that has stages, but that is “messy”, flexible, multilayered, iterative and not linear. It entails six stages that the students embrace when exposed to the divergent and convergent tasks. These are 1) explore 2) reflect, 3) reframe 4) envision 5) create and 6) make. It is my belief that research and the applied world have in the past paid too much attention to the stage of making and recently has been overemphasizing the stage of exploring. On the other hand, there has been research oriented to the middle stages of the design process (reflect, reframe, envision, create), but it has mainly been through the lens of cognition and creativity studies. After triangulating the information coming from eight months of in situ observations, pictures, interviews, a year of working on this communities’ online sources and other data collected, patterns were detectable. I realized that in converging tasks, students would face continuous negotiation points related to these middle phases of the design process. Figure 5.4 is a representation that models the behavior of the teams during the negotiation undertaken for fulfilling a convergent assignment.
After exploring through divergent tasks like brainstorming or researching human needs, the students embark in fulfilling a convergent assignment. They usually meet in a physical space as opposed to an online space. First, they dissect the assignment posed by the TT and try to understand it as a team. This means, to frame the mission by establishing common meaning among the group. Once they have reached common understanding, they build up a trading zone (Galison 1999). This is an ephemeral context that is constructed by the team members in situ and lasts while the project lasts. This common context entails a shared world of meaning that is inherent to the particular task the team is attaining. To set up this trading zone, they agree on behavioral principles (rules of conducts) and a shared epistemology that is inherent to that particular task. A trading zone is not necessarily tangible, yet is afforded by the materiality of boundary objects and the space involved. Through the use of BOs, the differences of opinion can be expressed in a lingua franca (common language), thus putting the respective opinions at the center of the dispute and reducing the opportunity for the dispute to become personal. In the stage that follows (n° 4) the team embraces the physicality of the negotiation and creation. Here, the ideas coming from the mind’s eye of any team member can be externalized safely into this shared context. Nothing remains tacit or left to erroneous interpretations. Ideas become explicit and visible for everyone.
through the use of particular boundary objects. This stage can take time, as it depends on the stakes involved in the assignment, the willingness of the team members to converge and the way the frictions are managed. After settling in one specific idea or direction, the team can proceed with the making.

Figure 5.5 Model of the Teams’ Agreement Instances During the Negotiations

Figure 5.5 shows the way the agreements are settled during the design process in the ME-COURSE. Figure 5.6 shows a parallel between the stages proposed in the ME-COURSE model discussed in Chapter 4 (Figure 4.13) and the negotiating instances.

Figure 5.6 Models of Design Process and Negotiation Overlapped
In understanding this process of negotiation, it is important to take into consideration that students don’t have to give up who they are, disciplinarily speaking, in the trading zone. Second, that the trading zones and boundary objects emerge naturally, without the students even realizing what they are really doing. They intuitively understand that the use of boundary objects facilitates the way of dialoguing in their team. Jacob mentions when I show him a caption of the recurrent visual models drawn by his team in a whiteboard, “it’s like a tool to help communicate better between each other.” Lastly it is important to talk in detail about how these trading zones are enabled by the conditions in this particular context, and the typology of the boundary objects that are present here. These can lead into defining the instruments to enable successful team negotiations in future design curricula assessments.

5.3.2 ENABLING TRADING ZONES THROUGH SPATIAL AFFORDANCES

Physical spaces are useful to visualize the intangibility of the trading zones. They facilitate the emergent context and provide the materiality for them to take place. As mentioned in previous chapters, the spatial arrangement of the school and of THE FLAT is not done by chance. This is the expression of their educational (and furthermore organizational) cultural values of the program and of the school. They are made in a way that they evoke impermanence and an idea of moving things around in order to enhance meaningful interactions. The artifacts that inhabit these spaces are rolling whiteboards, uncomfortable cubes for seating and rolling chairs within others. Also, because most of the space is open (with no walls) teams can move around pretty much where they feel comfortable to undertake negotiations. The spatial distribution of the building and the artifacts in it provide ideal conditions to breed ephemeral trading zones. This situation is equivalent to the ephemeral space that a circus constructs in order to house their events. After the spectacle is over, the circus puts down the tent and leaves. As witnessed in several occasions, the ME-COURSE engineering teams would do practically the same. They adopted a physical space to house their discussions. After that period is over, they reset the space back to its origins and disappear leaving no traces. That space can be utilized later for other purposes. This allows an organic spaces to emerge and meaningful interactions to occur. What if the physical spatial arrangements in this school weren’t like this? As the students state, it would become harder to house their negotiations by adapting spaces to their particular needs. In a similar way, negotiations with their international partnering teams in an online environment were perceived as more difficult than the ones carried in a physical setting. Pictures of THE FLAT can be found in the previous chapter.
5.3.3 ENABLING TRADING ZONES THROUGH CENTRALIZED CONDITIONING

In this particular case, a big factor that facilitates the creation of trading zones is preconditioning of the students through the course instruction. The class curriculum predefines the tools, methods, meanings and ways of interactions that the students would use while pursuing their team-project. This might seem similar to what was explained about the roles of deliverables, but instruction of particular ways to do things is a bit different. Unlike the deliverables that define stages or times where all of the individuals have to engage in a particular thinking mode, instruction works by preconditioning the ways that students will act. It is basically the way the process and the mystique of the process explained in chapter 4 is instilled. As if they were going to church, the nine teams meet during the first two quarters of the course in a weekly session LGM. There, they pontificate on the particular way to do things during this course and how to embrace the engineering design process promoted here.

During the LGMs, the TT would show several examples that the student audience would perceive as the "bar" to measure their success in resolving a particular assignment. These portray good practices or solutions executed by others in past versions of this course. This is what I call instruction by exemplar. This teaching technique is very common in design. During the course, a set of exemplars are showcased to the students in the form of slides, downloadable digital documents, the visit of guest lecturers and other audiovisual material. The downside of this technique is that it might strain creativity. A portion of the students will be looking at the example without being able to overcome it. The upside is that it can help diverse students to have a grounding of shared meaning, ways to do things and perception of "correctness". This will pair their viewpoints by placing a common very concise visual as a goal to match.

On the other hand, central conditioning also refers to some specific techniques imparted in the course. These entail the way to face team-building activities, training on software, visual techniques as mind maps, and others related to divergent phases like brainstorming and needfinding. This conditioning becomes crucial, as it primes the students to opt for specific ways to do things. As the team members adopt these ideas, they all become predisposed to a particular way to face their project. As soon as the students start preaching to others about "the way" to design at PRADBORD, they have fully adopted this particular process. Now, the whole team talks in the same tongue.

5.3.4 ENABLING TRADING ZONES THROUGH CROSS POLLINATION

Instruction and preconditioning are not always enough to convert outsiders into a way of do things. Not everything can be left to instruction during LGMs. The enabling of a shared context happens organically during the course through what I have called cross-pollination among students. "She is awesome at this! She has all these different ways of representing information and thinking about different things. I have always known about the idea of a mind map of these brainstorming bubble kind of
things, but I haven’t used them as much as I have here,” says David, one of the students referring to his fellow team member Gayle. Gayle undertook her undergraduate studies in product design at PRADBORD and usually spends time showing her team how to use the techniques learned there and their way of processing things. Gayle is not the only student that behaves in this way. There are three other product design majors and four mechanical engineering undergraduates that know the PRADBORD techniques pretty well. It is common to find these eight individuals in THE FLAT training their other team members on the ways that the design process is embraced locally. This is also a way that a baseline of common knowledge is built, and trading zones is facilitated. As opposed to the way it happens in centralized instruction, this occurs naturally; nobody asks them to do it.

5.3.5 ENABLING TRADING ZONES THROUGH A THIRD PLATFORM

“So what we do initially is do it on the board always, but the board, I mean, uh, the board right in front of you is really helpful but if you are thinking about getting into a computer it just doesn’t work. Because it’s a very small scale area, and the text isn’t really recognizable and that gives I think a mind map just, I mean, is a, so it’s very, basically what we do is screen size, if I have a screen size as big as this one, then I would probably just open the image again rather than like open the mind map” – Rishabh.

One of the key patterns observed repeatedly during team negotiations was the presence of a physical two-dimensional platform. This is what I have defined as a third platform. This was a material platform that served to externalize the individual’s ideas and to make them explicit for the rest of the team. Similar to a boundary object, the third platform is material. As Figure 5.7 shows, it is embodied in the form of white boards, large pieces of papers, Google Docs in a computer screen, a TV screen and an IPad, among others. The third platform hosts the intangibility of the trading zone in a similar way that the space does, making it visible. Instead of being a three dimensional space, it is a two dimensional one.
This third platform, however, is not a boundary object. Why is this? In the case of hosting a trading zone, the third platform doesn’t hold an ambiguous interpretation, whereas Star’s 2010 definition boundary objects do. The third platform hosts the already defined and constructed trading zone shared by the team members (with rules of conduct, shared meaning and boundary objects). So the trading zone and the third platform shouldn’t be subjected to further interpretations, because they are the medium through which these interpretations via boundary objects are expressed. This reflection and emerging definition will certainly contradict other research that looks at these platforms as boundary objects. But as every state-of-the-art idea, it should be subjected to further discussion.

In the same way trading zones can be populated with boundary objects, so can hosting spaces and platforms. Figures 5.8 and 5.9 show how platforms like whiteboards and large paper formats are used during the ME-COURSE teamwork. “Whenever we are working together like two, three or seven people all together it is better to stay in a big sheet of paper because we can all write at the same time,” says one of the students. For this to be truly a collaborative experience, students frequently opt for every team member to have a marker in order to ensure even access to the platform.

It is important to notice that these platforms can be reset to their initial state without leaving a trace of the interaction. “We erase the whiteboard a bunch of times,” one of the students stating when noting about the ephemeral quality of the platform. If they were not erased, it seemed that the negotiation was not settled. A non-erased whiteboard was “like having an ongoing discussion,” Scott, affirms. In the same fashion, the paper rolls have a continuous format that allows them to roll the paper up and start again when the negotiation is over, Tyler indicates: “the thing that has worked well is that the roll of paper like stays in one spot for a long time until it fills up and we roll it. It’s like per project. So each section is a pretty well encapsulated record of a two week or three week period when we’re working on a certain project.” As surprising as it may sound, students do keep record of what happened while utilizing these surfaces. They record their collaboration through pictures, and share or archive them in file managers like Google’s Picasa. As Jason indicates, they served to contextualize: “we did this (take pictures) so we can have a reference point about what we were talking about”. These records have the potential to reconstruct a past situation that portrays the way a community interacted, similar to how an archeologists sifts through a site. They could also be useful in the future assessment of the education process by analyzing in detail the context where the negotiations were made, and see step-by-step how the teams were able to reach agreement.
It is in my belief that these hosts are not only crucial for the negotiating instances during the design process, but they have yet an unexplored potential for instruction on teamwork. The more we understand these platforms, and the more we learn to identify them, the greater impact we will generate when defining the adequate spaces and artifacts that will populate the classrooms for design instruction, which concomitantly will be of a greater benefit to team creativity in design.

5.3.6 VISUAL BOUNDARY OBJECTS (BO) FOR INTERACTING

After defining the hosts for trading zone, it becomes relevant to talk about the boundary objects that inhabit these negotiation spaces. These BOs, as I have indicated before, have a certain materiality. This physicality qualifies them not to lose their identity when crossing boundaries; yet, they have ambiguous interpretations that allow them to be used by different individuals while engaging in the trading zone.
While revising long hours of video of the meetings, fieldnotes from observations and pictures that the students uploaded, myriad BOs became apparent. Sticky notes, sketches, graphic models and a series of other visual BOs inhabited the platforms hosting the trading zone. They become tangible when they populate the trading zone (when the idea travel’s from someone’s mind, tacit, to the shared platform, explicit). They become present to everyone and they have a color, a shape and a structure that is visible to everybody. The relevant thing here is that the students were aware that the use of these techniques (some were adapted by the team) would aid them in the negotiation process within their teams. As one of the students points out: “Especially when you are collaborating with others, like a picture might mean the same to you, but other people may mean different things. It might have different connotations. Especially if you draw a picture and they see it how you see it they might have a different notion of it as opposed to like a word. So even through your thinking of the same word you have different ideas about [it].” This student is describing the ambiguity in interpretation that all BOs have, and visual BOs are no exception. This ambiguity obliges the individuals to communicate explicitly what they mean when they are sketching or making a certain drawing. It elicits a conversation and an option to define shared meaning among the team. Figure 5.10 below portrays a variety of the visual boundary objects found:

![Figure 5.10 Teams Using Sticky Notes](image)

**Sticky Notes (Figure 5.10).** These were usually present when there were a large group of individuals involved in the negotiation (i.e. when externals were invited to a meeting). “There were just too many people to have everybody write on the board,” a student remarks. They were also useful when there were large amounts of information or concepts to decide. With sticky notes, the teams could handle a lot of information at the same time. As Scott indicated, “you can keep adding and adding.” They can be moved around (usually for hierarchical, categorizing or clustering purposes) or taken away from the
platform, and to be a great image to show in the student’s portfolio. “If you do post its, you must be doing something creative,” a visitor to the program asserted. When considering the impact that the Silicon Valley culture has on the course, this becomes more than a small detail. Having a colorful picture in your portfolio could be good for the job market. “You are more than a traditional engineer,” says Tommy. This is true, based on the conversations with instructors and SV consultants; you are perceived as more creative.

The way the sticky notes are used is very straightforward. The students write their ideas or concepts down on the pieces of colorful paper. They usually use a strong marker that can make the words or sketches visible from a distance. Then, these are pasted on a whiteboard (third platform), a wall (a spatial affordance) or large format paper. Then, while discussing, these are moved around, trashed or replaced. This makes them great for negotiation, as nothing in them is definitive. Finally, the students converge in one decision. Sticky notes are a technique that is usually learned by newcomers through cross-pollination and it can be combined with other techniques that follow in this chapter.

![Mind Maps](image)

**Figure 5.11 Mind Maps Crafted By All of the Teams**

*Concept Maps or Mind Maps (Figure 5.11).* Gowin and Novak define concept maps in their book “Learning How to Learn” (1999). Buzan (1974) address them as mind maps and homologues them with the hierarchical cognitive structure of the brain. These maps are based on radiant thinking (Buzan and Buzan 1996), which is a way of cognitive information processing that radiates ideas from a central image or word. Literature in these matters focuses on using them as a meaningful tool for learning (Gowin and Novak 1999, Novak 2010, Buzan and Buzan 1996) in educational settings where shared meaning between teachers and pupils can be reached. It has been also tested as a tool for facilitating discussions among individuals in corporations (Bresciani and Eppler 2008, Novak 2010). Individuals in teams, as I’ve documented before, are diverse. As everyone is wired differently, we are used to making particular
associations in our brain when looking at one word or concept. This is why understanding the nature of radiant thinking helps us understand how misunderstanding may occur. Individuals just make different associations in their heads. By externalizing those ideas they may serve to see what others are thinking.

Unlike the sequential steps that Dubberly defines in his working paper "Creating Concept Maps" (2010), the students just wrote concepts on the fly. These would become nodes, where other concepts would branch out. Concepts of lesser value would be branched out from lower level nodes. Usually students would use different colors to either imply which team member authored that concept or to categorize them. These are one of the BOs instilled through centralized instruction. During one of the lectures, Dr. Penn showcased an open-source software (free license and often web-based) that the students were encouraged to use for visualizing ideas called X-Mind. To my surprise, a lot of the students had never really worked with it. After the class was over, some of the teams started working on their computers to try out the software proposed in class. Others entertained the idea of working in other emerging open source software like VUE: Visual Understanding Environment, while other teams decided to use the same technique in an analog way by using markers on large format papers.

Scott, one of the students, stated that difference between making mind maps in the whiteboard versus the computer is that the computer force you to have a more thoughtful process because “when you are doing a digital copy there is only some space to work with in order to keep it somewhat clean, readable and legible.” This is an interesting point. Usually the computer mind maps are more synthesized and to the point than the analog ones. Each concept has to be decided upon by the team before being entered in the computer. Stevie adds, “In reality you have way more behind on what you were thinking and that might be lost in something like this. It would be probably be lost on the whiteboard too. It is something where you have to remember the conversation you had around it, because I am sure each point was discussed and debated before being written down.” Usually, it is because of this underlying context that strangers to the team cannot understand these mind maps without being accompanied by an explanation. This is what happens with most of human-driven illustrations (as opposed to computer-automated ones): human-driven illustrations are not self-explanatory because there is no common readable structure. Instead, they are subjected to contextual interpretation.

“We did this initially in a whiteboard and then we tried to summarize all this in mind maps that we could share in a better way through a computer,” a student mentioned. For this team, these mind maps helped them to revisit the ideas they had after the winter break when they were coming back to information collected in past stages of the process: “[we used them] especially when we were coming into the new quarter and trying to decide where to go, what to do next and going forward. So we went back to some of these ideas from the very beginning and kept searching for things we may have skipped over,” says Kristin.
Few of the teams that used the open source software stuck with the technique throughout the three quarters. Nonetheless, the groups that embraced a more analog version continued to use them. They gave me several reasons for this. For one group the computer format was not a collaborative enough platform, so it didn’t serve the purpose of negotiating as a team. For others, just working in the computer was an extra step. For the team that stuck with the computer format, they decided to print out the mind maps in large papers and displayed them in a board. They populated a third platform.

The maps were usually based on information gathered or ideas that the team would be entertaining. They would be always useful to make the ideas of team members explicit and the team members could physically point out what they thought about one or the other. In their words, it was easier to point to something that was in front of their eyes than to imagine a bunch of concepts that they should choose or discard. Apart from being a tool for externalizing ideas coming from the mind, some of the students used these to “break the ice” because branches and nodal structures do not need to be very formal or reasonable as one student indicates:

“That’s one way which I’ve felt after coming here [PRADBORD]. Mind maps bring out ideas really well. And, and one thing that really helps us, initially, I think if a person starts writing some crazy ideas on the board then it helps in breaking that ice- I would do a mind map as an engineer what I would do is like write reasonable things and then the other people who are doing the brainstorming with me would always be like a little conscious about what they’re writing, it should not sound stupid! But if you start by writing stupid things, like the most stupid things I do can think about a lot for a car interface. Then a person would read a lot more casual in that discussion and they would just come out with ideas that they don’t know if they, uh, are useful, they are, uh, they may be like really wild guesses.”

The use of mind maps just depend on what a team needs. If the group needs to break the ice, to revisit old ideas or to convene in conceptual rules the information will be gearing towards that. It is a flexible BO that can be tailored for the team’s need during the negotiation stage.

Figure 5.12 Students Using Visual Models and Sketches
Graphic Models (Figure 5.12). Different from concept maps and sticky notes, graphic models and sketches were found in diverse typologies. These related mainly to the purpose that the students had for these B0s. Throughout the course, I collected over a thousand images regarding different visual models that the students used as boundary objects. Mainly, graphical artifacts in this negotiation process serve to make the invisible visible so that the teams can interact efficiently in the trading zone. As I sorted those images, I realized that there were patterns across the teams. They would use the same graphic language in multiple situations. During the meetings, and as portrayed in chapter 3, I used these images in cards to ask them for contextualization. Can you tell me when this was done? As the students started explaining, they would start laughing as they remembered the situations where they used them “I had totally forgotten about that!” they exclaimed. They weren’t completely conscious or reflective about all of the techniques that they had been using until I exposed them to the cards. These techniques seemed to be of intuitive use to them. In the following three subsections, I will explain three typologies of graphic models. These are: sketches, visual models, graphs, lists and matrices.

Sketches (Figure 5.13). Fast drawings crafted with pens or markers are used all the time during the negotiation process. These are either placed on platforms like paper rolls, large format papers or whiteboards. “This is my terrible sketching,” Jason says. David refers to them as “goofy.” For the purpose of this sketch, they don’t have to be nice or well crafted. They are to be partnered with a face-to-face conversation. Jason adds that these are made “on the go” to externalize ideas to the team. “Let me explain and show you - kind of drawing,” Gayle affirms. Sketches are used here as tools to tell a story about an idea or concept. We are all wired for story, and as shown in chapter 2, we usually make images in our head about them. “It was hard to visualize without a drawing,” says another group member. Having a visual sketch out there, the platform allows the teams to come to terms and settle on their understanding
of an idea; to "get the point across" as another graduate student indicates. When students are envisioning unprecedented futures, it is difficult to explain to others what they are configuring in their brains. Sketches help to do so.

Sketches here do not only serve the purpose of visualizing the ideas in the mind's eye, they have multiple other uses in the trading zone. As students mention, they help to "de-stress and combat the block" when the team is stuck and doesn’t know what direction to take. It just helps us to "get the ball going," says a team member. Some like the storytelling ones have been referred by the students as "conversational sketches," While others state they allow them to "keep the team conversation on track and to proceed." This is relevant for team negotiation. If the students are not synchronized to work at the moment they meet face-to-face, the meeting in the trading zone can become tedious and can lead to team failure.

![Figure 5.14 Cards Showing Some of the Visual Models Captured](image)

*Visual Models, Timelines and Graphs (Figure 5.14).* Generating visual depictions of a particular phenomenon is common in design. The cognitive benefits of using them have been thoroughly explained in this dissertation in the chapters (2 & 3) that touch on visual theory. During the course, the students innately created visual abstractions of information or analytical frameworks that they were using. This is also a BO instilled through cross-pollination. That’s why there were teams that used more of these depictions than others, and there were team members that just thought very visually and had some previous training in that aspect. However, all of the nine teams in the course used visual models during their negotiation processes meant for audiences inside and outside their group. The interesting thing about these models is that none of the students is trained in graphic design. Most of them manage software like MatLab, CAD, Solid Works and LaTex. Most of them are skilled in programming languages like processing, C and C++. Some of them manage things like Photoshop. However, not even a handful of
them manage graphic design software like InDesign, Corel or anything of the sort. It seems you can be visually skilled to think and synthesize in models without having the requisite knowledge of the software tools. Nonetheless, remember that some of the students (overall the product design undergraduates from PRADBORD) have gone through courses that teach them about using 2X2s, matrices and other visual artifacts. Due to this combination, most of the models and graphics are crafted by hand using markers over a third platform. If using computer-aided strategies, the students usually use things like PowerPoint, Word or Excel (or their open source homologues like the Google ones).

Visual models make plausible things as intangible as emotions, creativity, the behavior of light or the stages in commuting. All of these are examples of what the students use the visual modeling for. “Oh, that’s the creativity model we developed at first quarter! It’s the foundation of our project, when we decided to work with kids,” Jackie points out. Making the model is part of a negotiation. Apart from synthesizing their ideas, it allows the students to convene in a framework that can be used as a “filter” for the rest of the decisions that they will be taking during the project.

One of the teams used the tool in diverse ways. David mentions: “That is like emotion mapping. This was basically a graph of commuters in motion throughout the day. It was an easier way, well a more intuitive way to see their emotions.” Additionally, they used the tool for other purposes, as another student mentions: “So this is more like a synthesis or analysis kind of thing, to try to learn about patterns or trends.” This team was intuitive in constructing visual representations that could be a synthesis of something as abstract as an emotional flow, and they were assertive in using these negotiated constructions to make comparisons in order to find patterns.

Another use of these models in the trading zones is their ability to communicate explicitly to audiences inside and outside the project. “A big problem with us is that we are not very effective communicators in terms of showing why we got there and how we got there. We always thought that was kind of implied. But we learn that if we explicitly say and demonstrate visually it makes it easier (for others),” says Jian. He refers to the difference it made for them to create this model and to show it to the TT. After this, their project became one of the most successful in the class because their team was pretty synchronized and they could communicate effectively and coherently where they were heading.

Another case where models where useful for teams was to communicate to specific audiences crossing a language barrier intensified by a missing shared context. As one of the students working for a project with a German company indicated, “We had people from the company visiting, not just from the US, but also from Europe. They were in a presentation from our team. This [a graphic model] was the first thing we presented. It is basically our framework. It put a structure to our thought process.” The presentation regarding this model helped to bridge a lot of cross-cultural communication. Also, the team negotiation behind the definition of a model that synthesized their thought process helped the students
to speak with one voice when communicating with others. Other versions of communicating to others were detectable in the use of graphics done in a spreadsheet. “There is a graph because we are talking to the teaching team and they are a bunch of engineers who usually respond well to graphs,” one of the graduate students points out.

Lastly, for most of the teams, the visual models were crucial for synthesizing the “large design space”, as the students refer to the ambiguity in the project prompt. In the same way the students negotiate each of the assignments (in stage 01 of the negotiation process portrayed in Figure 5.4), the students in the team need to negotiate the area that their project will focus on. “At the beginning of the project things were more confusing or difficult compared with other projects in the past. The design space was so huge! So using something like this is picking all the jumbled thoughts out of our head and putting it onto paper makes more sense,” indicates one of the graduate students from the ME-COURSE. The visual representation constructed and discussed over a large format piece of paper served throughout the whole course for this team to keep in mind what the design space they were facing in their project.

Figure 5.15 Cards Showing Some of the Lists and Decision Matrices Captured

*Visual Exposed Lists and Decision Matrices (Figure 5.15).* Lists written with markers inhabited THE FLAT during the three quarters. The platforms where they were hosted, usually whiteboards, moved around and were erased during certain stages of the process. These visible lists were usually made for negotiating either the content or schedule of an SGM or to allocate tasks among team members. “We do it to divide and conquer. We can’t be part of all of these. We would have never been done,” a student declares. The students would meet up, one of them would hold a marker and everybody would be sharing their opinions either on the tasks or on what should be the topics that had to be touched in their conversation with the TT. The large format allowed everybody to be part of the negotiation and to make
the topics explicit for everyone. The physicality of the board enabled the students to point out with their fingers a particular item that they would want to further discuss, erase or complete.

Conversely, the teams did not frequently use handwritten decision matrices. However, when some of the negotiations on a particular idea or direction got complicated and the team could not settle, they would reach out to evaluate the pros and cons of their options. "We were trying to figure out what to do, and we kept talking about the merits of each one back and forth. This was just like trying to assign a number to each rather than the feeling. This is how we made this," a group member affirms. Quantifying the pros and cons for some of the teams was necessary, even though there would be non-mathematical or statistical relevance on the values assigned. On the other hand, other teams negotiated the pros and cons through conversations, with no visual record of it. It seems that when talking is not successful, and feelings get in the way of decision-making, the use of visual language and explicitness of a matrix becomes useful.

5.4 CONCLUSION

This chapter touched on several conditions that portray the ME COURSE as a community where collaborative thinking is valued and individuals are empowered to embrace their learning process. The chapter points out the diversity in disciplinary training that coexists in the ME-COURSE and that can bring out friction and conflict in teamwork. However it also portrays the positive aspects of diversity and conflict to foster innovation. This section demonstrates that the course provides the context for good practices that convey a healthy environment for negotiation.

The development and resolution of conflict in the design process was analyzed and attributed to the middle stages (reflect, reframe, envision, create). Later, the analysis follows the configuration of trading zones and defines the "third platform" and 3-D spaces as the physical hosts for this intangible milieu. Finally, the chapter examines the visual boundary objects that populate those trading zones and exposes the way they were embraced by the students.

6. A FINAL WORD, TAKEAWAYS FOR ASSESSING DIVERSITY IN DESIGN EDUCATION

The world of disciplines seems to be rapidly changing. In these circumstances, diversity needs to be understood and managed consciously in favor of a professional world where meaningful engagements can take place. As the relationships between disciplines is in a state of flux, new lenses methods for research on these matters should emerge to keep up with the ever-evolving profession. In this dissertation I examined the use of a new method of research based on design and anthropology which focuses on the use of visuals lens to embrace new methods to explain how the ideation process works coming from the intersection between design and anthropology. Visual methods for data collection and
analysis allowed me to further explore on the dimensions related to the intangible dynamics present in the areas of negotiation and communication. They didn’t just serve as an efficient form of recording and using my memory effectively, but they also allowed me to make the ephemeral, visible. Without doing this, it would have been impossible to: expose the findings to a general audience, and to go back to the participants of this ethnographic research to request explanations of certain phenomena observed.

Something that came to light after eight months of fieldwork and a year of continuous online follow up with students and analysis was that communities of practice, like the ME-COURSE, could be micro-segmented. At first glance, some communities could resemble a traditional homogenous group with shared disciplinary beliefs. However, the enculturation of disciplinary values coming from, in this case undergraduate engineering training, prevail even if the individual gets to be immersed in a new program of discipline. With these preconceptions, it takes some time to come to terms with this new disciplinary environment. The downside of this micro-segmentation in design is that frequent clashes and friction result due to diverse interpretations of the how to resolve a particular project prompt. This friction is intensified by diverse factors such as: time constraints, different beliefs on procedure or disciplinary truths and because of the nature of the project. It seems that the more ambiguous the problem prompt is (as the student said: “the larger design space”) the more space it gives for conflict to occur. The silver lining of all of this tension however, is that the dissonance affords recombinant innovation.

But to organize that dissonance, techniques that foster positive negotiations should be introduced. In the case of the ME-COURSE negotiations among teams followed a particular pattern that relates to the rhythm imposed by the design process undertaken. Negotiations became more intense during the stages that followed the divergent phase of explorations. These convergent stages usually entail synthesizing large amounts of information and settling into a course of action. Handling a lot of information through diverse lenses is never easy. These steps are the ones where the team reflects, reframes, envision, creates or ideates.

PRADBORD is very invested in being a leader in innovation, so they ensure diversity in the engineering program by setting it as a standard. The ME-COURSE seems to provide several conditions to orchestrate the dissonance in the teams through some of their educational strategies. Through centralized instruction, the instructors at PRADBORD focus their teaching on a few key elements that enable the enculturation of particular belief systems and the mystique of a particular “non-traditional” design process for engineers: 1.) They fertilize the ground for healthy team interaction and a good disposition from the students through team building tasks 2.) They instill particular techniques through lectures and an orchestrated set of deliverables; and 3.) provide a functional, non-traditional space to support these team-oriented techniques.
All of these educational strategies have been part of an evolution of this course that has been around since 1967. Even though this course and THE CENTER evaluate periodically some aspects of the curriculum and educational strategies, I believe I have depicted in this dissertation some new research that had not been published before. This new research relates to the points of negotiation in the design process, ephemeral trading zones and visual boundary objects used to bridge communication in micro-segmented disciplinary communities.

As discussed in chapter 5, trading zones in engineering design are shared ephemeral epistemologies enabled by the type of teaching and spatial affordances. For me, trading zones are emerging and constructed intangible contexts that just have physicality when hosted either by (what I have called) a “third platform” or a three-dimensional space. When hosted the trading zone can be populated by boundary objects that, in the case of the design process, are mostly visual. These visual boundary objects were brought in (mostly) innately by the students in order to trade, exchange and settle during convergent tasks. These visual BOs embraced by the students were categorized into sketches, models graphs and timelines, concept maps and sticky notes. These artifacts the teams in negotiations in the following ways:

**Sticky Notes:** Used for organization and creation of hierarchies and clusters. They are also used to categorize and rank ideas, requirements, tasks or concepts. The potential to “add and add” sticky notes makes them ideal for dealing with large quantities of information. Also, they allow more than four individuals to integrate their ideas into a discussion while using this BO.

**Concept or Mind Maps:** The radiant thinking strategy built in concept maps enabled the students to negotiate each node and the hierarchy of the ideas they were promoting. The teams used them also to synthesize a large amount of ideas into one concept and to explore the design space. Being a visual tool of synthesis, they provided a good “snapshot” of the moment the negotiation was undertaken and also serve to document and later revisit old ideas. Alternatively, they serve to break the ice among newly met team members.

**Sketches:** Were widely used by all of the teams and team members. Their basic function is for externalizing an idea coming from “the mind’s eye” into a shared space for interaction. Sketches were used to tell the story behind an idea (storytelling) or to get “the point across” to other team members. Other alternative uses that these BOs had were for de-stressing or to keep the team on track while having a verbal discussion.

**Visual Models and Graphs:** Some groups used them to visualize abstract concepts like emotion, creativity or feelings. These models serve also to externalize ideas into shared spaces and to communicate to specific audiences. Being visual, they had the capability of bridging differences in language. Graphs were used to talk to specific disciplinary audiences like engineers or business
managers. Some visual models like timelines or graphs were used to compare data and to tease out patterns. Finally, various teams used the visual models to create project frameworks. These frameworks entailed a thinking structure that would help to filter all of the decisions taken in the future regarding the project. These structures also helped to align the team under a common major principle to solve the project prompt.

*Visual Lists and Matrices:* The lists were specifically used to negotiate team duties or the content of a particular meeting or SGM with the TT. Being large and visible to everyone, they promoted active discussion. Matrices appeared when making verbal evaluations of pros and cons didn’t work. Values were given to the merits of each idea or direction and this accelerated the process of decision-making among the team.

The purpose of this dissertation was not to give a value judgment on the educational techniques witnessed in this course. Rather, the intention was to expose how these techniques were performing in a real living lab. There are certainly premeditated decisions like space distinction or instruction as well as innately occurring decisions such as the presence of boundary objects, both of which promoted meaningful team interactions. These tactics shape the classroom culture in a way that it makes clear that collective learning is valued. Those things can set the standard for others programs to come or could be replicated in the assessment of existing academic programs in design.

Negotiation has not been a relevant topic in engineering design education. While the reason is unclear, it might have to do with technical-oriented, engineering academic circles undervaluing business management and organizational studies, the epistemological umbrella under which negotiation is usually studied. The ways teams communicate in design has been studied mostly in companies and if done in educational settings, it hasn’t been on longitudinal context-sensitive research endeavors. As I see it, having a thorough understanding of the bridging of perceptions in academic training should be key to open the potential of collective creativity.
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