# Toward Professional Practice: Student Learning through Participation in Engineering Clubs

by
Christopher M. Hinkle

A THESIS

submitted to

Oregon State University

Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Chemical Engineering
(Honors Scholar)

Honors Baccalaureate of Arts in International Studies
(Honors Scholar)

Presented February 28, 2018
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# AN ABSTRACT OF THE THESIS OF

Christopher M. Hinkle for the degree of Honors Baccalaureate of Science in Chemical Engineering and Honors Baccalaureate of Arts in International Studies presented on February 28, 2018. Title: Toward Professional Practice: Student Learning through Participation in Engineering Clubs.

Abstract approved:_____
Milo Koretsky

This study investigated learning in three engineering student clubs at a large public university. This included a small-sized chemical reaction car competition, a large-sized formula racing team, and an international humanitarian engineering club. Research methods included observations of work sessions ($N$=27) and semi-structured interviews ($N$=19). Using Cultural Historical Activity Theory to frame the activity systems, this study addresses how the organizational structure of each club influences the ability to prepare students for professional practice.

Key Words: Student Clubs, Engineering Education, Cultural Historical Activity Theory

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Honors Baccalaureate of Science in Chemical Engineering and Honors Baccalaureate of Arts in International Studies project of Christopher M. Hinkle presented on February 28, 2018.

APPROVED:

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Milo Koretsky, Mentor, representing Chemical Engineering

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Toni Doolen, Dean, Oregon State University Honors College

I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

_____

Christopher M. Hinkle, Author

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I would like to express my gratitude to my mentor Dr. Milo Koretsky. Thank you for your encouragement and insight, and for guiding me through many iterations from inception to completion of this thesis. To my second committee member, Dr. Philip Harding: thank you for your candid advice in reviewing my work. To Rebekah Lancelin: thank you for your feedback and for advising me through the Honors College and International Studies program.

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# Chapter 1

## Introduction

The first chapter is a reflection of my thesis experience. It recounts the motivations and background behind this project. This section documents how the thesis came about, what I have learned, and how the thesis addresses internationalized education.

## 1.1 Background

My initial inspiration for this project took root fall term of my freshman year when I joined three student clubs and began working in a research lab. Over the next three years, I participated in a gamut of co-curricular activities from internships to engineering competitions. Along the way, I developed a belief that these extracurricular experiences had a profound effect on my education. I saw that they differed fundamentally from the classroom and I developed a curiosity about the ways in which people learn and interact and how co-curricular activities contribute to the knowledge and skills needed for professional practice.

Three years after joining my first club, I approached Dr. Milo Koretsky, with the idea of researching these clubs for my International Studies and Honors College thesis. The plan was to compare how the structure of each club influences learning by participants. Many studies on co-curricular activities use quantitative research methods such as surveys, and focus on outcomes—such as acquired skills—rather than how those outcomes come about. The idea behind this study was to understand the underlying structure of each activity. From a data collection standpoint, this perspective called for qualitative research methods. Qualitative research methods have a rich tradition in engineering education, and we decided early on that I would use semi-structured interviews and participant observations as the basis for my data collection. A qualitative approach to the research offered the advantage of affording a deeper look into the experiences and opinions of club participants. While a survey would primarily address preconceived research questions, a qualitative study deepens the process. The interview and observation format would allow a more open exchange of information and richer characterization of each club.

It was also necessary to present the findings in a manner that encapsulated the holistic essence of each club. This led us to Cultural Historical Activity Theory (CHAT). CHAT is a theoretical framework that understands human activity as collective. It describes activity in terms of six elements (Engeström, 1987). These elements are: (1) Tools; anything used to achieve the objectives and outcome. (2) Subject(s); the central participants. (3) Rules; any written rule, informal norm, or other guideline that mediates interactions with the other elements. (4) Community of significant others; all other participants and stakeholders. (5) Division of labor. (6) Object(s); otherwise known as objective(s), which drives the outcomes of a particular activity. These elements can be visually understood as depicted in Figure 1, inspired by a similar image from Engeström

(1987). It is important to note that an activity (henceforth called an activity system) is not comprised merely by these six elements. The fundamental importance of CHAT analysis is understanding the interrelations between each element along with the historical and cultural context. For example, the object profoundly influences the rules, and vice versa; the rules influence the division of labor; etc. This makes CHAT a very useful theoretical framework for analyzing and describing the complexities of a co-curricular club.

With my general research strategy established, the next task was a literature review to determine where my work could fill in the existing literature. I also took an eight-week Coursera course from University of Amsterdam about qualitative research methods. In the spring, we developed a specific research protocol and received approval by the Institutional Review Board.

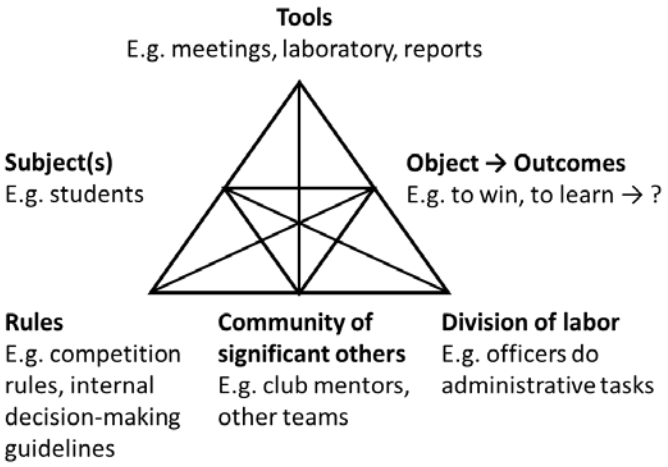


**Figure 1. CHAT diagram with examples from a typical student club, adapted from Engeström (1987).**

We narrowed the scope of the research study to three student clubs. One would be small-, one medium-, and one large-sized. One would have an international focus, one would be entirely domestic, and the third club could focus on either component. It was necessary that each club was relatively accessible for research, with sufficient participants willing to volunteer for an interview, and members open to being observed during club activity.

Over the spring and summer, I completed seven interviews. The other twelve interviews were conducted fall of 2017. Over this data collection period, I also attended meetings and workshops for the three clubs as a participant observer. Observation added to my overall understanding of each activity system and corroborated and supplemented impressions revealed by interviewees. Figure 2 presents a timeline of the thesis process from start to finish.

As data were collected, they were analyzed for trends and patterns. Each interview was audio recorded. I transcribed recordings into a text document for more accessible analysis. From the transcriptions, I coded every interview to indicate how it described each of the six CHAT elements. For example, if a participant indicated that the objective was to learn or to win competitions, those would be coded as the object. Interviews were also coded in other categories such as perceived learning outcomes. Examples of three interviews and example coding, one from each club, are available in Appendix 2 and Appendix 3. The aggregate of codes from all of the interviewees painted a descriptive picture of each club. Patterns, trends, and findings emerged from that picture. Once a pattern or trend emerged, it could be corroborated by re-coding the interviews for

additional evidence or by drawing on my own experiences through observing and interacting during participant observations. These participant observations offered a firsthand look at the tasks taking place and the dynamic within day-to-day club activities. Importantly, quantitative research is broad in scope. This makes it important to analyze iteratively, constantly checking findings by re-reviewing the data and aligning the synthesized understanding with the CHAT framework.


**Figure 2. Project milestones from inception to completion.**

In December and January, a conference paper was written based on this study and submitted to the American Society of Engineering Education (ASEE) in February of 2018. Pending approval and peer review, it will be presented at the 2018 ASEE Annual Conference and Exposition June 24-27 in Salt Lake City. The ASEE conference paper is presented as Chapter 2 of this thesis. It is meant as a standalone work of scholarship and portrays the results from this study. In combination with Chapter 1, Chapter 3, and the appendices, this body of research and reflection constitute the contributions of this thesis.

## 1.2 Internationalized Education

There is a growing body of research calling for increased global experiences for university students. Many researchers have argued that experiences abroad strengthen a suite of skills such as language proficiency, cultural awareness, and ability to work in intercultural teams (e.g. Stebleton, Soria, & Cherney, 2013). Engineering educators also highlight the importance of student experiences abroad. The prevailing attitude is a need for increased international competency and global engineering skills (e.g. Del Vitto, 2008). These international experiences can increase "global awareness" and develop other similar abilities among engineering students.

The majority of these sources focus on international experiences as an avenue to cultivate skills (e.g., Downey 2006, Parkinson 2009). They view this need as particularly high in the face of globalization. This thesis contributes to the literature by comparing how the experience of students in international clubs differs from that in an entirely domestic club. Rather than understanding it as checking a box for global experience, the research reported in this paper unpacks how the international aspect affects the fundamental essence of each activity system. It explores participant learning outcomes beyond purely the acquisition of skills and "awareness." It analyzes how the international experience affects the mindsets and decision-making philosophies of participants.

One question posed in this study asks how an international engineering club differs from a non-international engineering club. To address this question, one of the studied clubs is an internationally focused humanitarian engineering club. This humanitarian engineering

club revolves around annual three to four-week trips abroad. These trips send students to work on engineering projects in developing countries such as Nicaragua and Cambodia. The projects have typically related to water supply and distribution in small rural communities. For many participants this experience represented their first international trip, and travelers described the experience as a unique and influential incorporation to their education. Using the CHAT framework and qualitative research methods adds a descriptive element to the study of this club. This approach affords a deeper view into the behavior and experiences of participants and differentiates it from previous studies of humanitarian engineering clubs, which primarily relied on quantitative survey data (e.g. Jaeger & LaRochelle, 2009), or literature-based discussion (e.g. Chan & Fishbein, 2009). A second club, the formula racing team, completes internationally and has a partnership with another team in Europe. This allowed study of a second club with an international aspect.

Interpreting the interview data of other students in terms of the influence of their international experience demanded personal reflection about my own educational experiences abroad. My first trip overseas was the summer after my freshman year when I traveled to Kenya for an Engineers without Borders project. I led meetings, conducted sixty household surveys, and prepared for a water well to be implemented the following year. During the fall of my sophomore year, I studied abroad in Quito, Ecuador for a semester. I stayed with a host family and attended classes with local Ecuadorians, becoming fluent in Spanish. Upon returning to Oregon, I signed up for a Spanish minor and for the International Studies program.

The International Studies degree is a unique program that allows undergraduates to earn a supplemental Bachelor of Arts degree while incorporating global studies into their education. It requires additional coursework, a ten-plus week experience abroad, fluency in a foreign language, and a senior thesis with an international aspect. Working with Engineers Without Borders, studying abroad, taking a Spanish minor, and completing this thesis were fundamentally influential in my education. The International Degree program was an umbrella covering all of these experiences, and constituted an important cornerstone of my undergraduate education.

# Chapter 2

## Toward Professional Practice: Student Learning through Participation in Engineering Clubs

This chapter constitutes the paper submitted for presentation at the American Society of Engineering Education Annual Conference in Salt Lake City, June 24-27, 2018. It is meant as a standalone piece, and presents the formal results from the research in the scholarship traditions of engineering education research.

## 2.1 Abstract:

This study investigated activity and learning in three engineering student clubs at a large public university. These included a small-sized chemical reaction car competition, a large-sized formula racing club, and an international humanitarian engineering club. Research methods included observations of work sessions (*N*=27) and semi-structured interviews (*N*=19). Using Cultural Historical Activity Theory to frame the activity systems, this study addresses how the organizational structure of each club influences the ability to prepare students for professional practice.

## 2.2 Introduction:

One objective of engineering curriculum and co-curriculum is to prepare students for effective professional careers. Clubs constitute an important co-curricular activity, yet the role of engineering clubs in the education of students is poorly understood. Existing literature largely focuses on the outcomes of club participation, often lumping extracurricular clubs into a singular entity without exploring how those results come about. Tellingly, the majority of studies rely solely on quantitative methods such as surveys e.g. [1], [2], [3]. The research reported in this study, in turn, contributes a contextualized understanding of three co-curricular engineering clubs within a large public engineering college. We investigate the activity system of each club to connect how their underlying structures drive the growth of participants and their preparedness for professional practice.

In order to evaluate the contributions of engineering clubs in co-curriculum, it is important to understand what constitutes effective engineering education and effective professional practice. Engineering education is trending toward an emphasis on learning outcomes rather than "covering" content. In response to a new ABET process called Engineering Criteria 2000 (EC2000), graduates in 2004 reported learning more actively, including more instructor interaction and feedback, more study abroad and international travel, and more involvement in competitions than previously [4]. Compared to graduates in 1994, the post-EC2000 graduates in 2004 reported significantly higher competency in lifelong learning, societal and global issues, experimentation, and communication skills, among others [4]. In *Educating the Engineer of 2020* [5], a similar push is made to go beyond the traditional engineering education curriculum, advocating for a more

diversified engineering education experience that better prepares engineers for professional practice.

Despite these calls for reform, coursework remains focused on covering mathematics, science, and engineering content that builds a foundation of technical knowledge and abilities. Technical competency is critical to any engineer. However, professional skills are overlooked and oft cited as inadequate among recent engineering graduates. This is an important gap because professional engineers spend much of their time on non-technical tasks. Trevelyan [6] reports that engineers spend "about 60% of their time on communication activities and socio-technical work."

The disparity between the demands of professional practice and the emphases within the undergraduate engineering curriculum can partly be addressed through co-curricular activities such as undergraduate research, internships, and student clubs. These activities provide students a practical task in a social context. They can therefore help engineering students learn how to more effectively apply their technical knowledge to the socio-technical work they will face as a practicing professional. In this qualitative research study, we seek to identify some of the ways that the activity in engineering clubs aligns with those of professional practice, and how that might lead to students' professional formation.

## 2.3 Theoretical Framework:

We take a sociocultural approach that situates students' professional formation through their increasing participation in the engineering club's community of practice [7]. We use second-generation Cultural Historical Activity Theory (CHAT) [8] as an appropriate framework for this study. CHAT allows us to describe and analyze how each club's collective social action towards a common objective mediates activity and learning. The term "cultural" denotes that members within a social system are influenced by enculturated beliefs and understandings; "historical" demonstrates that systems change, yet previous histories still regulate how people behave; and "activity" is used to indicate a process-as-a-whole system, where an "activity system" is an indivisible aggregate of influences that together make up a given enterprise [9]. Therefore, each club will be evaluated as an activity system, and this becomes our unit of analysis

CHAT looks at the social system as a whole and examines activity in terms of six interacting elements often depicted as a set of interconnected triangles. These elements are: (1) The tools used to work toward the object, (2) The human subject(s), (3) The rules (both written and unwritten) that dictate how community members act toward the other elements, and), (4) The community (or stakeholders) involved, (5) The division of labor, and (6) The object which drives outcomes. Object may be better understood as objective, but will be referred to as object to stay consistent with CHAT terminology. Because student engineering clubs are complex and shaped by an intricate combination of influences, these CHAT elements are useful to help characterize each club, and to juxtapose the activity system between clubs. This approach is used to answer the following research questions:

(1) How does each club operate as described by the CHAT elements?
(2) Which elements are most critical in influencing club activity?
(3) In what ways does participation enable students' professional formation?

## 2.4 Methods:

This qualitative research study sought to characterize the activity systems of three engineering clubs to infer how the activity systems interacted with the professional formation of student participants. These clubs were selected because they represented a diversity of size, level of competitiveness, and degree of internationality, and were perceived as accessible for participant observations and interviews. (1) The small sized club of about twenty students is a chemical reaction car racing competition, hereby shortened to "chemical reaction," and is entirely domestic. (2) The large sized club of about one hundred participants is a formula racing club, hereby shortened to "formula racing," and competes and collaborates internationally. (3) The humanitarian engineering club of about 40 students revolves around international service projects, and is hereby shortened to "humanitarian engineering club".

Data collection consisted of participant observation and semi-structured interviews as shown in Table 1. The participant observations were conducted by an undergraduate engineering student, by regularly attending club meetings and work sessions. The observer was situated similarly to how a new club member would be, and did not to call attention to himself. To enable a more in-depth understanding, a semi-structured interview protocol was developed and executed. Using convenience sampling, interviewees were recruited via email and in-person announcements during club events. Interviews were scheduled for another time or conducted during or immediately following the club events in a nearby private space. Interviews were audio recorded and generally lasted 30-45 minutes, with an average length of about 36 minutes. The distribution of the 19 interview participants according to club is shown in Table 1. This research was approved by the Institutional Review Board and all participants provided informed consent.

**Table 1. Summary of data collection.**

| Activity | Interviews | Sessions Observed |
|---|---|---|
| Chemical Reaction | 6 | 6 |
| Formula Racing | 5 | 11 |
| Humanitarian | 8 | 10 |

Transcribed interviews were analyzed using an iterative process to seek themes and patterns in the data, and to answer the research questions. The coding focused on the six elements borrowed from CHAT as a mental model to characterize each club's activity system. We also analyzed the attitude and perceived learning outcomes of students, and discussed how this sheds light on the professional formation of participants. Interviews were conducted until responses appeared to be saturated. The participant observations contributed to a holistic understanding of how the activity systems function, and helped corroborate impressions revealed in the interviews.

## 2.5 Results:

Results from each club are presented separately, beginning with the chemical reaction club and ending with the humanitarian club. In each section, the activity system is described via the six CHAT elements, followed by an interpretation of the learning opportunities for participants. All conclusions and discussion points are drawn from the interviews and participant observations.

## 2.6 Chemical Car Club

In this small group of about twenty active members, students build a shoebox-sized car powered and stopped by chemical reactions. Students meet twice a week – a one or two hour meeting on Wednesday and a two to four hour work session on Saturday. Participants brainstorm and design the car in fall quarter. It is built and tested in winter term and into spring term, when it is brought to a regional conference for competition, where the car must stop as close as possible to a predetermined finish line. Top finishers advance to a national competition. The central activity is extensive experimentation focused on chemical reactions, programming, and mechanics.

***Club Activity System (CHAT)***

A visual representation of these results is presented in Figure 3. The subjects are undergraduate chemical engineering students, along with a few mechanical, electrical, and biological engineering majors. Five chemical engineering and one biological engineering student were interviewed; five were men and one was woman. Although it is explicitly a competition club, the latent object of the club is to educate students: all six interviewees said that education is an objective, and at least four of those indicated that it is the primary objective.

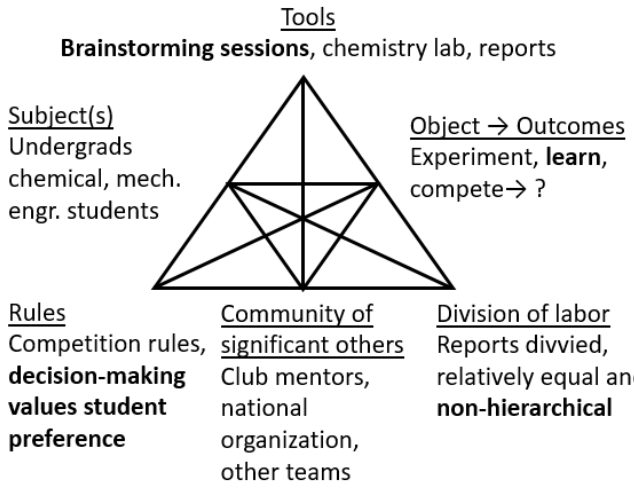


**Figure 3. Summary of the activity system for the chemical car club, with most notable findings in bold.**

The central tool for this club is the laboratory, where brainstorming, experimentation, and fabrication of the car occurs. Meetings begin with brief updates often followed by discussion. Then the club breaks into sections of one to three students tackling various aspects such as running chemical trials to record empirical data.

A governing national organization sets specific rules to which the student chapter must adhere. These rules predominantly involve competition, but also specify safety guidelines. The student club has few formal self-imposed rules. It does not have a constitution or strict decision-making guidelines. There is no “right” answer and

oftentimes students try several alternatives rather than agree upon a perceived "best choice" ahead of time. The team builds three cars, including one called the "innovative car" in which participants choose an entirely new design each year.

The national organization plays a minor role aside from setting rules. Faculty mentors also play a small role in the club, generally responding reactively to student inquiries rather than offering advice or mentorship up front. All six interviewees either said that they had little interaction with a faculty mentor or that the mentors play a minor, hands-off role.

Division of labor is relatively equal and non-hierarchical. Elected officer positions exist for club president, secretary, safety coordinator, etc. There is also a captain for each car, and leads for each component within each car, i.e. mechanical systems, electrical systems, stopping mechanism, and powering mechanism. The club is small enough that nearly every member is either a lead or an officer, or a part of a group of two or three members responsible for a certain component. There are no officer meetings and nearly all work is conducted within the two weekly work sessions attended by all participants. Officers and team leads complete most of the administrative work, but the flat hierarchy and little need for fundraising makes for minimal managerial work. As one member put it, "for the daily operations in the club [the division of labor] is actually fairly evenly split because there's a lot of subgroups in each team within the car." The larger administrative tasks, such as the engineering documentation package (a 50-page report) are split up such that everyone "does two pages of it so then it becomes a very manageable task." This flat hierarchy and equal division of labor is integral to the character of the club.

***Opportunities for Learning***

This club offers a platform for experimentation and entrepreneurship among participants. Two CHAT elements stand out that enable this learning environment: (1) A relatively even division of labor. This flat structure leads to equal access to participation and learning opportunities. (2) An object to learn, where design decisions are made to emphasize student interest and learning rather than performance of the car. The object encourages open experimentation and entrepreneurship, as students feel safe to take risks and try new methods.

Club activity is largely influenced by the central object to experiment and learn. Students consider competition as a means to learn, as none of the interviewees said that winning or placing highly at competition is an end objective in and of itself. As one student explained, "At least at our school […] we're pretty laid back about it and not really trying to win". On the other hand, all six interviewees said that education is an object. This leads to a decision-making framework oriented toward student preferences. One of the cars is an "innovative team" intended specifically for trying out new ideas. Because the focus is to learn, inefficient or risky ideas are not discouraged, as can be the case in performance-motivated activities. One student said,

> I just enjoyed coming up with creative ideas for new car designs. There were many ideas we came up with that we never ended up using, but we talked about various types of thermodynamic engines and we talked about biofuels and at one point we even took

> apart a weed eater motor to try to look into building an internal combustion engine that ran on biofuel.

Emphasizing creativity and experimentation encourages students to develop technical skills outside of their comfort zone or expertise, and attempt methods that may otherwise be considered not worthwhile. For example, a chemical engineering student learned to program an electronic micro-controller despite lacking prior experience. Becoming comfortable with trying and failing is an important attribute for young engineers and an important characteristic that increases innovation in the workplace [10]. There is generally no hard metric to make decisions; rather, students pursue ideas that interest them. One student summarized the essence of experimentation on the team:

> [Part of the team] had some conflicts because people wanted to use different designs and different methods. So basically what happened was people just tried a bunch of different methods and posed ideas and went with whatever seemed to work.

Another key influence to the club is its relatively equal division of labor. The division of work into subgroups allows each member to take ownership of a particular system, an important attribute to effective teamwork and entrepreneurism. A study of an engineer-entrepreneur education program found that the teams performed best when each member held responsibility for a specific area [11]. Furthermore, the informal status quo helps create an inclusive structure. For example, quantitative evidence such as calculations or predictions are generally not required to enact design decisions. While at first blush this may seem undesirable since it reduces the connection to technical coursework, this aspect prevents restricting decision-making to those who are perceived to have more knowledge and seniority. The de-emphasis on performance allows more shared authority in decision-making. A review of effective strategies to increase innovation in the workplace noted **“**most companies have hierarchical structures, and differences in status among people impede the exchange of ideas” [10]. A non-hierarchical division of labor helps avoid that hindrance in this club.

The equal division of labor and non-hierarchical community also helps newcomers overcome the feeling of intimidation. It further encourages them to get involved in decision making. The constant introduction on new designs also means that members cannot claim expertise or seniority, as the design is often new to all involved. As one interviewee put it,

> But then I learned everyone was in the same boat as well, just kind of figuring things out equally. I guess you sort of learn the information just through experiencing what was going on and how things work or just background information through online sources.

As alluded to by the interviewee, everybody started out at in a similar place, which helped the student quickly overcome their initial intimidation and begin contributing.

In summary, the non-hierarchical structure of the chemical car club allows students to express their opinions, thereby likely increasing the overall creativity and innovation of the team.

The confluence of an equal division of labor and the primary object of learning (rather than winning) as well as its relatively small size creates an educational platform for experimentation and entrepreneurship. The non-hierarchical community allows all members to make decisions, mitigating issues of status associated with seniority or perceived ability. Lastly, the de-emphasis on winning emboldens participants to try new ideas without fear of jeopardizing performance. The emphasis on experimentation encourages attempts to try otherwise risky, non-traditional, or unproven technologies.

## 2.7 Formula Racing

Formula racing is a global competition in which students design and fabricate a race car. The car is designed and modelled fall quarter and manufactured winter term. In the spring, the car is tested and fine-tuned, and competes in the United States and Europe through the summer. It competes in performance metrics, as well as formal business and design presentations, and participants emphasized the goal to win these large competitions. The club attracts upward of a hundred participants, and holds meetings Monday through Friday and a daylong Saturday work session.

***Club Activity System (CHAT)***

A visual representation of these results is presented in Figure 4. The subjects are largely mechanical engineering students, but also include other engineering and business students. Most are undergraduate students, predominantly seniors, but several graduate students hold leadership positions on the team. Participants joined primarily due to preexisting passion about race cars, a desire to race and win competitions, and the opportunity to learn about race cars first hand. All five interviewees were mechanical students. Four were men and one was woman. Four of five interviewees said that winning is an object. An equal number stated that learning is a key club objective, and that this experience fits into their career plans of working in the automotive industry or a similar field.

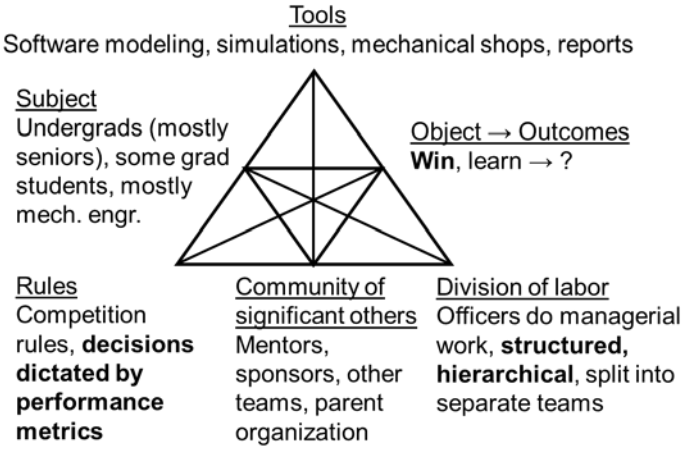


**Figure 4. Summary of the activity system for the formula racing club, with most notable findings in bold.**

The team is a large enterprise, and as such, involves a broad set of tools. Most obvious are the tools used to fabricate the car (manufacturing sessions, machine shops, equipment from sponsor companies) and to design the car (AutoCAD, other software, and simulation techniques). Testing, data collection, and simulation occurs year round, either

on the newest version of the car or using an older version. Senior capstone projects are another central tool. Mechanical engineering seniors have a choice of doing their capstone on the team; these students attend class and also work on a specific component of the car, which is used to both contribute to the team and satisfy their capstone. In this sense, it is a hybrid curricular and co-curricular project. A final important tool is collaboration with a partnering team in Germany, which the club works with while designing, building, and competing. Weekly conference calls with the team in Germany is an important method to communicate and exchange information.

The team has a strict set of internal rules to guide the process of building and racing the car, for example, an internally-specified date when designs must be finalized. The rules set by the national organization also dictate in a very specific manner what the team is allowed to build and bring to competition. The decision-making framework within the club is very influential. The competition is points based; two-thirds are awarded for the car's performance, and one-third are awarded for the formal presentations given by student members. Due to its object of winning competitions, the team makes design decisions based on how a given change is predicted to affect the points scored.

The national organization serves as a governing body, but otherwise plays a small role. Sponsoring companies also play a role to the club, by donating advice and materials. Faculty or professional mentors often interact with participants on an as-needed basis as a response to issues, questions, or concerns. The professional or faculty mentors interact primarily with club officers or technical leads, who in turn pass on knowledge and expertise to other members.

Division of labor is such that leads and officers perform the majority of administrative tasks. Due to the complexity of the team, more experienced members accumulate knowledge and become *de facto* experts. A hierarchical structure is thus formed in which information must pass through certain individuals to reach the broader population of less-experienced members. Most work goes through these officers and technical leads, who guide other students to perform certain tasks. Because the team is performance-driven, managerial tasks and decision-making is often reserved for the senior members who are perceived as most able and knowledgeable.

### *Opportunities for Learning*

The formula racing team provides a structured, performance-driven work environment similar to that often found in in industry. This parallel to industry manifests itself in two key manners: (1) The team is performance-oriented. Competitions are primarily judged by quantitative metrics on a points scale. The performance-oriented object can be compared to professional practice, where points scored can be replaced by profits earned. (2) Participants become experts on small subsets of the whole system. Due to the breadth and complexity of the car, most students focus on a specific technical aspect. As in professional practice, subject area experts must work together to manufacture a coherent final product.

The object of winning competitions regulates the decision-making framework of the club. Four of five interviewees said that "winning every competition" that the team enters is a primary objective. That object is also explicitly stated at team meetings. Because competitions are judged largely by quantitative, measurable metrics such as speed and acceleration, the team makes decisions based on the calculated, simulated, or modeled effect on points that will be earned. One student explained the decision-making philosophy of the team: "so really it's a big optimization problem figuring out where can we gain points and then just adjusting the car to meet that." This prioritization is analogous to industry where efforts are directed to high-impact areas that heavily affect profit margins or managerial priorities. Another student had a similar explanation:

> Really what it comes down to is what is the best decision for the car, what is the best decision for the team. And when it is the best decision for the car that not only means cost but also means time also means for us the weight of that thing. Like something we try our best to have a lightweight car but if a really cool design decision weighs more than another we're not going to use that unless it has other benefits to gain points.

This student captures the essence of the club: actions are regulated by the object of winning competitions, which is done by scoring the most points. Even in the case of a "really cool design", performance is prioritized. As one interviewee put it,

> Yeah it comes down to running it like a business decision. Like, businesses don't just choose something because it's cool. They choose it because it's backed up from a cost and design perspective, and manufacturing, and manufacturing ease, and a lot of decisions that go into that overall decision.

One interviewee specifically said that the intention is to prepare students for industry:

> And then we're also trying to expose people to industry [...] And prepare them ultimately for the careers that they are going to be going into [...] And you know, we believe that our objective of winning competitions is going to best prepare people for that.

Another similarity to industry is that participants become experts on specific subsets of the car. Members who use the club for their senior capstone project provide an example of this: as one interviewee put it, "You know, like the car gets sectioned up into 40 projects and each one of those covers a specific component," and "all those seniors have to write 100 page reports [about their project]…" This level of in-depth focus allows participants to gain an intimate technical knowledge of a certain part of the vehicle, delving in much deeper than an introductory-level understanding of topics. Many participants perceived technical skills as the most important learning outcome. When asked about the "best thing you have gotten out of [participating]", one interviewee responded, "Really just knowledge. There is stuff that I haven't, like, higher-level stuff that you could not learn in the classroom that you can learn through [this club]." This student felt that the club afforded a more in-depth experience than the classroom.

The team is divided into specific technical teams, headed by technical leads: chassis, powertrain, suspension, aerodynamics, etc. Technical team meetings often occur at different times and locations, further contributing to the separation between groups of participants. As such, it makes the most sense for participants to focus on single area for technical expertise. Some participants—generally officers and tech leads—focus primarily on administrative or technical aspects, whereas many participants without

official leadership roles focus almost exclusively on technical work. This parallels the environment in many companies, where select members of the community hold administrative power, while others work under those leaders in subdivided areas.

The similarity to industry leads participants to identify career paths, especially with an automotive company or comparable industry. Many members expressed a desire to work in the automotive industry in similar capacity to their current roles within the formula racing team. One participant professed, "[Being passionate about cars] is why I'm still here; it's something I really enjoy and something I want to do as a career so why not get started on it now?" Other participants echoed similar desires to work in the industry, such as one who said:

> So my reason for joining the club was that I knew it would give me the experience that I needed to be successful in industry. This [club] in general gives you experience that is almost analogous to exactly what you see at Big OEMs or rocketry industries or any of those types of big transportation, mechanically-focused industries.

Another participant held a similar sentiment when asked about the trade-offs of focusing exclusively on school versus also becoming involved with the formula racing team. They suggested that the team is more similar to professional practice due to the relevance of skills and applicability to working in industry.

In summary, the essence of this club is an organizational and decision-making structure that is analogous to some large manufacturing companies. First and foremost is the emphasis on points, where points scored can be compared to profit earned. The division of labor is also similar to industry, where participants generally focus in a specific content area, led by a handful of managers and administrators. As is often the case in professional practice, participants must collaborate with each other through formal decision-making processes to produce the final product. This structure affords students experience comparable to working within the organizational structure of a traditional engineering company.

## 2.8 Humanitarian Engineering Club

This organization of about forty active participants adopts engineering projects in developing countries. The club commits to a five-year partnership assessing, implementing, and monitoring projects proposed by the partnering community overseas. Students currently run programs in Nicaragua and Cambodia, both aimed at improved water distribution systems in rural villages that lack reliable access to potable water. Each program revolves around annual four-week trips comprised of four to five students and a professional mentor. The club holds weekly meetings for the Nicaragua and Cambodia projects, as well as weekly workshops or general events.

### *Club Activity System (CHAT)*

A visual representation of these results is presented in Figure 5. The subjects represent students in a variety of undergraduate engineering disciplines, with no singularly dominant discipline. Of the interviewees, there was one ecological, two biological, two

industrial, one mechanical, one civil, and one electrical engineering student. Computer science, environmental engineering, and chemical engineering students also participate. While members in the other two clubs are mostly men, this club is about half women, including four of the eight interviewees. The object of the club in the minds of the interviewees is to learn and acquire experiences while helping others. Almost all interviewees mentioned the importance of participating in a "real world engineering project" and many expressed interest in acquiring a breadth of new technical and non-technical skills.

This club uses tools that facilitate effective communication. Written reports play an important role in documenting and preparing for trips. During trips, community meetings and surveys are used to gain an understanding of the community and build relationships. Design and construction of projects represent only a fraction of the work, because report writing, phone conferences, assessment and monitoring activities, and logistics occupy club activity leading up to, during, and following implementation.

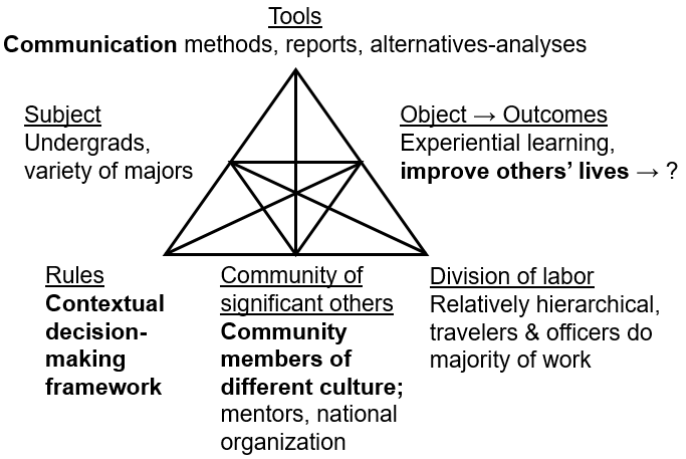


**Figure 5. Summary of the activity system for the formula racing club, with most notable trends in bold.**

A club constitution lays out formal rules for club organization. These rules include information on how to select the travel team, responsibilities of members, and how positions shall be filled. Decision-making is flexible by nature, as projects must use local materials and labor and tailor to social needs such as cultural preferences or community politics. Decision-making is generally made by group consensus, often by vote within project teams or at officer meetings, based on decision-matrices and alternatives analyses. The national organization also sets rules and guidelines regarding safety of travel and soundness of technical designs. Before implementation of projects, a technical advisory committee from the national organization must approve designs.

There is a notable disparity within the community of significant others. Villagers in the partnering overseas community comprise a key stakeholder with very different cultures, languages, and socioeconomic backgrounds than the students. The national organization and the university are major stakeholders, serving primarily to support the students. In addition to guidance from faculty mentors, a professional mentor always travels with the team and a responsible engineer in charge (REIC) must sign off on designs. Partnering non-governmental organizations (NGOs) with similar projects often assist with logistics and advice.

The division of labor is distributed more so to participants who demonstrate the most knowledge. More experienced members, officers, and especially those who have traveled to the project site know details that allow them to carry out these tasks, whereas newer members have less ability to contribute due to their unfamiliarity. As such, whether or not a student traveled to the community plays a large role in their participation; those who travel generally work on a broad suite of tasks, from calling community contacts to writing post-trip reports. New members have more difficulty finding a path to participation, because much work revolves around reports, communication with the communities in other countries, and designs specific to those communities. This difference leads to a relatively hierarchical division of labor.

### *Opportunities for Learning*

This club provides a platform for developing socio-technical skills. It also teaches participants the importance of a decision-making framework that allows for non-technical considerations. The disparity in cultural tendencies, socio-economic standing, and educational background between student and community member is key. These influences demand a high level of negotiation, reconciliation, and communication. Working closely with a small community also forces students to acknowledge the broader implications of how engineering and society influence one another.

Club participants introduce technical projects to villagers who are untrained in engineering. In turn, students must learn from the villagers to work effectively in an unfamiliar sociocultural environment. Communication methods and social skills thereby become central to club activity. For example: while preparing for trips, students in the Nicaragua program make weekly phone calls in Spanish to the community to discuss logistics, ask questions, and touch base. The first one or two trips to the community are dedicated solely to assessment activities. These activities constitute some technical work such as water quality testing, topographical mapping, and hydrogeological surveys. However, they primarily comprise of community meetings, educational workshops, household surveys, focus groups, and other communication and rapport building strategies. Participants must seek input from the community and reconcile this information to provide solutions that satisfy both the desires of the villagers and the wherewithal of the student chapter. A participant, when asked about what they learned in the club, explains it:

> Maybe the most important thing would be the self-development that I have had because of the necessity for me to think about other ways of thinking. So for example, since it is important to think about how members of the community that we are working with think about something, it has forced me to bring a different approach to problem solving that involves a lot more input from people's voices that aren't my own.

The student sought community input to select an effective design. Regardless of the specific discipline, this type of socio-technical communication comprises approximately sixty percent of work time for professional engineers [6]. The additional experience communicating between engineer and non-engineer may be particularly important in many industry jobs such as manufacturing and consulting, where professionals frequently

interact with clients, operators, and other non-engineers. There has also been recent criticism of poor engineering decisions that result when engineers do not interact meaningfully with the community affected [12]. Student participation in the humanitarian club can lead to more community-focused engineering decisions.

Attention to considerations like local politics and cultural context guides decision-making away from calculated models or "optimizations" frequently seen in engineering curriculum. For example, even if the cost can be minimized or the efficiency can be maximized, the previously mentioned social considerations disabuse the notion of a purely technical best choice. When asked how the club settles design decisions, one participant explained:

> We did a, I forget what it's called, some sort of design matrix. Basically, it's an alternatives analysis where you look at all the options and then have people informed about those options rate how they think those options work. And then you kind of create an average of the rating of a bunch of different people and whatever alternative has the highest rated average for a certain parameter, that's the best one for that parameter. And then all of those parameters get a certain weight and those weights go into a total number that says, okay, this is the project you should do.

The design matrix considers a spectrum of criteria such as cost, cultural fit, preference of the community, and ease of maintenance. Using a comprehensive alternatives analysis forces participants to employ the aforementioned communication tools and social skills. Traditionally, engineering curriculum focuses on technical knowledge, where it is as if the material exists "separately from society, in an insulated sphere of quantification and objectivity" [13]. By using an alternatives analysis for their decision making framework, students learn to recognize that engineering decisions need to consider social context. This practice has important implications, because many notorious engineering incidents trace back to a lack of regard for social responsibility. For example, in the early 2000s, a city engineer falsified water tests reading high levels of lead. The engineer who signed off on the report later recollecting thinking a crisis was "avoided," suggesting that in his mind, the issue was a high lead reading and not the underlying health dilemma [13]. In analyzing the incident, it has been suggested that "we need an engineering education that integrates the technical with the ethical and the social, acknowledging that engineering comprises all of these" [13]. The humanitarian engineering club provides students the opportunity to see how engineering interacts with society, enculturating those students to think critically about the social implications of their actions as engineers.

In summary, the humanitarian engineering club prepares students for communication, reconciliation, and social interactions. Although many participants also learn and practice technical skills, the aforementioned professional skills are lacking in traditional curriculum and oft cited by employers as inadequate among recent graduates [6]. Interacting with people from diverse backgrounds and worldviews prepares club participants for professional practice. As professionals, engineers will draw on those socio-technical skills to interact among one another and with a gamut of clients, blue-collar workers, and other non-engineers. More importantly, the decision-making framework within the club teaches participants that engineering is more than an objectively calculable "optimum." These students learn to consider social context as central to engineering practice.

## 2.9 Discussion:

In this study, we used participant observation and semi-structured interviews to characterize three different engineering clubs. We detailed each activity system to address the research question of how each club operates as described by a CHAT framework. This was connected to opportunities for learning in each club. In all cases, these measures suggest that activity in the clubs supports the professional formation of engineers. However, the manner in which formation is enabled and the barriers to participation differed between the clubs.

The second and third research questions asked which elements are most critical in influencing club activity, and how participation enables students' professional formation. The low-stakes environment (i.e. the object), internal decision-making rules, and the relatively equal division of labor found in the chemical reaction club was conducive to creativity and experimentation, providing opportunities for entrepreneurism and a low barrier to participation. This suggests that object, rules, and division of labor were critical elements to this activity system. This activity system enables heightened engagement in creative engineering practices. Conversely, the large, performance-oriented formula racing club with its emphasis on winning points and its highly-structured division of labor provided activity that more closely resembled some traditional automotive companies and other engineering firms. Again, the object, rules, and division of labor had a critical influence. This activity system enabled the formation of social and technical practices that align with a possible future as an engineer in industry. Activity also afforded engagement in technical concepts toward design, construction, and operation of a real engineering system which provided a deeper technical experience than is typical in a classroom. Finally, students in the humanitarian engineering club needed to collaborate with community partners from widely differing cultures, socio-economic standings, and educational backgrounds. This club provided an opportunity to learn effective communication and develop more balanced sociotechnical engineering practices that better account for the experiences and input of those most familiar with the context at hand. This suggests that the rules (i.e. the decision-making framework) and the community of significant others were critical to shaping this activity system. It also suggests that participation enabled the development of greater situational awareness and propensity among members to seek feedback and input.

While interview participants often described their technical and sociotechnical work in lucid detail, we focused on observation and self-reports and did not directly measure student learning. The small, convenience sample size may have a bias toward the experiences of members who were willing to participate in the interviews. Data collection was also limited to three clubs within one large public institution. Therefore, it is difficult to generalize specific findings, and this study should be taken primarily as a case study. It would be valuable to investigate whether the findings from this study hold true in similar engineering clubs at other institutions. The importance of decision-making rules across all three clubs suggests that future work could benefit from a more meticulous examination of decision making frameworks within co-curricular activities. Furthermore, the findings suggest that differences between clubs are attributable to fundamental

elements such as the object or the makeup of the community of significant others, rather than a single attribute such as being a competition club or qualifying as an international activity. This suggests that future engineering work would benefit from a more rigorous CHAT analysis that situates pedagogy in terms of the fundamental elements underlying an activity.

Considering engineering clubs as complex activity systems, we suggest that a single effective aspect observed in one club cannot be directly recreated in another. For example, the low barrier to participation for newcomers in the chemical reaction club was tied to central aspects of its activity system and could not be directly applied to a club of a different nature. Moreover, we cannot say that any of the activity systems of the engineering student clubs is preferable or better than the others. They each align with professional formation in important and fundamental ways. Ultimately, the arbiter for a potential club participant should consider whether their values and professional goals align with the activity system of the club. In this vein, educators may find value in characterizing co-curricular engineering clubs as activity systems. It allows a better understanding not only of what outcomes are emphasized from activity, but the underlying influences that drive these outcomes. For entering students, this information can guide club choice in a manner that coincides with their goals for their future careers. For student leaders and faculty associated with a particular club, we suggest that an understanding of a given activity system can provide insight into structural and social changes that better align with the participants' professional formation.

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# Chapter 3

## Conclusion

It can be tempting to characterize co-curricular activities as a singular entity. The research presented in this thesis paints a different story. Fundamental differences become apparent between each club. The approach presented in this thesis differs from the majority of existing literature. It does not treat co-curricular activities as merely an avenue to cultivate a shortlist of skills. Rather, it explores the underlying structure of each activity system. It interprets how the central characteristics and the connections between them influence each club and provides richer understanding of how those structures affect the experiences of students to produce learning.

Most directly, this thesis addresses the original purpose of understanding the similarities and differences between the three studied clubs. The findings and potential implications are a valuable case study in and of themselves to stakeholders in these clubs or similarly-structured activity systems.

The chemical car club offers a platform for experimentation. The confluence of an equal division of labor and an emphasis on learning creates an environment in which innovation and risk-taking are encouraged. In particular, the lack of emphasis on winning enables an approach that focuses on creative exploration rather than choosing what is thought to be the most competitive choice. The non-hierarchical structure allows a range of students to make decisions, thus lowering the barrier of participation for newer participants. An activity system similar to that of the chemical car club may be one way to foster increased creativity and innovation.

The essence of the formula racing club is an organizational and decision-making structure focused on meeting performance metrics of a competition. A key characteristic for this club structure is the emphasis on wining. Decision-making within the club is oriented to maximize points earned at competition, which can be seen as an analogy to profit within a company. The division of labor also compares with many engineering firms. Due to the scope of the club, participants generally focus on a specific content area led by a handful of managers and administrators. As can be the case in professional settings, participants collaborate through formal decision-making processes. The depth of technical demands and the organizational structure of the formula racing club may prepare students to work within a similar framework upon graduating.

The humanitarian engineering club affords an entirely different learning experience. Members strengthen the professional skills oft cited as inadequate among recent graduates. Students are forced to interact closely with community members from diverse backgrounds and cultures. The necessity to seek input and feedback influences the way in which participants approach decision-making. Rather than a mechanistic mindset in which any problem can be solved using math and physics, students learn that considering context and seeking community input is critical to engineering decisions. Context and input is important because notorious engineering incidents such as the water crises in

Flint, Michigan and Washington, D.C., can be tied to a lack of regard for community input. Situational decision-making is important regardless of where an engineer works. Perhaps an engineer works in a manufacturing setting. Using their calculators and measuring tapes to find the most efficient design is not sufficient. Unless they seek the input of the operators who are most familiar with the operation, the engineer may overlook an idea that is better ergonomically, or more safe, or avoids a logistical pitfall of which the engineer was unaware. By seeking the input of the people who are most intimate and familiar with the context at hand, an engineer can find a much more appropriate solution. The humanitarian engineering participants learn this important lesson that effective engineering decisions go far beyond a mathematical optimum.

There is increasing attention toward international experiences for undergraduate engineering students. International activities are sometimes homogenized as an avenue to cultivate global skills or to check a box that the student partook in a global experience, as if global or international is a defining characteristic. This thesis demonstrates that qualifying as international says very little about an activity system. On one hand is the humanitarian engineering club with its international projects. On the other hand is the formula racing team with its global collaboration and competitions. Both are very different activity systems. Two implications can be taken from this observation. The first is that educators need to be careful about characterizing an activity based on a single attribute. The second is that, if being international is not the defining characteristic, then perhaps a similar activity system—and hence similar learning outcomes—can be recreated domestically via a similar confluence of fundamental factors. This could increase accessibility to the large percentage of engineering students who are not able to partake in international educational activities. Take for example the humanitarian engineering club. The findings presented in this thesis suggest that the learning outcomes for participants come about largely due to the decision-making that emphasizes community input; tools that are heavy on communication; and a disparity between the backgrounds, cultures, and languages of the subjects and others among the community of significant others. By creating a similar activity system—such as a service-learning project in prisons or multicultural urban centers—participants could potentially be exposed to similar learning outcomes.

The findings reported in this thesis are also a valuable to educators in a larger sense. While the results themselves are a useful case study, it is also valuable as a model for how to analyze any activity system. This need not be limited to a student club or other co-curricular activities – almost any educational experience can be interpreted as an activity system. For example, a classroom could be examined as an activity system. An educator could seek to understand how the interplay between the rules, object, division of labor, and other CHAT elements influences the outcomes and student experience. For example, do students view a given project or an extra credit opportunity as way to learn or as a way to improve their grade? Could shifting this paradigm have an effect? Could project teams be crafted in such a way that a certain outcome is attained?

The methodology and findings from this thesis also suggests implications for students choosing between involvement in different co-curricular activities. For example, perhaps

an incoming student desires an entrepreneurial experience and the ability to make their own decisions early on, as in the chemical car club. Let us call them Student A. Using the findings put forth in the present study, Student A could seek an activity with a certain underlying structure. This student could seek an activity where winning is not the top priority. Student A could look at activities where the division of labor is relatively equal and where the opinions and personal interests of participants are valued in the decision-making framework. Conversely, perhaps another incoming student—who we will call Student B—seeks an opportunity to gain experience as a manager. Student B wishes to master a specific technical ability, and one day aspires to be a manager within a large company driven by performance metrics. Student B may be best served by seeking a performance-oriented activity. This activity would have a strong emphasis on winning and high performance. Through their involvement, Student B could eventually become an expert in a particular specialization and become a leader or manager within that activity. Student A and Student B both hold admirable aspirations, but differ in how they hope to develop from their experience. Acknowledging the need to examine the fundamental structure of an activity can help them choose the club that best aligns with their interests.

Student leaders and faculty advisors can use this approach to better market their own club. Poor member retention was a common lament among interviewees. A large share of new members join the club only to drop out later that year. One potential explanation is that newcomers lack a full understanding of what the activity entails. The experience is not what they expected or hoped for. Even after an introductory overview, newcomers retain misconceptions based on their preconceived ideas and impressions. This often results in a failed investment in students who opt not to stick around. A CHAT analysis and examination of their own club will allow club leaders to better articulate what kind of experience a new member may be able to expect. New members will better understand whether a given activity aligns with their personal interests and motivations. This suggestion can be expanded to other educators seeking to accurately understand and describe a given learning opportunity.

The essence of this thesis is twofold. First, it is a holistic case study of three clubs. It contains valuable findings about those activities in and of themselves. Stakeholders involved in similar activities may find the results useful. Second, and more generally, it provides insight in a useful method to examine an activity system within a pedagogical context. It offers a template for how to use CHAT framework and qualitative research methods to examine co-curricular student clubs and other educational experiences. It suggests broader implications on the importance of understanding an activity based on the fundamental characteristics and relationships among them, in order to address the underlying dynamic of the given activity system. From this study emerged a number of important implications and recommendations. By virtue of these, we can better educate the next generation of engineers.

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# Appendix 1: Interview Materials

## 1.A Interview Protocol

Preamble:

Thank you for participating in this research project. I am conducting this study as a part of my Honors undergraduate thesis. I am interested in several College of Engineering-sponsored student clubs, and the experiences of student participants. Let's get started.

Questions:

1. How are classes going?
    a. Rapport
2. Where did you hear about the club?
    a. I.e. from friends, fliers, a professor, etc.
3. Why did you initially join the club?
    a. Was the motive for resume building, social, to learn, to perform service?
4. Why do you still participate?
    a. Determine whether their motives have changed.
    b. Determine if they are still happy that they joined.
5. What is the objective of the club?
    a. Determine explicit and implicit goals.
        i. Is it to "win"? To gain engineering practice? To have fun? To contribute service or volunteering (e.g. humanitarian engineering club)?
6. When you were new to the club, what key aspects about the club did you learn, and who taught these to you?
    a. How are newer members treated? Is it "sink or swim"? Is there a structured process for newer members?
7. What tasks do you do on a weekly, monthly, and yearly basis?
    a. Probable follow-ups
8. Can you walk me through the [culminating event]?
    a. Culminating event will be the competition, national meeting, trips, etc.
9. What role does this chapter play within a larger parent chapter or national organization?
    a. E.g. is there a national chapter? Do you follow strict procedures from the national chapter? How much oversight do you receive from this national organization? Does funding come from an overseeing body? How flexible is the chapter in its own decision-making?
10. Can you describe the role of the chapter's faculty advisors?
    a. Are faculty mentors highly involved? Is their involvement seen as positive or negative?
    b. Are there other professional mentors, e.g. an advisor from the national chapter or professional engineers?
    c. Question should get at oversight and how much input the chapter receives from non-students.

    d. Can you describe the opportunities you have had to collaborate with professionals and faculty?
    e. Professionals and other students.
11. To your knowledge, how does the club document its work?
    a. Are there technical reports? Required documents? Meeting minutes?
    b. Determine who records these documents, and how important of a role they play.
12. How much of a commitment is the club?
    a. Determine specific time commitment - hrs/wk and where that time is allocated.
    b. With what regularity to you attend?
    c. Determine whether it has always been so, or if they used to be more involved
13. Do you look forward to participating in the meetings and events?
    a. What aspects do you enjoy and not enjoy?
14. If it is a busy week, how do you choose whether to go to the meetings?
    a. What is the priority? Make sure to learn how they prioritize the club. Is it more or less important than classes, friends, etc.?
15. How do you contribute outside of the regularly scheduled meetings?
    a. Are they engaged in contributing in other ways? Try to determine whether they actively seek out opportunities to contribute, or if meetings are more of a "chore".
    b. Individual or with a team?
16. When a deadline approaches, who shoulders most of the work?
    a. Who is responsible? Who helps and who does not?
17. Can you walk me through a challenge your team faced, and how you solved that?
    a. I.e. when that year's challenge first comes out, or a new project, etc.
    b. Make sure student walks through an example.
18. Can you walk me through a time you came had to devise a unique solution to an issue?
    a. Learn more about how much flexibility/creativity they have.
19. What aspect has been the most difficult for you with the club?
    a. On a personal basis and technically.
20. Can you describe a time your team resolved a disagreement or conflict?
    a. Follow up with probes.
    b. Try to walk through specific example.
21. Have you ever encountered an ethical dilemma?
22. What do you see at the most important trait of students that stick with the organization?
    a. Within this question, try to learn what type of student leaves the organization, never getting highly involved.
    b. What do you see as the most important trait to help a student succeed in this organization?
    c. What trait do you see in students that do not stay with the organization?
23. What plans do you have for continued involvement?
    a. Are you going to be an officer next year?

    b. Or, if they will not be back, *would* you join again next year?
24. Reflecting on your experiences, what have gained from your participation in the club?
    a. Determine in what they place most value. The engineering experience? Leadership or teamwork? For fun, or satisfaction?
25. Aside from this club, what other activities are you involved in?
    a. How do they compare? Which do they prefer?
26. What else would you like to share that we have not discussed?

## 1.B Example recruitment flier:

Our research group is seeking participants for a research study. To be eligible for participation you must: be a student in the College of Engineering participating in a student club, at OSU for six months or more, and be at least 18 years of age. Lacking any of these characteristics excludes enrollment. I am conducting research about College of Engineering-sponsored student clubs on campus as part of my undergraduate thesis. I am researching how the activities and structuring of different clubs affect what students learn and take away from their involvement.

My study is title is “Learning outcomes for participants in engineering student organizations” mentored and overseen by Dr. Milo Koretsky, a long time researcher in engineering education. As part of my research, I am conducting semi-structured interviews, which involve a series of interview questions pertaining to your involvement with [inset given student organization]. Interviews last approximately thirty to forty-five minutes. If you are interested in participating, please contact me so we can set up a time to talk about the research and have an interview. If you would like more information about sharing your experience with your club by participating in my interviews, please contact me at hinklec@oregonstate.edu. For other questions, feel free to contact Dr. Milo Koretsky at milo.koretsky@oregonstate.edu.

Best regards,

Christopher Hinkle

# Appendix 2: Example Coding

| Club | Passage from Interviewee | Coding | Emergent Findings |
|---|---|---|---|
| Chemical Car | "[…] you take input from everybody who wants to do a ton of different things and then you just kind of have to like figure out a reaction that incorporates a ton of them so everybody feels like they have participated." | **Rules:** Decision-making deliberately values the interests and curiosities of members.<br><br>**Object:** Object is to learn and experiment with a variety of ideas, rather than a sole emphasis on winning. | Four of six interviewees suggested that learning and education is the primary objective; winning is not the key decision-driver. |
| Formula Racing | "Really what it comes down to is what is the best decision for the car, what is the best decision for the team. And when it is the best decision for the car that not only means cost but also means time also means for us the weight of that thing. Like something we try our best to have a lightweight car but if a really cool design decision weighs more than another we're not going to use that unless it has other benefits to gain points." | **Rules:** Decision-making is metric-oriented. Decisions are made based on how it is predicted to affect points earned at competition.<br><br>**Object:** Gaining points (aka winning) is an important part of the club's object. | Four of five interviewees said decisions are made by predicted effect on points. Four of five interviewees mentioned winning as key objective |
| Humanitarian Engineering | "Maybe the most important thing [I have learned] would be the self-development that I have had because of the necessity for me to think about other ways of thinking. So for example, since it is important to think about how members of the community that we are working with think about something, it has forced me to bring a different approach to problem-solving that involves a lot more input from people's voices that aren't my own." | **Learning outcomes:** Listen to the input of local community members. Different approach to engineering problems: interacting with other people who are impacted. | Six of eight of interviewees highlighted community input and interaction as important to problem-solving or decision-making. |

# Appendix 3: Example Transcripts

## 3.A Chemical Car

(Length: 33:09)

**Where did you hear about [this club]?**

I heard about it through freshman advising. High school senior year I took AP Chem and we did like a Chem E Car competition so then I asked my advisor if there's anything, any clubs like that and she said yeah.

**And what you made you want to join?**

Let's see, I really enjoyed it in high school and so I just kind of thought it would be fun get in contact with the, I don't know with not higher, just older students, more experienced students yeah.

**So you stuck around for a while, what made you keep coming?**

Yeah I really enjoyed it I love problem solving and then creating a final product that, hopefully works, and…

**What do you think are the objectives of the club, the team objectives?**

I think one of the main ones, it's just trying to produce a car that can that runs, but main objectives are more of just like coming up with a design trying to create that design. It probably won't work the first time so you have to redesign it and run experiments and there's a lot of like hands on that kind of thing too and you get different disciplines as well… there's mechanical, electrical stuff and…

**Do you think it's meant to be a learning experience?**

Oh yeah definitely.

**So when you were new to the club, who taught you what was going on, got caught you up to speed?**

Let's see, it was mostly the president at the time but I was a freshman so I was kind of shy so I just kind of watched a lot and got a feel for things and once I knew how everything sort of worked I started providing input.

**Was that at all intimidating or difficult for you or first because you didn't know anything, since you didn't know any of the technical stuff behind it at first?**

Yeah a little bit first at first I didn't think I knew enough about everything to provide useful insight and information and… but then I went into… But then I learned everyone

was kind of in the same boat as well just kind of figuring things out equally. I guess you sort of learn the information just through experiencing what was going on and how things work or just background information through online sources.

**How do you document your work and then pass it on to the next generation of students?**

Google Docs. I was one of the captains last year and I tried to do notebooks so like we split everything up into starting and stopping and then mechanical/electrical teams and they all had their own notebooks and anything that they did they write it down and then we also have the meeting minutes as well from some dedicated person who would go round and just kind of record what was going on to kind of conduct inventory and make sure that all that information was captured.

**Did that work?**

I think so yeah…

**But you're not doing it this year?**

It's a little more relaxed this year we're still doing meeting minutes… right now we're brainstorming phase still I guess we initially started writing stuff down but once we've gotten all the reactions down and all of the details of everything we'll start recording data and making sure that we have everything.

**What's your actual role, what do you do on a weekly basis?**

So I'm one of the captains again so I do the slides and decide what the agenda is going to be each week but a lot of that is dependent on… kind of the stuff that we've accomplished in previous meetings so if one of the meetings we had a brainstorming session and then the next meeting I would assign people to go research about that specific reaction… or piece of equipment and then the next week we would come back and share like our information that we found where, like, what we think and… I guess it would be more of a facilitator and making sure that everyone's on the same page really.

**What about the first couple of years?**

The first couple of years I really would do whatever needed doing.

**So you would do whatever they told you to do or what?**

Yeah so let's see I think it was the starting reaction my first year. They just needed like people to work on that so I was just… started doing experiments and that kind of stuff… we as a group would decide what kind of battery we want and we would test that so lot more hands on stuff at the beginning… which I feel like is nice… because it keeps you

interested and then as you… acquire more information from your classes and maturity you start… giving people assignments to do and…

**Does it feel like you have more work now that you're in a leadership role than you did when you were more of a less of a leadership role?**

A little bit it's not […] overbearing […] it is very doable and […] I don't think it's really more work it's like I've signed up for this position and because I wanted to do this position so it's sort of a responsibility on my part to do what I'm supposed to do for the club.

**How much work do you do outside of the meetings?**

No more than I'd say an hour mostly at this point mostly it's just creating PowerPoint slides for the meetings because I want to make sure… I include everybody in all the decision-making and so it's mostly just making slides or […] or financial things in the club like budget stuff…and also working with CBEE Club as well and I don't […] I feel like that's just of a separate part of the club and more like administrative…

**So do you have your own scheduled board meetings for [the team], like where all the leadership people meet up?**

No we do not all though I think we will start doing that […] once we sort of… figure out all of the reactions and stuff like that. So right now it's just kind of hectic just playing around with what we're going to do once we have that then it'll be more of a team and more but… sub-team I guess you would call it where everyone knows what we're doing and then we'll start doing more of that administrative stuff like updating our website.

**How much of a commitment is it as a whole?**

As a whole like over the four years or […]

**Yeah sure. How much time do you spend on it every week?**

Initially maybe like 2 hours a week and before we started doing Saturday meetings where we actually are testing things and building stuff which is probably more like 5 hours a week once we started doing that.

**Do you look forward to participating?**

Oh yeah.

**All the time?**

Yeah most of the time towards competition it starts getting a little more chaotic making sure we have everything and everything works **s**o we spend a lot more time with the club and but yeah but the brainstorming phase, testing phase, I feel like is a lot of fun.

**As it does get close to the deadline who ends up shouldering most of the weight and feels responsible?**

I think it leans more toward the officers of the club… so we have to submit like the EDP to [the national organization] which is a huge document so in the past I know that the captains spent a lot of time doing that stuff so what I'm trying to do is split it up and have each team like provide their information about what they work on for the document so… it's more like everybody has to like participates in in this document… and then a couple of people volunteer to like do the formatting and grammar and stuff so… I would say like the officers do that kind of stuff but with everybody working on it probably doesn't take more than a couple of hours.

**Oh I see so if it's a really busy week and you have finals coming up and also a report due, how do you prioritize your time?**

So this is a club and so I guess schoolwork comes first so if I know a lot of people have midterms like there is the physics mid-term or something and I get a lot of emails saying oh I won't be in the club this week and they have a paper due or something then I would just like make an executive decision I just sort of cancel the meeting for the week because they can work on school work and because yeah on their school work so yeah it's a priority.

**How you explain the competition, both the regional and national, to someone who does not know anything about what it is like?**

So let's see our regionals is a competition between an average of five different cars and we all compete to see who can get closest to the finish line using chemical reactions and the two closest teams from regionals, or our regionals at least, go to Nationals where it is like 40 teams compete and it's the same format layout trying to stop on a line. And you don't know what the distance is until an hour before the competition so you have to make sure that all of your stopping reactions are calibrated and you have to go this distance and then this specific time. Let's see what else…

**So besides the cars is there anything else do you have to do for it?**

For nationals or regionals I guess again more administrative stuff, we have to ship chemicals so you have to do that prior and shipping the car if it's unsafe or if we're not driving there then it just kind of adds on to the grand schedule and then coordinate for the team who's actually going to be with the car on the competition so you can only have five people working on the car and getting it set up to actually run. So just making sure those people set up and they know what they're doing.

**What's it like do you have fun or is it?**

Yeah it's pretty fun, it's stressful if the car if there's a problem with the car it's a rush trying to figure it out like an hour before because like I know recently at Nationals the stopping reaction wouldn't work so they had to problem solve like 20 or 30 minutes and problem-solve like why it wasn't working and figure out what component was the main reason why and change that component or fix it and test it and then use it… Leading up to the competition it's a pretty stress-free environment… pretty fun and then during the competition… you know there's a little bit of stress to goes into it but it's kind of like fun stress.

**What is your process for when you come up against some kind of challenge like the one you mentioned what's your troubleshooting and problem-solving process look?**

First we try and determine like the source of the problem so just using the Nationals example the car was disqualified because it went over some disqualifying line so we knew it was the stopping reaction because the car was running. So then we checked like the reactions to see if it had changed it all and it didn't so they knew it must have been some component that was wrong, where they did something and using the wrong concentration or something so then you go through the procedure like we did these three things and used this concentration and this amount and why won't it work now, and… just kind of backtrack through the procedure to see where something might have gone wrong and then they figured out that they used the wrong chemical at the start they were using the wrong chemical, so just kind of backtrack and working through the procedure to see where something went wrong. And that's been the best the best way to go about it.

**Can you think of any times you had a conflict on about what to do about something?**

Let's see… 2 years ago or last year with the Innovative team we were doing a gas producing reaction and let's see when we were running our car we had discharge out the back which you can't have any liquid spilling on the court so we tried to figure out why or how we could fix it and there were like a bunch of ideas thrown out there were some people that were dead set on this idea like we have to get a filter to catch all the liquid that does out. There were other people that wanted to increase the number of turns of the pipe before like it hits exhaust. I think we spent maybe 2 weeks trying to decide what the best… and at that point it was more like testing to see what the best so we just tried all the different… I guess all of the ones that we think could have been, we tested them all just to see which one produced the best results.

**Who's the one calling the shots in that situation who's going to make the final decision?**

Probably the team responsible for the car so in this case it was the starting reaction team so whoever was the lead of the starting reaction team so last year and also this year I assigned like people who had been in the club for more than a couple years and knew how it all works to run like a certain aspect of the car so just kind so then it would be a combination of like their input about what they've seen work and also budget so what's the cheapest option. And also the other teams as well because we have to share resources

so I would say a combination between whoever is the captain of the whole entire car and then of the sub captain of whatever specific part of the car it is.

**Who mentors you?**

Mentors […] so I believe right now it's [professor] and then [another professor]. I think [professor] is our advisor and then [second professor] is our mentor I'm sure I could ask…

**So I'm kind of guessing you don't talk to them a lot because you don't know who is supposed to be doing what?**

Yeah we try and so we send a doodle poll about the meetings just to make sure that whatever meeting time they would be able to make that time. I think a year ago [third professor] was the mentor and he showed up a couple of times just to make sure. It's more important toward the end where we have more of a car that's trying to troubleshoot the little things and I feel like they participate a little more than the beginning stage..

**Uh huh okay yeah do you have any other kind of mentors like professional mentors?**

When we were making our batteries a couple of years ago we reached out to the electrical engineering department just to see because it wasn't working as we had planned so just to see if they had any insight or information that would help us. And then also we have a lot of mechanical engineers too so we use their machine shop and I guess maybe mechanical department.

**How about the National Organization that oversees you what role did they play in the club?**

That's where we send all of our documentation to. The competition is through them so they are more of judges I guess. So I guess another part of it is safety aspects of the car just making sure that what we're doing actually what we're doing is safe to run so yeah they are more of a facilitator and like judges so at this beginning stage they hardly ever do anything really. It's more towards like the actual conference itself when they're more involved.

**So I know one of the teams is called the Innovative team how much of what goes in the club feels like it's potentially going out and trying new stuff and innovating and how much of it is using and adapting well-known methods so you can actually be successful and do go that route?**

It's a little bit of both so in past years I used to say it's mostly the starting [mechanism] that changes a lot and that's where we don't rely on previous years' experience because it's like a completely new you know we try and test and figure it out. Stopping I want to say it cycles or we change slightly…This year we're doing thermoelectric which I know maybe four or five years ago they attempted but it didn't actually run so and I guess

batteries as well. So it's more about trying to take previous years' ideas but tweaking them and making them better. So this year we're doing thermoelectric stuff I know four or five years ago that they tried it and it didn't work so we're just trying to improve on their design. Same thing with the stopping reaction as well just tweaking like reactions because that completely changes your times and everything so I don't know it, it brings in new ideas and previous ideas blended together really.

**How much does it feel like does that the objective is to come up with a newer better design or does it feel like it's for your own sake as a learning experience?**

Let's see here [….] I want to say it's a little bit of both but previously like the learning experience a lot of it is like new depending on the reaction. So you pretty much have to relearn everything that goes on with it in that particular reaction or piece of equipment or something so you can draw from previous Knowledge of the different cars and if it worked in the past but you still have to learn what's actually going on in the system.

**Alright so wrapping up with a little bit of reflection what do you think is the hardest part for you being a part of the club?**

I think it's the getting started you're like trying to decide alright this is going to be the reaction and this is what we're going to use and just go with it because, you take input from everybody who wants to do a ton of different things and you have to try to figure out… I guess a reaction that incorporates a ton of them so everybody feels like they have participated and in the end you know you still have to decide alright we're going to do this reaction so that's probably the hardest or most difficult part. But once that's decided it's pretty easy.

**What have you gained from participating?**

I've learned a lot outside of my discipline so […] one of my goals last year was to learn how to program an Arduino and yeah through the club I've gotten a lot of experience from people that I've talked to and previous members with experience with an Arduino. So yeah that just sort of learning. Just passively you learn stuff that you wouldn't really be exposed to outside like in the classroom and stuff.

**What do you think is the […] I'm guessing there are people who come and they are very involved and enthusiastic and stuff and other people come and are more marginally involved and drop out and stuff [...] what do you think is the characteristic that is most important for people to come and get real engaged as opposed to people who and aren't so engaged?**

It's probably mostly the hands-on stuff when we start actually testing it draws a lot of people in because we're actually doing experiments and… let's see I think we have a couple of people that are still just kind of testing the waters and you just try and incorporate them into everything you're doing, and you know they might not even be paying attention but at least you're drawing them in and… almost, not forcing them to

participate but more of like creating opportunity for them to be involved and work on something.

**Yeah so kind of building something to make them feel like they're doing something and being a part of it?**

Yeah.

**So for you what's your plan for continued involvement?**

So I volunteer a lot for the competition at Nationals as just a like a safety coordinator I would say so I want to stay involved through [the national organization] and also I'm debating on asking [professor] to see if I can be like an advisor or something because I will be here anyway.

**For grad school?**

No I got a job at [engineering company] so I will be around anyway so asking if I can tag along and just sort of be a graduate advisor.

**That's cool. Have you aside from this club how would you say your experience in this club compares to what it's like being involved in other co-curricular activities that you do?**
Can you repeat that again?

**So what other clubs or co-curricular activities are you involved in and how did your experience in this club compare to your other ones?**

So I'm also involved with [another club] which I don't know if it technically counts because [this club] is underneath it. I'm [this club's] representative for that so sort of hand-in-hand I update them on the club. Let's see freshman year I went to a couple of different ones the solar car team I think it was but they ended up not being a club and so I guess my experience for this has been […] more involved different than I thought it would be just because I've been around for a long time and I've been a part of it for so long… and I feel like other clubs are probably the same way. It was supposed to be for hands on stuff.

**Cool so have you ever seen any unethical behavior going around with the club or competition or anything?**

No.

**Sweet. Is there anything else about the club that you feel like it's worth mentioning at this time?**

No, I think I have said everything that I needed to say.

## 3.B Formula Racing

(Length: 30:48)

**So how did you first hear about the club?**

I was actually at I had seen it multiple years of the row at the auto show in Portland, [this team] and [another team] had come up [...] I think it was while I was looking for schools actually I talked to some of the people at [this team] at the auto show they gave me a bunch of information about the engineering program and about [this team] and [other team] and I knew where it was when I came on the tour and they showed us where it was so came down here the first day I moved in and came and talked to some people they put me to work.

**So the auto show is at PIR?**

PIR is the racetrack up in Portland. Portland international auto show, so PIAS.

**Anyway what was your reason initially for joining the club?**

I like race cars.

**Alright and then what do you think is the objective or objectives of the club?**

To go fast to win every competition that we enter. I mean try to build a fastest car that we can.

**So you can come in as a freshman and how did you get up to speed how did you learn about how to navigate the team, how is that process?**

It the kind of general process that everybody seems to follow is you show up as a freshman and jokingly they say you push brooms around right. But really what you do is you follow a senior or a grad student and you ask them what can I help with and you do it and then at the end of the year you have a working car which is cool. I like getting my hands dirty working on cars and stuff like that so if I can do that which is close to where I live and where I go to school then that's cool…

**Was that process easy or hard to get integrated with the team?**

It was difficult at first because a lot of times I would come in and ask is there stuff to do and everyone would be so busy that there really would not be much for me to do. And it's also hard when you're trying to balance keeping your grades up and. It is difficult to balance school and formula racing because I work if I took 10 credit then I could be formula racing God but yeah no it's still gotta try and get As. There are certain terms I have been less involved than other terms but… This term has been pretty light for me so it is good.

**So you came on but then you stuck with it you got more involved so what was your reason for what kind of got you and kept you coming?**

I really like C Pow side of things so the combustion powertrain. That's something I have always been interested in with like road cars that sort of like my background is tuning culture and autocross and road racing and that kind of stuff. I never really had any formal Motorsports training I didn't cart professionally when I was younger or anything I would always go out on rental carts and go to drift events and stuff like that. That's kind of why I learned to drive and work with cars you know you drive cars hard you break them so, yeah.

**So you enjoyed working on that part of the car or specifically what about it did you enjoy?**

The [formula racing car] or…?

**Yes, the [formula racing] car.**

You kind of look at it and say I want to work on that just the kind of stuff you're most interested in. I don't know why c-pow why I was drawn to that I kind of like Engine Tuning the whole, not many people know how to punch in numbers to computer and go and make more power out of a car [...] They don't know the science of how to make more power and it combines a lot of different things that combines mechanical engineering, it combines chemical, physics, math. You know you've got a little bit of CS in there as well. It's all encompassing so that's why I like it.

**Alright so when you're working on the car what are you actually doing on a weekly basis or monthly basis?**

As of right now it is a lot of manufacturing [...] I'm learning NX currently I learned a little bit of [inaudible] last year but as of right now I've just kind of been helping out with whatever I can. Mainly on c-pow but other people have had jobs for me to do so I've been doing them. I'd like to drive we'll see if that happens we're having carting day tomorrow and then we're going to Dalles Port probably few weeks from now so that will be good.

**So when you say you want to drive you want to get the opportunity to drive or you want to actually be the driver at the competitions?**

Competitions yeah.

**So can you explain how the competitions work?**

Are you familiar with it at all?

**Not much.**

Okay so basically we travel to multiple different competitions the first one is in I believe May in Michigan and then there's a couple of other U.S. I think they call it Formula SAE and then the ones in Europe are for formula student but it's all kind of the same series. We start off at Michigan and then there's also Lincoln and one down in California somewhere but we don't go to those at least right now. Then we pack up the car and ship it over to Germany to DHBW [Ravensburg] which is the sister school and then they build an electric car as well so you know about that whole partnership?

**I've heard about it.**

As far as the competitions go it's broken down into static and dynamic events. Static events are you know cost, business presentation, design. And then there's a bunch of tech stuff so they can make sure the car can pass technical inspection. And dynamics is skid pad, acceleration, autocross, and endurance. Do you know what all those are?

**Yes.**

So that's that each autocross and endurance run has two runs so two drivers and the drivers change between each run so it's fair so you got two shots two different times to see who can get the better time [...] And then each one of those events has points assigned to it and all those points have need to add up to a thousand points and whatever team has closest to a thousand points at the end of the competition wins. So really it's a big optimization problem of figuring out where can we gain points and then just adjusting the car every year to meet that and then rules change and point values change every year so you have to figure out what you want to focus on every year to make the car better cuz you can say you want to add say 10 horsepower to the car or 15% fuel efficiency but if it's not a point sensitive area then it's not one that's really going to matter as much something that say you know your suspension set up for skid pad say skid pad is worth 50 points more this year then you want to focus on that.

**How much of a commitment has the whole thing been for you?**

Like hours per week?

**Yes both qualitatively and quantitatively.**

Not too bad I mean like I said there have been times when I've been more involved and less involved there have been times when I've been here till 2 in the morning making parts during spring term I gave up the majority of my spring term, or spring break not spring term. Yeah that would be bad. Yeah I have up the majority of my spring break this last year to help put the car together to get ready for competition and there was a couple of nights I was there till 1-2 in the morning and would sleep in til noon and then come back the next day. It's a pretty big commitment but it's no […] it's doable.

**How many hours do you think that translates to?**

Depends on the term anywhere from 10 to 20 but probably around 10 per week as an average.

**Yeah so do you look forward to participating? And what do you look forward to and is there anything you don't look forward to?**

You always kind of have the end goal in mind you always kind of want to see the car done you want to see the car compete and see it win. So that kind of is a big motivating factor to get stuff done. You know people have issues with each other and stuff like that there's always going to be people who are bickering with each other and whatnot so that's never fun but you just try to keep a good attitude and it's going to be fine.

**Yeah so say it's a really busy week with say you have a bunch of midterms and school projects and you also have some stuff coming up for [the team] how do you prioritize there?**

School first. I mean I cannot justify going to competition if my grades are suffering like it's more important I mean yes there is [...] There's a good trade-off to working on [formula racing] and getting that experience because, you know, it translates directly into a job in the industry right? The skills you learn here you can use in the job. It's a little bit more relevant to what I would be doing or what I want to do than the stuff you learn in the class.

**What do you mean by that?**

Like you don't learn […] you don't learn vehicle dynamics really in any classes that kind of stuff and if I wanted to go into the automotive industry that would be something I would want to know. There's certain things that you need to know building a car designing a car that if you want to go into the automotive industry that is really important.
**Yeah okay.**

You learn that here so.

**How much of your time you spending meetings forces schedule and work schedule work versus time on your own that you're kind of putting in extra?**

Could you repeat that sorry?

**Sorry it's how much time do you spend in meetings and scheduled work periods. And how much time do you spend coming in extra staying late over, that kind of thing?**

I just kind of come in when I can. I mean I come during the Saturday work sessions all the time but if I have time during the middle of the week I just come in when I can I don't

really sit down in too many meetings it's kind of more when I get here I ask what can I do or I already know what I'm doing.

**So you don't really go to the meetings?**

Oh the team meetings on Monday yeah I go to those. That's always on Monday at 7:00 doesn't really get in the way of anything.

**Okay so when there's a deadline coming up who ends up shouldering the weight feeling the responsibility doing most of the work?**

At least from what I can tell the majority of the grunt work of the design and building the car is done by by for senior projects. So a lot of the times it is their responsibility to get it done from at least from what I understand we have had people you know fail to meet deadlines and then that typically falls on either underclassmen who know what they are doing or the grad students. Last year I was machining a lot of parts for c-pow just so I spent a lot of hours in the machine shop. That was partially because I asked a senior if I could help him and he really appreciated it and some of it was stuff that didn't get done on time and needed to get done to get the car together which was more over spring break. I mean it happens but you got to do what you got to do to get done and it gets done no matter what.

**What role do you guys play within a bigger National SAE organization?**

What role?

**Yeah what is the relationship between you guys and the National Organization?**

Well I have not gone to competition yet which is something I am definitely doing this year. I had stuff go on during school it was a pretty rough term for me both freshman and sophomore during spring term when we go to the first one and I was working all summer so I decided not to go to Germany or anything but this year I am hoping to go. But as far our relationship within SAE from what I understand it's just kind of just the sanctioning body for the competition as far as our relationship with other teens we are pretty successful and in past years. The last year or two it has been a little iffy we had a fast car but not so much reliable so that is something obviously that we need to work on so I think teams kind of see us as a pretty solid consistent team but definitely in the last couple of years has been a little interesting.

**So what about the […] I assume you have some sort of faculty mentors or how much of a role do the mentors play?**

Dr. [professor] plays a pretty large role he is probably one of the most active faculty advisors or at least that is what everyone says I see him pretty often around here but I have talked to him a handful of times he does not really do too much concerned with what like I'm doing I'm not making you know really large decisions, design decisions or management decisions, that's kind of more what he oversees.

**What, how do you end up documenting all of your work?**

It is all in as far as part files and drawings and reports and stuff like that is all in Google Drive for the most part [...] Google Drive and then the CAD model is this year and NX in the collaborative work space and it was in [inaudible] last year.

**How do you end up transferring all this knowledge and information say it's a successful team one year how do you transfer that down to the next?**

That is one thing I've kind of been wondering that seems to be at least last year kind of one of the weak points if the team and I was really interested in learning NX and the guy who was doing it just did it by himself basically and he didn't really transfer any of the knowledge I guess. I think that is something we are definitely working on this year from what I understand it even just walking through the doors starting a new year this year it seems like there's a much better team dynamic than there was last year so that's good.

**So what is like an example of something unexpected that happened and what was the approach for solving. What is the [team's] approach to solving some kind of issue?**

Get it done haha don't really waste any time you just figure out what needs to get done and who's gonna do and do it. If someone doesn't get their stuff done then somebody else has to make up for it that's not you don't shame them into doing it it's just it gets done.

**Yeah so do you have conflicts where there's a disagreement on which which path to take or?**

I have not experienced any of that. I'm not really in a position where I am doing much design stuff, and that's I think where the majority of those things happened. Yeah I don't really experience that.

**If you know if there was like if the stuff you're working on there's two factions that can't agree on what designs to make what is the mechanism for making that decision?**

Which one is going to make the car faster. Yeah what is going to be reliable, light, and fast.

**So you use a lot of metrics too?**

Yeah there the general design philosophy on the team as well basically: lightweight, reliable, simple.

**So it started trade-off between, are you choosing that over?**

Yeah a lot of teams will go make 4 cylinder engine or a custom-built 2 liter V8 or whatever the heck they do and it's not reliable and it's heavy and the car can't handle but it is cool. But it does not win competitions so it's the whole thing you focus on the areas that are most sensitive to points.

**Yeah that makes sense is there a sort of is there an official strategy because you said there is a strategy for light and reliable. Is there an official structure for that?**

I mean there is rules for that.

**Within your team or?**

No for all of SAE for the competition I mean there is technical rules that you have to abide by that is what tech inspection and all that stuff is for.

**Within your team do you have some sort of decision-making guidelines to say if we have to choose between two designs we go with this is one because it's lighter and more reliable?**

Yes typically yes it's not you know the most solid structure. Most people just design stuff and it works. I haven't really had too much experience with that yet. So guess I will find out.

**So usually do you do pretty well known designs that a log of people have done and that you can find a lot of resources on, or do you try out new things that have not been tried as much trying to get an advantage there?**

Yeah yes we do. A lot of the times we'll take stuff from previous years and make better slightly and just make incremental increases but. Yeah there is stuff on C Pow that we did last year that we talked about doing this year actually that we were thinking about adding a secondary throttle body and that is something we have to ask rules questions about to the SAE or Formula Student. We have to pose a rules question and say hey can we do this? And if they say no then we can't do it.

**So how does it work when you ask a question? You shoot them an email?**

I would not be the person to ask. You would have to ask [officer], he's the one that would be doing that.

**So do you have, what is your role on the team do you have an official role or is more like you work on that?**

Yeah I work C Pow and whatever else people throw at me. I'd like to drive, we'll see if that happens this year. It all comes down to skill and who's the fastest so [...]

**What for you personally what has been the most difficult part of being a part of the club?**

I think the most difficult part is that initial and I think it is what drives a lot of people away from the club actually, is the initial freshman year you get really excited about working on stuff and then you realize there's not much for me to do. I think that it's something we are definitely working on the least from what I understand and actually creating structured files where freshman can go in and look at a Google Doc and it says here are the jobs you can do that will take you know an hour or two hours whatever and you check it off whoever did it and then you run it past an advisor. But I think they come into the team thinking they can get their hands on the engine right away and design wings and stuff like that and a lot of that is stuff that is assigned to senior projects and that is why it can't be done by a freshman but when I came in I did not realize that, nobody explained that to me, so I was asking always to do things that I couldn't do, so.
**And how did that work out?**

I just ended up doing work so it was fine.

**So the students that do come and stick around. What traits do you see in those students as opposed to the ones that come and get scared off or drop out?**

Yeah that is a good question. I think people who are really passionate about and racing and automotive, it is really the passionate will keep them in it like if they are excited about it they are gonna keep doing it. If it is something they are really into there's no reason for them to stop doing it you know unless they get discouraged or something or they see something they don't like. But I mean that's why I'm still here it's something I really enjoy something I want to do as a career so why not get started on it now?

**So the students there end up dropping out how about them?**

I think a lot of the times and I haven't really it's not really a reason I have pulled back by involvement a couple of times but I think it's a lack of stuff to do and also it might just not be what they are interested in. They might think you come out and race cars you get to drive race cars and they might not realize there's a shit ton of work that goes into this it's like a full-time job for some people here and I don't think they realize that you know you have all of the fun events at the beginning of the year. We're going karting tomorrow we're going to Dalles Port everybody drives the car on an abandoned airstrip. Like it's cool stuff and then you get back to Corvallis and you go back to pushing brooms so I think that can deter some people but if they've got you know the passion for it and they're really excited about it then I think that will keep people interested I know my freshman year in particular my friend [name] you could tell when he was speaking to everybody in front of the room that this was his thing he really loves this like it's is his passion and I it was infectious and I felt the same way so it you kind of relate to that and you say I want to keep doing this and I think some people get that some people don't. And it's kind of the deciding factor and this year I don't know if you saw that tends to the meeting but like I think last year we maybe had 45 people filling the room and what was it Rogers 228 or

whatever it is and this year we filled up almost all of Dearborn 118 which of the big lecture hall […] we like had 150 freshman there.

**So why do think is that?**

I think we just did a better job of getting the name of the team out there getting the cookies and clubs I think that was a really big event for us I mean that's I think we got a hundred and twenty people signed up on the interest list at that event alone and they all came. Which is cool so.

**Do you, have you ever have you seen ever seen any ethical issues with what some of the people are doing?**

No.

**So you are a junior right? What is your plans for continued involvement next year the rest of this year moving forward?**

Yeah I mean just continuing to balance it with school trying to get my own projects to work on some larger projects that I can work on some larger projects that I can spend some more time on but also figuring out you know what is reasonable to balance with my school work and that is what everyone does here I think with more people on the team and specifically more people who have been around especially next year we will be really good if we've got all the freshmen here this year that spend a decent amount of time on the team and know what's going on if they are all around next year and are integrated with the team again it's going to be killer. I will do my capstone with [the team] continue to do projects for them and hopefully drive.

**So when someone like [experienced older member] is going to move on how do you see the club feeling those rolls of senior leaders?**

I think it's kind of setup you know seniority or whatever people just kind of move up into the other position people who follow people like [older member] they'll move up into positions like him [older member] has been around for a long time he has been around for 6 years I think and he will be here for a couple more but yeah it is really good to have somebody who's been around for such a long time because he knows everything about the car he knows everything about every individual subsystem so it's, he can just fit in with whatever team which is kinda cool.

**So as kind of a reflection what do you think is the best thing that you have gotten out of it?**

Really just the knowledge. There is stuff that I haven't like higher-level stuff that you would not learn in the class room you can learn through [formula racing] and it's fun especially when you go to competition and drive and all that kind of stuff there's a fun factor to it if you're into it. Yeah I mean yeah I can't really say anything else about it.

**Yeah that makes sense what about the other students that you have that are part of it do you think it is the same for them?**

Yeah I mean I've met some of my best friends have joined the team and stuff like that too. I had a lot of friends I made freshman year who that first year we were all together we all came in at the same time and worked in the same projects and it was a good time. What was your question?

**If you think about the other students that the reasons they are joining what they are getting out of it do you think it is similar to what you said?**

Yeah there has been [...] I know a lot of people who have not continued to work on the team [...] And it's just because they told me they didn't have anything to do they felt like they were not getting anything out of it it's just a lot of grunt work which [...] Really I don't think they were asking enough questions right... They really weren't really that interested in it [...] They were just there showing I think what they were looking for was like how do I get into a position where I can have a little bit more say in something and that's not really what it's about; it's more about learning and then applying that knowledge [...] Right?

**Kind of like earning that spot? Instead of looking for it?**

Right which is what they wanted to do and they they realized they couldn't get that through the route they wanted to do it and that as well a lot of them has other commitments a lot are in fraternities and sororities and I know not many girls are on the team but [...]

**Yeah how do you compare your experiences with [formula racing] with the other experiences you have had in college with classes and other clubs you have been a part of?**

I have not really been a part of, this is the only thing I've been a part of been in. As far as compared to class if it's not really you're learning in a different way you're not sitting in a lecture listening to someone babble on for an hour about differential equations or whatever […] It's a lot more fun. I enjoy it sometimes I will put off if I'm feeling frustrated with homework or whatever I'll just pop in here for a couple hours get my hands dirty and then I'll go home and I'll be ready to work on homework.

**That's cool can you think of anything else you want to talk about that I did not touch on?**

Nothing I can think of no.

## 3.C Humanitarian Engineering
(Length: 45:30)

**So where did you hear about [this club]? Initially?**

From a friend he was trying to get me to go to the meetings freshman year but I didn't end up going until sophomore year when there was the new program?

**And what convinced you to join?**

What convinced me to join… the answer I should give is altruism, but I think it was a desire to be more involved on campus and because you know my freshman year I didn't do anything definitely that would be the primary thing just get involved and being around people and obviously the club had cool stuff going on too.

**So obviously you stuck with it so what kept you going once you came?**

A combination of sense of duty I think like once you take on enough tasks and responsibilities you kind of feel obligated in a good way. That and just a sense of kind of community within the people that were or are in the club.

**Okay what do you think what are the objectives of the club in your opinion?**

The objectives of the club? To, got to get my elevator pitch, basically to develop sustainable projects with basically to have a group of students develop sustainable projects and in developing countries and or even here that are community driven and… basically from start to finish.

**When so you joined as a sophomore right?**
Yes.

**So when you were new to the club who taught you what was going on and brought you up to speed?**

Well I had the… fortunate case of coming in on the ground floor with the new project so there were a lot of people that didn't know what was going on so probably like I can't remember exactly but probably [program coordinator] during the first couple meetings they were the ones that seemed to know what was going on.

**Was there any kind of formal reading or meetings or something to help the new members get up to speed?**

Nothing specific but I think everyone was kind of getting up to speed at the same time or adapting at least just because it was sort or an explorative project in the first place… Yes and the sense that everybody had to. No in the sense that there was nothing separate from the regular group, at least.

**Yeah that makes sense so for you personally, what do you actually do for the club on a weekly basis or a monthly basis?**

That's changed a lot over the years, I was the… the first year in the club I was mostly just doing you know trying to get as involved in as many tasks or report that need to be written or things that needed to get done by somebody, and just trying to do those to be an actively-involved person in the club but now I feel like my role has shifted a little bit I was the Planning Monitoring and Evaluation Learning Lead last year and… which had some sort of sense of responsibility attached to it but now my role is more along the lines of guiding other people and being an elder voice in the sense that I am most familiar with the project probably among many of the members.

**So what does that actually look like on what are you doing on a weekly basis?**

To actually answer your question what am I actually doing on a weekly basis well for example I just got out of a meeting with [another student] who is the other head for the basically we have two groups, the technical group and the community interfacing group and [the other student] and I just got done talking about basically the agenda that we wanted to go through today. So developing agendas for smaller groups that we're working with and sort of crafting a plan for work that others can get done.

**Okay how much of a commitment has it been?**

A large commitment haha […] do you want me to give you hours per week or hours per month or?

**Sure yeah just on average.**

I think on average probably about… it totally depends on the time too, some weeks I don't spend any time on it and other weeks I spent 3 or 4 hours maybe more and last year leading up to the trip it was probably about 6 hours a week before we left just going through a bunch of trip tasks and so definitely before a report's due it's a lot more work.

**Do you look forward to participating?**

Yes definitely, I think it's interesting role to like kind of have in college I guess. Sort of a real life scenario that you might not get in just a classroom setting.

**Yeah so if, do you look forward to all of it or is there some stuff you don't look forward to or? What do you like the most?**

Like different activities and stuff like that?
**Yes.**

I look forward to the group meetings I think the most because that's the time when everybody is most… most able to communicate about new things that are happening in the project. It's also the most social setting and I'm a fairly social person so that's where I like to be haha I am not a huge fan of doing a lot of report writing by myself haha I like doing that with others generally because I like to be able to bounce my ideas off…

**Ok. If it's a busy week and you have a bunch of midterms and also an [club] report due you, how do you prioritize your time?**

That's a good question that hasn't really been too much of a problem for me actually generally because I'm not the one who solely responsible about turning the report and haha I think to be honest but… I would say I juggle it by prioritizing school first. [The club] is, it depends like if there's a report due the next day that's going to have to get done, but if there's a report due Friday and I have a midterm Monday then I'm going to just put it off because I have to do the midterm.

**Okay so who does have to shoulder most of the weight once you're getting towards the deadline?**

Definitely the project lead.

**And beyond that is it just a project lead or do you see some other people shouldering the weight?**

In the past has been mostly the project leader I think last year under [last year's lead] leadership he shouldered quite a bit of the weight… I think [current lead] this year is trying to do more delegation, splitting up two subgroups and being more of a delegator rather than being a you know person responsible for everything in some kind of sense but he's also the primary point of contact for the community so there is inherent responsibility that others might not necessarily have.

**What how about with other work in the club is it does it seem like a lot of the work is pretty evenly distributed or do some people get more of the work?**

Yeah, it is getting better, there is still disparity I think but as […] I'm hopeful, optimistic that as we kind of go into the next term with more time concrete work to do that there'll be easier distribution of labor and kind of more clear hierarchy of who's in charge of what and who, who to ask questions basically about what they should be doing.

**How much do you work do you do in the meetings versus outside of the scheduled meetings?**

Probably like 80% meetings and 20% outside meetings depending on the week obviously sometimes if we have a work party it'll be 50 since we only meet once a week it's kind of depends but generally I will have a meeting outside of the meeting once a week as well just to kind of go over an agenda that we want to talk about during the meeting or just

you know either that or time spent writing emails back and forth so… so I think in that sense there's a lot more communication right now about how the meetings are going to happen than maybe there has been in the past whereas the sole responsibility for coming up with ideas for what we're going to do in the meeting or drafting a meeting agenda isn't solely only on the project lead.

**Yeah what can you, so how would you explain—kind of switching gears—you went to Cambodia last winter break right, how would you explain what traveling is like to somebody who doesn't know anything about it?**

How do I explain it […] it's a lot… You learn things you didn't expect to learn. So I guess […]

**So how does the process work and then what's it what's it, just like to go?**

Okay. The process for going on the trip it pretty like, there's a lot with [the club] there's a lot, basically this whole task list that you have to get done so there is two months or so maybe 3 months prior to travel that every member that is going to be traveling meets probably once a week to discuss logistics and to basically write all these reports that [the national organization] has us write, so they have us do a safety report, a task plan timeline, all these other documents that have to be submitted and accepted […] the process is fairly involved leading up to going on the trip, and then the process of the trip is, you're just kinda there.

**Also pretty involved?**

Yeah it's in the moment you kind of have to be working on the fly, for sure.

**So what tasks did you do on your trip?**

On the trip a lot of surveying that was a big part of it when we got to the community a lot of walking around in the hot sun and sweating a bunch and surveying in the sense that we would talk to community members and figure out what the wells were like and what they thought about our project and that sort of thing. And also do a little bit of surveying of the road to kind of get some elevation […] general idea of what the elevation was in certain areas and do a little bit of pipeline surveying as well so lots of feet on the ground.

**So where you staying with a host family?**

We were staying with a host family yeah and they basically housed us and on their front porch because it was warm enough that we could just sleep in hammocks on the front porch and provided a kitchen for our translators to cook our meals for us and sort of organized logistics for us, getting around the community as well…

**More from a… not necessarily what you did standpoint, but what it was like going on the trip… and how it influenced your involvement with the club…?**

Okay going on the trip was amazing. It's funny, the entire time leading up to a trip I didn't know what to expect and the entire time I was in the trip I didn't know what to expect next. It was always it's just sort of flying by the seat of my pants or however that saying goes and so […] a lot of adaptive learning was taking place like *oh turns out there's 60 wells here not 4, okay now what do we do?* And that sort of thing where that was really fun to me… it was fun to be in the moment like that and I will not sure what the rest of your question was…

**How did it influence your involvement?**

It switched my role basically instead of being someone who was planning and sort of being a support role, it was more of the leadership role because there is certain things about the community that you are not necessarily going to be able to know unless you've been there, because of the experiential learning you get while you're there is just so much in such a small period of time that it's hard to, you can't really explain seven days' worth of experience to anyone in any period of time you know you take a long time to explain that to the whole group… and so I guess there's a lot of, my role is now more one of… Okay […] what do you think the community would think about this for example or what does this, does this plan that we have that we're thinking about in the conversation with this group line up with what you saw while you were there […] so more of a reality checker or a […] reference […]

**So having realized that, do you think that […] to make you think about the students who have not gotten the chance to travel yet did it give you any ideas about how to get them or involved?**

Did traveling give me any more ideas about how to get them more involved? Not really I think that's been a really that's been a struggle in general with the club and I think it's there's a lot of factors that will play into that… I think uh… no not really I did not learn anything on that trip that made me think oh this is how to get people more involved because of the things I did on the trip…

**Yeah what roles do the mentors play for the club?**

Like by [mentor]…

**Yeah so any kind of mentor that's not a student, so that's faculty mentors and then trip mentors and any other kind of mentors?**

There are, there we ask are we doing this right? like basically they are the people that we reference and so when we are in the design stage they are the people that sign off on our design making sure that we're not building something that's a really bad idea or during the assessment phase when we are first there, they are the people that go along with us on the trip to sort of be a guide in the sense that this is all this is how you do a survey or this is how you […] I'm thinking this is what's up with the groundwater in this area… how

about we approach our thinking in this way, because of their experience that they've had. So again they're a reference for experience because none of us really have that technical know-how or breadth of knowledge…

**So who is playing that role, which mentor is that?**

That would be like the travel mentor, I am… I don't really interface much with the faculty mentors or haven't in the past I mean I see him at like potlucks and stuff and the mingles we have with them but I think part of that is because our team is isn't in the design phase so we haven't really had to bounce a lot of ideas of people yet for a little while we had some faculty a I forgot her name but she does she's a member of the anthropology department and she came to a couple of our meetings kind of giving us you know, pre-assessment advice about what to think about anthropology-wise.

**So the anthropology professor was that someone went to and asked for that or did she kind of reach out an offer?**

I don't know I was not a part of that… I know that like [previous project lead/coordinator] was having some conversation with her I don't know she emailed him first or he emailed the department.

**So how does knowledge get transferred say from one say one generation of students to the next?**

Well, reports are a really good way to do that, written reports because it's essentially the idea with the report is that everything that should be known about a project is included so… if you have a pre-assessment report, your pre-assessment report should include all of the information that would be needed to be known, for not only that trip but kind of for where the whole project was. We also have an annual report, I know [club president] just published one of those…

**How do you document all of your work besides all of your reports?**

Oh you mean in general? All, all of our all of our work is done in a shared [Google] drive which is side note, needs to be cleaned up a little bit I think we need to organize it a little bit better but that's a monumental task haha haha but yeah. In there so if a document needs to be found or that was done like a year ago or a year and a half ago can be accessed by anyone who has access to the drive which everyone who's a member gets access to the drive so…

**What role does the national [name of organization] organization play?**

They are out… they offer us guidelines and a process so both materials to help us succeed in a sense that we haven't done a water project before which is not true for us but say we had not done a water project before, they have a bunch of materials on their website and we can also email them to say okay what questions might we need to be asking about a

water project and you know, project X and they would answer those questions for us. And then in the sense that they offer a procedure they also have, they're the ones that are, they are the ones we submit reports to so it's in that sense they are kind of guiding us through the process of making sure that we are doing things right.

**Does it tend to be they force you to do it or you go to them for help or how does that work?**

Well both I mean to be an [the club's sponsoring organization] program we are required to basically abide by their process to be able to have a report that is associated with them so in that sense we are forced to … but the additionally we go to them for anything we need help for example we couldn't find a mentor we asked them do you know of anybody in this area that might be a good resource or who to ask about that sort of thing. And then when we were planning for our assessment trip last year and there was a lot of, okay, what might a survey look like? Or what might, what things might you be to think about while talking to a water board, and they have a bunch of resources. And that sort of thing. And also we have an email contact or many contacts actually to ask questions about those sort of things.

**Okay for you personally what has been the hardest part about being involved with the club?**

Hardest part about being involved […] probably navigating stress so navigating both stress coming from having a report that is due and also stress in a Meta sense of like are we doing what's right for the community.

**Okay.**

Are we, is this going to succeed? So it's a lot more actually not necessarily that kind of stress but what keeps you on track to make sure that you keep asking the right questions.

**Right so like when you're trying to figure out what you want to do with your project worrying about is this the right choice we're making?**
**Yeah.**

**Okay. Does it feel like when you're implementing designs and projects, and I know you said you're not quite in the implementation phase…**

No. But we have done some research.

**Does it feel like you mostly go with pretty well-tested and well-known methods that the club is pretty familiar with or are you more trying out new things and seeing if you can figure out new way to do it?**

Generally following this principle hence that… the first thing. That we go with the things that have been well tested mostly because when you're creating solutions for the

developing world it's not generally a good idea to be experimental because there is a lot on the line. Because a lot of what we're doing is referencing designs that have been done in the past, I think where we're a little bit more like breaking new ground is just because the communities are all so different so there's different things you have to consider for each case… for example navigating the situation in the community we are going to be working in is a lot different than what maybe Nicaragua is navigating. Because everybody in the community we are working in live somewhat close to a well, most of the members in the community live close to a well so there's sort of a different set of dynamics than you have to think about when you're doing the design. So it's not like we had a template, really, however there are tested ways that have been proven to do things because there we are not egotistical enough to think that we know better than thousands of people who are doing that right now.

**So it is kind of like figuring out more how to apply concepts to new situation?**
Right.

**That makes sense… do you ever have disagreements in the team about what options to go with or how to make a decision?**

Certainly. I don't, I can't remember a time when there was a really big disagreement I know that when we were in the community there were a couple things that were like is this the right way to go about this is the right way to think about this or it's…

**So how did you settle that?**

I guess through discussion haha. Like I said there really never was at least during the trip anything honestly or at home in our group meetings that I can think of where there was such big disagreement that there was no resolution through discussion.

**So when you are trying to come up with a resolution say you have your alternatives that you're looking at and probably not everybody's going to agree on that same thing, what is your method for ultimately choosing on what you're going to go with?**

Yeah we have a—that's a good question—we did a, I forget what it's called, some kind of design matrix basically it's an alternatives analysis where you look at all the options and then have people who are informed in those options, rate how they think those options work and then you get an average of the ratings of a bunch of different people and whatever alternative has the highest rated average for a certain parameter – that's the best option for that parameter. And then all of those parameters get a certain weight and those weights go into a total number that says, okay, this is the project you should do. So kind of crowd-sourced approach.

**Okay so what's a can you think up like specific challenges that you had to figure out and how you, how you ultimately decided on what to go with?**

Like a specific case?

**Yeah.**

Okay yeah there was a tough challenge haha over the summer trying to figure out if we were going to try and push for an implementation trip or it we would do another second assessment trip. So kind of at the end of last spring we were like okay over the summer we're going to meet and we're going to come up with designs for the fall and for the winter we will be traveling and implementing a system. And then the road to the community got flooded and so somebody that we were going to have to do tests, vital tests for us, wasn't able to get into the community so we had to have a really sort of serious discussion about what what was going to happen next in the project. And I think some people were really wanting to push for the project to, you know implement because it's exciting. And there were others who were… okay well maybe I was arguing for us push for another assessment and other people were pushing for that so… I think the how do we come to a resolution on that? Sort of out of necessity I guess. The ultimately that was a decision that [the program coordinator] and I made and that was mostly because there was really low attendance at the summer meetings. There was like three or four people there. Which was obviously it wasn't an ideal situation but we had to make the best of it because I think for most of these large decisions nobody wants to make them for themselves because they are so important that you don't want to be the one responsible. And so I'm kind of rambling but…

**So speaking of low attendance, what do you see as the most important trait between the people who come and get really involved or enthusiastic and do a lot for the club as opposed to someone that comes maybe in a similar situation joins at a similar time in their college but ends up not getting as involved and don't end up contributing as much?**

Hm it's probably different for everybody a little bit. I think I can give you like…

**Just because I know the club has had some problems retaining people and I'm wondering what you think and also looking at different people and their involvement some people get really involved some people not so much […] So obviously it's going to be on a case-by-case basis but do you see any differences between the people that stick around a lot in the people that don't do so much?**

I think the people that tend to stick around tend to be more confident in their opinions. At least that's what I see, the people to stick around are usually the people that are talking more… For better or for worse that's just something that I've observed. That's not entirely always true there are plenty of people that come to every meeting or come to like a lot of meetings and don't necessarily say anything or contribute in that way, and they are contributing in other ways obviously but… I don't know if that entirely holds true but I think the people that tend to be the most involved tend to be the people that have confident voices… and I don't know where that confidence comes from, if it's like a confidence to feel welcomed in like the club environment and I don't mean confidence in

the sense that it's like their internal confidence, but I think they are just confident in the club setting. They are people who feel like their voice is valued.

**Was that hard for you at all when you joined initially to feel like you were welcome, and that you have work to do and you were really a part of it?**

At the very start a little bit because I think there is just such a steep learning curve that there's a lot to soak in at the very start and I mean like I said I was fortunate enough to come in at the ground floor so I feel like there were a lot of people in that boat so I don't really have the, I don't really know what it would be like to join now… because the project is in such a different spot and like everybody knows so much more than we did two years ago.

**Were you just going to this Cambodia meetings or where you also going to the general meeting?**

I primarily went to the Cambodia meetings I went to a fair number of the general meetings my sophomore year more for like the social aspect than for learning about the club is generally why I went to them, but I don't think I have been to a single Nicaragua meeting intentionally, maybe I stopped in to say hello when we had the meetings at the same time.

**Have you seen anyone in the club doing stuff that was unethical?**

Not that I can think of. I had to think for a while cuz […] no.

**Okay so reflecting on your experiences, what do you think is so far the best thing that you have gotten out of it?**

Okay let's see… oh goodness that is a hard question…

**Or not necessarily the best thing but what have you gained from it?**

Okay sure. Everybody's asked the question what do you learn from the trip? …and I'm always drawing a blank because it's always the things that I, I think for me it's things that I don't recognize that I learned that're the most important things that I learned, so going into the trip it's like… everything that you expect to learn you probably already know. So if I expect to go to the community or I expect to be involved in this project and learn about how to interact with other cultures well then I already have this preconceived notion about what interacting with another culture is like and so… but it's things that I don't necessarily recognize as being things that I've learned that end up being most important. But to answer your question in a way that's not really vague, I think like real world experience and a different perspective that I didn't necessarily expect. Maybe the most important thing would be the self-development that I have had because of the necessity for me to think about things […] because of the necessity for me to think about other ways of thinking… so for example, since it is important to think about how

members of the community that we are working with might think about something, it has forced me to bring a different approach to problem solving that involves a lot more input from people's voices that are other than my own.

**Okay. What are your plans for continued involvement? Because you're a junior?**
I'm a senior.

**You're a senior? Okay.**

Make sure that things go smoothly in the transition to the next leaders of the club and that sort of thing.

**Would you do anything differently if you had the option of joining again and doing it all over again?**

Like if I was a freshman or sophomore I guess? I don't think so I maybe wouldn't be [officer position] coordinator because that was a lot of stress added on to my fall term last year in addition to being a traveler, but that's more of just like a personal stress handling thing than it is a club experience…

**So what other co-curricular activities are you involved in and how would say your experience in [this club] compares and differs from those other experiences like other clubs or campus jobs or anything else?**

Okay it varies very much so it's the only one that I have that is technical in an engineering sense, all the other co-curricular things that I do like I am involved in the music department here on campus, I work in a café. And I also do as of this year I do sound editing production work for the College of Engineering and so those are all things that are not really engineering heavy […] except for maybe be in concept and theory you know like but they are not really actually interfacing with other professionals on engineering problems, so that's the big difference. It's the only club that I am a part of so there is that…

**How about compared to the classroom and what you're learning in your formal education?**

It feels a lot more like engineering than the classroom does […] the classroom is really theory based and well, you know, learn all these concepts and I think engineering in general tends to be a lot more "trial and error" a bit more, you know, rule of thumb based… and that tends to be a lot more what we do [in this club] because it's like well, you could try and do math here but it's just going to be a waste of your time you know that this will work and so that's nice to have that perspective that maybe I wouldn't have gotten if I hadn't been in the club. Which is not to say that those theories are not important – it's just to say that you don't necessarily need to think about it too hard all the time.

**Yeah, cool… so is there anything we didn't touch on that you feel like is worth mentioning about the club?**

Nothing that I can think of you were pretty in depth. I think I'd like to see our club improve on member retention, whatever that means. It's been something that was struggled with a bit in the past and in the present and something that I've like tried to advocate for. But I don't really think I know how to do that best so it's not something I really advocate for well…

**So is that something the club is actively working on right now?**

Yes.

**What are you guys working on to try and fix that?**

Subdivision of labor. That's the big thing, having more people responsible for smaller tasks so instead of having just the project manager we have team leads for… basically we have 4 team leads within our project team so there is two people that are the lead of the technical side and two that are the lead of community interfacing… and just that subdivision of labor kind of makes the hierarchy have smaller steps.

**Do you think about is working?**

We will see, we start this term…

**No opinion so far?**

Well, I don't know we should probably ask for input on how they think it goes…

**Yeah that's a good point. So previously did you feel like the subdivision of labor was mostly one person doing a lot of the work?**

Yeah I feel like it was one person doing a lot of the work coupled with people that were seniors in the club. Who knew how to do most of the work and could communicate about it.

**Or the travelers?**

And I mean that's not too different right now. It's just that now we're trying to, with the breakdown of the hierarchy, now the people who are the project lead or the team leads on the project, can bring on more people to be in direct communication with them, so instead of having a project lead that all the seniors talk to, now you have four team leads that ideally everybody can talk to and they can talk with the project lead and sort of like that…

**Do you know if Nicaragua is also doing that?**

I know that there has been some communication in the board meetings…

**Do you go to those?**

Not any more.

**You did last year?**

I did when I was a [officer position].

**So what happened at the board meeting?**

That's where all the behind the scenes stuff happens. You know all the finances and the more business side of things as well as the kind of planning overall that's where the general meanings get planned and outreach and fundraising obviously and… general planning of club activities that don't necessarily pertain to the projects.