DISCURSIVE RESOURCES IN THE EVERYDAY CONSTRUCTION OF ENGINEERING KNOWLEDGE

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By

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A candidate for the degree of

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And hereby certify that, in their opinion, it is worthy of acceptance.

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TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

ABSTRACT

Science and Technology Studies (STS) is interdisciplinary and concerned with showing in various ways how it is that science and technology are social. Within STS, lab studies literature has made some very important contributions by showing how lab members construct scientific knowledge, and by showing the co-construction of science and scientists. But other important questions have been neglected such as what are the conditions of possibility in which lab work is embedded? And how do lab members draw on resources from outside the lab? This study has been an effort to sketch out some answers to these questions. In terms of conditions of possibility, I have shown that lab members can rely on more than resources like machines, lab leaders, articles, and knowledge about these things to construct the realities of their lives. They also draw on a number of discursive resources, including the body, spirituality, business, and the national to do what they recognize as robotic vision engineering. Discursive resources are culturally intelligible and prototypical storylines and clusters of categories available to us to construct our experiences as meaningful (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). And these discursive resources function in different ways in the lab. They can be used to explain behavior and events, assign motives to lab members, to tell atrocity stories, to construct contexts, and to discount particular kinds of knowledge about lab members.

CHAPTER 1:

A SOCIOLOGIST VISITS THE LABORATORY

I wasn't a complete newcomer to EARL – the Engineering And Research Laboratory – when I first started fieldwork there. Sure, I had never taken an engineering course or a computer science course. But my novice role was not complete. Latour and Woolgar (1979), in their chapter "An Anthropologist Visits the Laboratory", which inspired the title of this chapter, argue that the observer is never a complete novice because s/he brings cultural knowledge with them to make sense of lab life. We don't start with a blank slate. We start right in the middle of things. I was no different. I was familiar with labs from chemistry and biology classes in high school. And a sociology department where I earned two of my degrees maintained a lab. We called it the "SOCQRL" – the Sociological Quantitative Research Laboratory. But I don't remember calling it "the lab", or hearing people call it the lab when I was a student there. Instead, people tended to call it the SOCQRL. And so I thought about how the SOCQRL compared with EARL. These things, then, were parts of the knowledge I brought to bear in making sense of my observations and interviews. And there other parts in addition to the taken-for-granted that I carried into EARL. I carried into the lab a view that what counts as surveillance is more or less clear, most of the time. Now I am significantly less sure about this. And fieldwork changed my views in other ways too.

In the early days, the lab was "the lab". It was composed of two rooms that were sealed off from the world in many ways. The walls were thick concrete. Lab members often kept the doors to the lab closed and locked to safe guard the expensive equipment

inside. And although each room had a big window about the length of one wall, sunlight was kept out. In one room with several cameras set up around an open space, the window was papered over with thick paper and tape. The lab's computer vision projects required the lighting conditions to be carefully monitored, and so in this lab room sunlight was virtually sealed off. And in the other lab room, the blinds were sometimes closed to keep sunlight out, either for the same reason or because the glare it cast on computer screens made it difficult for lab members to see the programs they worked on. While the elements were sealed off, the lab members were often sealed in. They often arrived late morning and worked into the early hours of the morning, often stopping only to eat and go to the bathroom. When they did leave the lab, it seemed as if they only went to other places on the campus: classrooms where they took courses of helped as Teaching Assistants, the lab director's office, and other labs. And so I took it for granted that this was a "lab".

But as time went by and I did more fieldwork in general and changed my fieldwork strategies in particular, my views changed. I became less sure of where the inside of the lab was, and where the outside of it was. I learned that three lab members maintained active spiritual lives, going to church, praying everyday, and in one case receiving furniture from a Christian organization on campus. And I watched the traffic from the lab to business and from business to the lab. Entrepreneurs visited the lab in search of projects to commercialize. Lab members worked campus jobs like restaurants, and still others attended career fairs searching for engineering jobs. Furthermore, I rethought categories of nationality and language. In the early days, I worried about these things as obstacles to rapport and trust. The first three lab members I met were "international students", and two of them had accents that were at times difficult for me

to make out. But as time went on, I began to see this not as an obstacle, but as a resource for highlighting how nations work in and through the lab, and a possible motive I could offer when questioned about my questions.

Learning from, watching, and listening lab members in everyday lab life and in and through interviews raised questions about where the lab ended and other things began. And so I began to follow these boundaries by listening to how and when lab members created the inside of engineering by setting it in comparison to an outside entity. My observations and ethnographic interviewing had taught me that it was by no means clear where engineering ended and other things began. Challenged by these things, my analytic inspiration came more and more from the ethnomethodologically-informed analytics of following the folk theories members have of these boundaries. And so I thought more and more that one of the important things I should do is document the member's methods for creating these boundaries.

These ethnomethodologically-informed analytics take the view that everyday life is an accomplishment. Rather than being straightforward and pre-determined, everyday life is an accomplishment that people work at. And so the realities of everyday life are maintained by people who work hard to construct them in that way. While we all engage in this reality-maintenance work in everyday life, it may be tempting to assume that people who do science and people who do engineering do not engage in reality-maintenance work because the knowledge they produce appears to be of a general kind. But from the standpoint of an ethnomethodologically-informed analytics, scientists and engineers are not completely different from other people. They are equipped with ordinary ways of making sense of the world just like us all, and the knowledge they

construct faces the same problems all forms of knowledge face: no system of general knowledge, including scientific and engineering knowledge, is capable of understanding its own concrete applications. Unable to understand its own concrete applications, engineering draws on other systems of knowledge. These other systems are not independent of engineering knowledge, but are also not wholly dependent on engineering knowledge.

And so in what follows, I try to do this by analyzing how and with what extra-engineering resources robotics engineering is accomplished in lab life. I show how lab members use discursive resources to make their activities meaningful and accountable. Discursive resources are linguistic devices that enable speakers and writers to construct their experiences as meaningful by talking or writing about them (Chase 1995; Foley and Faircloth 2003). They do this by referring to a culturally intelligible and prototypical storyline or cluster of categories (Holstein and Gubrium 2000). While discursive resources enable us to anchor our experiences in a culturally recognizable storyline or cluster of categories, they do not function the same way all the time. Their use shapes how they function. And they are used in different ways in the lab. They can be used to explain something inappropriate or extraordinary, to assign motives to lab members, to assign speaking roles to others in storytelling, to contrast who one is or ought to be by comparing the self with an alternative self, to discount particular explanations of a self, and to construct an atrocity story.

And I show how and when these discursive resources are activated as well as how and when they are delimited in order to highlight the descriptive work performed by lab members. I found that lab members use four discursive resources: the body, the spiritual,

business, and the national to plan, complete, and describe their activities. But sometimes lab members felt that these discursive resources were inappropriate, and so I also show how they work to limit these discursive resources.

CHAPTER 2: LITERATURE REVIEW

In what follows, I draw on two broadly conceived bodies of literature; what is known as Science and Technology Studies (STS) and what Jaber Gubrium (1993) has called "the sociology of description". STS is interdisciplinary and concerned with showing in various ways how it is that science and technology are social. And one branch of STS is known as "laboratory studies." Lab studies have made important contributions by showing how scientists construct scientific knowledge in laboratories, how science and scientists are co-constructed, and how medical knowledge and physicians are co-constructed. This study extends that to engineering knowledge.

How Scientists Construct Scientific Knowledge in Laboratories

Bruno Latour and Steve Woolgar (1979) published one of the earliest laboratory studies, in their case a study of a neuroendocrinology laboratory at the Salk Institute. And they show how scientists construct scientific knowledge in a laboratory by posing the research question: how are facts constructed in a laboratory? (Latour and Woolgar 1979:40). They then go about addressing this question by following the construction of a single fact – TRF(H). Thyrotropin Releasing Factor (Hormone), or TRF(H) has a meaning that varies with context. To many of us, (like your author) it may mean nothing. But to medics, TRF is a test that screens for pituitary malfunctions. And to some endocrinologists, TRF refers to a subfield. It is important for Latour and Woolgar (1979) to begin with these observations because it helps them highlight what they see as an important process in the construction of facts – the freeing of the fact from the

circumstances of its construction. According to Latour and Woolgar (1979), statements are transformed into facts when they lose the circumstances of their production such as who produced them, where they were produced, and when they were produced (pp. 105-106). And one resource invoked by lab members which effectively sheds a statement of the circumstances of its production is what Latour and Woolgar (1979) refer to as an "inscription device" – the equipment or equipment strung together in practice which transforms material substances into a chart, table, diagram, figure or graph (p. 51). Latour and Woolgar (1979) suggest that attention ought to be paid to inscriptions like graphs and tables because once these inscriptions are made available to lab members, the steps lab members took to produce the inscription are forgotten and attention is instead paid to the inscription itself. For example, when lab members write articles, they refer to inscriptions rather than material substances.

Drawing on a plant protein lab, Karin Knorr-Cetina (1981) has studied how lab members construct facts by following how they reason in everyday life. By tracing where and when lab members engage in "practical reasoning" to make decisions as they produce knowledge, Knorr-Cetina (1981) argues that scientific work should be understood as constructive rather than descriptive (p. 152). Knorr-Cetina (1981) also argues that scientific work includes "indexical reasoning", which relies on contextual contingencies rather than non-local universality to do lab work. Lab work, then, produces scientific change through indeterminacy (Knorr-Cetina 1981:152). Knorr-Cetina (1981) also argues that lab work relies on "analogical reasoning", which orients the opportunistic logic of research and circulates ideas (p. 152). Next, Knorr-Cetina (1981) suggests that scientists engage in socially situated reasoning to sustain resource relationships. Lab

work is also said to involve "literary reasoning" where lab members engage in the conversion of their objects into local, contextual, and socially situated breeds of action (Knorr-Cetina 1981:152). And finally, since she has shown lab work to include practical, indexical, analogical, socially situated, literary, and symbolic reasoning, Knorr-Cetina (1981) problematizes the distinctions often drawn between the natural and social sciences in methodological debates. In later work, Knorr-Cetina (1989) uses a Conversation Analysis approach to lab talk in order to show how scientific thinking is not a private matter of the mind, but instead a socially organized activity which includes a number of interactional devices. Like Knorr-Cetina (1981), Michal Zenzen and Sal Restivo (1982) also draw attention to the role of contingency in lab work. Drawing on 2 years of fieldwork in a colloid chemistry lab whose members maintained an interest in the intermediate stages between liquids and gases, Zenzen and Restivo (1982) argue that contingency does not simply affect lab work, but instead it is an integral part of that work. In other words, there is no predetermined path traveled by scientists to construct knowledge. Instead, background knowledge, equipment, roles, and funding at hand are modified and negotiated in everyday life to construct knowledge.

Drawing on a neuroanatomy lab, Michael Lynch (1985) focuses on how scientists use talk and action to make distinctions between facts and artifacts. In his case, lab members view themselves as concerned with a neural regeneration phenomenon called "axon sprouting", which is only documentable and therefore knowable through electron microscopic photography. And so Lynch (1985) traces the ways lab members work to count some parts of some micrographs as creditable and others as not creditable. Facts, then, are the parts of some micrographs that lab members recognize as creditable while

artifacts are the parts of some micrographs recognized by lab members as not creditable. “Lookers”, Lynch (1985) tells us, are viewed by lab members as micrographs that can exhibited outside the lab in demonstrations of findings. Micrographs recognized by lab members as scarred by “knife marks”, “holds”, and “folds” are counted as observations of axon sprouting by lab members, but not as useable for demonstrating results outside the lab. Lynch (1985) also shows that when lab members recognize their own work in producing the micrograph rather than only documentation of the object they work to observe, they construct “artifacts”. And these artifacts, he argues, can be understood as “positive artifacts” and “negative artifacts”. Positive artifacts are artifacts attributed to, and only to, the distortions of lab equipment. Negative artifacts, on the other hand, are recognized by lab members as the absence of expected effects, and are high stakes for lab members because the existence of the object itself is understood to be at stake. Lynch (1985) also analyzes how lab members use “shop talk” to accomplish agreement about their activities. One way Lynch (1985) argues this is accomplished is through the assertions and reassertions of lab members, which illuminate the features exhibited by an object by casting them into different contexts where divergent accounts of the objects can later, and only later, be understood as compatible with each other. Specifically, Lynch (1985) identifies 3 devices lab members used to accomplish agreement: “redescription”, the “I think” preference, and the introduction of additional accounts. The “I think” device admits possible disagreement. And additional accounts provide a means of supporting both an original statement and challenging statements.

Limitations of Lab Studies

While lab studies have made important contributions by showing how scientific knowledge is constructed in labs and also how science and scientists are co-constructed, they have also neglected two questions: 1) What are the conditions of possibility in which lab work is embedded? 2) How do lab members draw on resources outside the lab? I begin with the first question. Michel Foucault (1977) has suggested that socially organized settings establish "conditions of possibility" for what can be said, when it can be said, and how it can be said. Studies of human service professionals have empirically shown this, and argued that what members of a setting say about their activities is "organizationally embedded" (Gubrium and Holstein 1990; Gubrium and Holstein 1997).

What can be said, when it can be said, and how it can be said are not uniquely improvised each time members speak (Holstein and Gubrium 1990:116). Instead, members refer to locally available resources in speaking and writing. By local, it is meant that activity is not likely to be presented in the exact same terms and forms in a different lab (Holstein and Gubrium 1990:116). I argue that lab studies have neglected some of these conditions. While they all call attention to contingencies and the situatedness of scientific labs, these studies tend to focus on locally available resources like machines, journal articles, lab leaders, knowledge about machines, and knowledge about journal articles at the expense of what Wayne Brekhus (1998) has called the "unmarked" – the "politically unnoticed" and taken-for-granted resources available to lab members.

I now turn to the second question: how do lab members draw on resources from outside the lab? To be sure, some lab studies have begun this project. Latour and Woolgar (1979), for example, devoted a chapter in their ethnography of the Salk Institute to

"cycles of credit" wherein lab members convert money into data and data into prestige. And Knorr-Cetina (1981) has written of a "transscientific field" scientists make themselves accountable to in their reasoning. And we are told that this transscientific field includes university administrators, funding agencies, journal editors, and government workers. A more recent lab study has also began this project of investigating how lab members draw on resources outside labs. Drawing on participant observation in a plant pathology lab, Daniel Lee Kleinman (2003) explores the relations between academic science and "commercial culture". And he finds a number of indirect effects of the chemical industry on agricultural pest-control research such as in the ways scholarly writing in the field is framed, the ways experiments are organized, the measures of success that are used, and the tools that are available (Kleinman 2003:88).

But these treatments are all limited, I argue, by their focus on economic actors and metaphors to the exclusion of other kinds of resources. For example, Latour and Woolgar (1979) and Knorr-Cetina (1981) both examine how and when lab members use economic metaphors to construct their experiences in general and their careers in particular. And Kleinman (2003) attempts to show the indirect effects of "commercial culture" on academic lab practices. I argue that economic actors and metaphors are not the only narrative resources lab members use to construct their experiences. By "narrative resources", I mean stocks of knowledge emergent in interactions that we use to frame our descriptions of our activities (Holstein and Gubrium 1995). To be sure, lab studies have begun the process of exploring narratives in scientific work by exploring how indeterminacy is "converted" into doubt through the literary reasoning of the scientific article (Knorr-Cetina 1981:130-131) and by viewing the laboratory as a system of

"literary inscription" which works at transforming a natural object into an inscription which can then be presented, published, and argued with or about (Latour and Woolgar 1979). In the following chapters, I identify these stocks of knowledge, when they emerge, and how they emerge in social interactions.

EARL is a suitable setting for answering these questions that have been neglected in lab studies because its participants are not only expert engineers in training, but also already experts at drawing on resources from outside the lab. First, lab members are experts at drawing on national resources. My key informant and the lab members I have spent the most time observing are "international students" working in the US on student visas. And they are also citizens of countries like Guatemala, countries in the Middle East, India, and Algeria. And so they are practiced at drawing on one or more national resources from outside the lab. Second, many lab members are also practiced in working in businesses or during the course of my fieldwork began jobs with businesses. These ranged from an educational robotics business for high school students in a Middle Eastern country to a surveillance camera company in India. And so lab members are also practiced at drawing on business resources from outside the lab.

A more recent lab study is the one conducted by Park Doing (2009). Drawing on fieldwork conducted while he was working in an x-ray lab associated with a synchrotron at Cornell University, Doing (2009) poses the question: "How can the practice of judging scientific facts change and endure in a way as to continually secure the status of fact claims that emanate from that practice?" (p. 39). In other words, how can fact claims continue to be recognized by lab members as facts when lab members can also recognize that judgments about these facts claims change? And so, Doing (2009) explores how

groups holding power to shape the criteria through which fact claims are judged come to hold their power, and how they manage to enforce their authority over time (p. 39). The big science team which clusters around the Cornell synchrotron provides a good field site for Doing (2009) to explore these patterns because it involves many modes of multidisciplinary collaboration and a division of labor between scientists and "operators" – the technicians who maintain equipment and ensure that it does not overheat. One way the scientists sustain their authority over time has to do with the equipment. Doing (2009) argues that in the early days of the lab, many operators had participated in building the lab's equipment, which enabled them to appeal to their experience to support their claims of expertise and control. But as new operators joined the lab over time, they could not make these appeals to experience to support claims of expertise and control, and so Doing (2009) argues that they only left with a dependence on scientist's claims of expertise and control.

The Co-Construction of Science and Scientists

One early study of the relations between subjectivity and technoscience is Sharon Traweek's (1988) study of particle physics labs in the US and Japan. Traweek (1988) traces the transformation of novice undergraduate students to practicing physicists as they learn what makes good science and what makes for a good physicist. Undergraduates learn stories about the iconic geniuses of physics as they demonstrate knowledge of physics in their coursework, but rarely gain opportunities to design their own experiments like the graduate students (Traweek 1988). The graduate students, then, learn to distinguish ordinary work from good experimental work, and the significance of

"feeling" physics (Traweek 1988). Post-doctoral physicists are expected to be "meticulous", "hard working", supported by a partner, and not easily distracted by everyday life (Traweek 1988). Like undergraduate physics students who learn stories about the geniuses of physics, another study focuses on stories among technicians.

Hugh Gusterson has also written two books that analyze his fieldwork at the Lawrence Livermore National Laboratory (LLNL) in Livermore, California. In the first book, Gusterson (1998) traces the co-construction of science and subjectivities by analyzing the process of "becoming a weapons scientist". While we might expect this process to include something about learning how to speak about Russian or other threats, Gusterson (1998) instead finds that the scientists cited their dislikes of university and corporate work as reasons for working at LLNL. We are told many scientists felt that university science departments had too much cutthroat competition and that corporations undermined academic freedom in the quest for profit (Gusterson 1998:48-49). Interestingly, Gusterson (1998) also analyzes when and where these scientists talk about the ethics of their work. And he finds that weapons scientists did not talk about nuclear ethics with each other, and that potentially suitable settings for nuclear ethics discussions such as the churches weapons scientists attended endorsed or failed to oppose LLNL nuclear ethics by privatizing moral thinking on nuclear weapons, and viewing nuclear weapons as the best hope of preventing war and saving lives (Gusterson 1998:67). Furthermore, Gusterson (1998) follows the everyday practice of secrecy and the estrangement it introduced between the scientists and their families. In addition, Gusterson (1998) analyzes nuclear weapons tests as rituals where rookie scientists are transformed into "senior scientists", where the challenges of human mastery and control

over nuclear weapons can be managed and symbolically resolved, and where weapons work can be viewed in terms of birth metaphors that construe it in terms of hope, renewal, and life. In his second book, Gusterson (2004) elaborates and expands on many of these same patterns. For the purposes of this literature review, I will summarize one more distinctive part of his second book. According to Gusterson (2004), the secrecy laws that constrain LLNL scientists have supplied conditions for an interesting mode of knowledge production. Amidst the high tech equipment, computers, and tools, LLNL scientists maintain and communicate much of their knowledge the old fashion way – orally. Because written knowledge must be secured in elaborate ways which demand much time and energy from scientists, they often prefer to maintain and communicate their knowledge orally. While scientists tended to prefer this arrangement over what they saw as the cutthroat competition of publish or perish in university departments, Gusterson (2004) informs us that there's more to their story. The few writings that scientists do author are so tightly regulated by secrecy laws that they may not be able to own copies of their own articles, circulate their own papers, and sometimes even name their own papers, which all work to prevent them from constructing the public persona authors often do.

Informed by her earlier work (Knorr-Cetina 1981), Knorr Cetina (1999) wrote another book worth mentioning here. In contrast to the view that "science" is homogenous and straightforward in everyday life, Knorr-Cetina (1999) introduced the concept of the "epistemic culture", which helps sensitive us to the means by which science is performed and recognized in everyday life. In this work, Knorr-Cetina (1999) takes the view that subjectivities are produced in these epistemic cultures when machineries of knowledge production are deployed.

Following Judith Butler's (1993) exploration of the performativity of gender, and Donna Haraway's (1991; 1997) situated knowledge approach to the performance of scientific knowledge, other scholars have investigated the performance of technoscientific knowledge situated in the practices of medicine, molecular biology, and engineering. Natasha Myers (2008) has shown how protein crystallographers in molecular biology use their bodies as a resource to learn about, work with, and communicate molecular structures, and in the process do a kind of "body-work" (p. 163). Drawing on observations and interviews with surgeons, medical students, medical technology engineers, and educators, Rachel Prentice (2013) argues that surgeons are made through bodies acting in the world (p. 6). In contrast to dominant models of knowledge that frame knowledge in terms of mental models and seeing, Prentice (2013) offers a more complex model of knowledge drawn from studying the practices in medical labs and surgical suites. In this model, the Cartesian dualism between mind and body is dismantled and replaced by a view that knowing is made possible in and through the body, and the tendency to articulate knowing only in terms of seeing is complicated by observations of surgeons who learn by touching and smelling patient bodies (Prentice 2013:12-13).

The Sociology of Description

Another body of literature I have found useful in thinking about and analyzing my data is the sociology of description. In general, this literature can be understood as showing how singular objects we often taken-for-granted in everyday life are multiple and complex in everyday life. And this is observable in everyday life when people work

at describing their activities to each other. I deliberately use the analytic term "description" rather than "representation" because representation smuggles in a connotative distinction between an object and the expression of the object, which implies that an object exists independently of expressions about it. In contrast, I assume objects are not independent of expressions. Descriptions of objects construct objects by constructing objects as real. Objects, then, are accomplishments of description in everyday life. And one of the means by which descriptions are deployed in everyday life is through the use of discursive resources – linguistic devices that enable speakers and writers to construct their experiences as meaningful (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). And in institutional environments like schools and rehabilitation hospitals, multiple discursive resources are available for people to use because multiple audiences are known to people in the environment. The other important parts of the activity of describing include the thing being described, the descriptions themselves, the descriptive circumstance, and the audience that is meant to receive the description (Gubrium and Buckholdt 1982:3). The descriptive circumstance includes the conditions that make certain descriptions possible for members. And the audience includes hearers or readers of particular descriptions.

Constructing Discursive Resources as Constructing Contexts

While these parts of the activity of describing can be understood with the term "context", the literature I draw on informs and is informed by a specific view of context which is not shared by all kinds of sociology. Some cultural and naturalistic ethnographic sociology treats context as the thing to be described by the sociologist. But many studies

inspired by Harold Garfinkel's (1967) urging to study "common sense knowledge of social structures", including studies of technoscience (Law and Moser 2011), mental illness (Smith 1978), and British health visitors (Dingwall 1977b) have informed my analyses with a different conception of context. This conception regards context not just as about people's lives, but also a resource people use in their lives to construct social order. Thus, context is not just a sociological topic, but also a resource for people to mobilize in everyday life. And so whether that context is understood as an explanation for how a disease spread (Law and Moser 2011), as a way that a speaker instructs a listener to hear them in an interview (Smith 1978), as the social theories-in-use among British health visitors (Dingwall 1977b), or as "common sense knowledge of social structures" (Garfinkel 1967), the work of doing social order is the work of assembling and holding together a context.

Using and Delimiting Discursive Resources

It is also noteworthy that authors who treat context in this way emphasize the interactional work it takes to invoke a specific description. And inspired by Jaber Gubrium and James Holstein (2009) and Holstein and Gubrium (1995), I use the term "activation" as a shorthand way of emphasizing the active interactional work of invoking a particular discursive resource to describe activity. While authors who treat context in this way have been enormously influential to me, I also want to foreground something they have neglected: the absence and regulation of discursive resources. From this perspective, discursive resources are the means by which members construct meanings and so discursive resources replace other resources in the ongoing life of people. But how

discursive resources are limited and replaced by other resources has been neglected. Although placing limits on discursive resources may seem like a simple process of not using the resources, many studies challenge the assumption that an absence of an activity only reflects an absence of something or passivity on the part of people. Jamie Mullaney (2006), for example, has shown how social identities constructed through abstinence take a lot of interactional work to accomplish, including defining abstinence, when one abstains, considering the audience for performances of abstinence, and communicating these things to others. Studies of hospitals (Glaser and Strauss 1965), volunteer groups (Eliasoph 1998), and politicians (Zerubavel 2007) have also shown the vast interactional work it takes for participants to avoid talking about death, politics, and extramarital affairs, respectively. Inspired by this work, I also analyze how lab members work to place limits on discursive resources. Holstein and Gubrium (2000) have made a similar point. They suggest that "narrative slippage" occurs when speakers apply recognizable storylines to their experiences in ways that do not accord perfect traction to the storylines. Instead, the storylines "...are applied partially, contingently, judiciously, and variably" (Holstein and Gubrium 2000:110). And since these storylines are modified and applied in different ways that vary with the circumstances stories are told in and through, they are limited. People do not feel that they are always appropriate for constructing experiences. Broadly, I suggest the same thing: talk is limited. But I also want to emphasize the interactional work people engage in to limit this talk, and so I use the word "delimitation" to refer to the process of placing limits on particular kinds of discursive resources in particular situations. Delimitation is a form of discursive control, which is also part of a

broader class of phenomena – social control. And so delimitation is a form of social control that regulates the use of particular kinds of discursive resources.

Studies in this vein problematize singular objects by not assuming that it is obvious and straightforward what an object looks like in everyday life. Drawing on a wide variety of texts and fieldwork in human services agencies, Gubrium (1986) shows how the pathological entity "Alzheimers Disease" (AD) is made distinct and elaborated through the work of caregivers, human service professionals, medical researchers, and AD patients. Gubrium (1986) argues that "...the unity found in diverse troubled individual and interpersonal experiences representative of Alzheimers disease is not only a discovered or diagnosed product of its existence in people's lives, but is equally an artifact of the descriptive work engaged in by those concerned persons who present, read, view, and hear a disease in a variety of depictions" (p. 3). Gubrium (1986) finds that in the AD literature, written descriptions of AD which use indefinite terms like "some", "may", "often", and "sometimes" enable AD to be both elaborated through many experiences, but also consistent and unified because the logic of situated emergence can be brought to bear on many different kinds of experiences. And among medical researchers, the facts-in-use that AD is an object and that it has concrete manifestations are preserved in conferences when medical researchers work to background challenges to these facts. They do this, Gubrium (1986) points out, by describing utterances highlighting the inseparability of what is known from how it is known as "philosophical" or "semantic", which is way participants effectively work to communicate that the speaker has not paid enough attention to the basic facts of AD.

Other studies have taken a similar approach through investigations of other kinds of objects like artheroslcerosis, birds, and an airplane. Annemarie Mol (2002) draws on a participant observation study of clinics and pathology labs to describe the ontology of medical practice. Mol (2002) describes how the seemingly single disease of arthrosclerosis is multiplied through different medical practices such as arthrosclerosis being pain in the legs to a clinician and a thick intimae of an artery wall to pathologists (pp. 35-48). Then, to coordinate these objects into the singularity of arthrosclerosis, practitioners talk about "the disease", test results are added together to inform decisions, and correlations are established to make things comparable (Mol 2002:84-85). But other things that appear natural have also been investigated in this way. Drawing on fieldwork with and as amateur birdwatching, John Law and Michael Lynch (1988) examine the descriptive organization of seeing. In contrast to the perceptual model of knowledge where birdwatchers can be viewed as simply seeing birds, Law and Lynch (1988) propose a reading and writing model where lists and field guides help organize what is seen, when is it seen, and how it is seen. Lists having to do with species, time, trip, and region are assembled by birdwatchers and then organize seeing when they supply motives for searching the environment, regarding and disregarding experiences, talking or not talking about an observed event, and treating the announced sightings of others as ordinary or extraordinary (Law and Lynch 1988:274). And field guides which are informed by picture theories of representation instruct birdwatchers on how to distinguish species, a resource useable to birdwatchers but also modifiable or ignorable because the comparison between what is seen and the images in the field guide is problematic at best (Law and Lynch 1988:292-297).

Building on Marieanne de Laet and Mol's (2000) important work on the fluid boundaries and use of the Zimbabwe bush pump for pumping water, Law (2002) uses the case of a seemingly singular object he has followed closely for some time – the TSR2 aircraft – to show how multiplicities make singular objects. He does this by deconstructing texts, pictures, and stories which work at describing the TSR2. And in identifying and analyzing the folk theories informing texts and pictures, and analyzing the narrative strategies used to describe the history of the TSR2, Law (2002) shows how several different elements – both human and non-human – are made to hang together to enact the TSR2 as a singular object.

CHAPTER 3: METHOD AND ANALYSIS

During preliminary fieldwork at a robotics laboratory, the director of the laboratory asked an undergraduate student if he had heard of a "GL", or a Graphics Library. The student hesitated a bit before answering, and eventually answered that he had heard of it. It was like he hesitated because hearing about something and learning it were not the same thing, and so he would have to learn the GL on the computer. Experiencing that moment brought me back to some of my graduate training in Geographic Information Systems (GIS) because one of the things I didn't like about my experience with GIS was all the tedious time spent working on digital maps. My frustrations with GIS had since led me to see it as one research method among many rather than a field of potential job opportunities. Recalling early mornings and late nights hopelessly fiddling with "geo-visualization" software, I wondered how in the hell I ended up doing preliminary fieldwork for my dissertation among people who often log 10 hour work days on computers. Like my pathway to an ethnographic study of a robotics lab, the experience of ethnographic research has changed in unexpected ways.

But the community I wanted to study has not changed so much. When I began thinking about a dissertation topic, I started with the working idea of doing an ethnographic study of a workplace involved with robotic airplanes remotely controlled from great distances called Unmanned Aerial Vehicles (UAVs), and ended up doing something a little more general in doing an ethnographic study of a robotics lab. As I anxiously awaited my committee members' comments during the downtimes between drafts of my Master of Arts (MA) thesis, I read many newspaper articles and a few books

on UAVs and began thinking about UAVs as a way to theorize surveillance and consumption. I continued doing this after I earned my Master's degree and moved to Missouri. Writing papers and analytic memos on UAV's in my classes, and even presenting some of them at conferences, this interest continued to fascinate me. By late 2011, I was hard at work searching for a way to turn this interest in UAVs into an empirical sociological dissertation in general, and an ethnographic study in particular. I talked with many people to explore possibilities. There was the director of the "Center for Geospatial Intelligence" – a group whose logo included an image of a UAV – who discouraged my interest in the everyday life of geospatial security work because the data and analyses were "For Official Use Only". There was the computer scientist at the Jet Propulsion Laboratory (JPL) who insisted over the phone that my questions needed to be more specific. Then there was the aeronautical engineer who worked on UAV projects for Boeing in St. Louis, and who was warmer than most I talked with. But by the time I met this man, another possible project at a robotics laboratory looked more and more promising.

Access

It was December of 2011 and I didn't expect this possibility to be very promising at the time because of how I approached the gatekeeper. Unlike the people above, I emailed this gatekeeper without anyone he knew first introducing us. Up until this person, I had talked with people only after a committee member or family member had introduced me to them first. This time I couldn't find anyone he already knew to introduce us to each other. So, my preliminary fieldwork began by meeting this gatekeeper – the director of a robotics laboratory. I call this robotics laboratory the

Engineering And Research Laboratory (EARL). EARL is an academic robotics engineering laboratory located on the campus of an American university. The lab director, who I call Dr. DaSilva, is a tenured professor of electrical and computer engineering. The lab members include both graduate students and undergraduate students, most of whom are working on electrical and computer engineering degrees and some of whom are working on computer science degrees. There are also collaborators such as computational biologists, disability technology specialists, and veterinary researchers who collaborate with lab members of projects, but do not work in the lab and attend lab meetings. I considered this robotics lab a possible field site because the lab members had posted several articles they published in electrical and computer engineering journals on the lab's website, and some of these articles were about UAV technologies.

First, I met with the director of EARL and asked him about current lab projects. At this first meeting, I also received a tour of one of the two lab rooms. By early 2012, I finally worked up the nerve to tell the director of EARL why EARL would make a great study in the "sociology of science". I regretted this talk of "science" later on because I learned that they see themselves as "engineers" rather than "scientists". The director responded by asking me what I needed for the lab, and how much of whatever it was I needed. I replied that I'd like to spend several hours per day, three days per week, and 1 year "shadowing" people involved in the lab, and "watching and listening" to the everyday work of people who are involved, and then occasionally making notes and taking photographs of things rather than people. The director responded by telling me that he thought 1 year was a big commitment, that he worried that I would disrupt lab work

with questions, and that he would see how lab members felt about it. My next response was that I did not intend to disrupt, that I could sit quietly because watching was just as important as listening, and that my dissertation would take a long time because I want to understand lab work over time rather than only during a short period that is unrepresentative of other periods. By early February, the director told me that the lab members were willing to give me a "trial period" of a week or two to see how it works.

On the first day of participant observation, I met all of the current graduate student lab members and asked them when they tended to spend time in the lab during the week in order to plan my future visits. After a few weeks of preliminary fieldwork, I also received an IRB exemption because my study centers on "normal educational practices". The first time I met the lab members I write about a lot in this dissertation, they were concerned that I was going to disrupt their work. I responded by saying that those concerns are understandable, and that I didn't intend to disrupt their work. To help persuade them of this, I also said that I was interested in watching as much I was interested in listening and so I would not ask a "million questions". In the beginning, we also worked out a tentative schedule. I asked lab members when they spent time in the lab, and then did field work there during those times. And so in the beginning, I did fieldwork from 12-4 on Monday, Wednesday, and Friday.

Fieldwork

In the beginning, I tried to develop a sense of the range of activities lab members engaged in. I sat next to lab members as they wrote line after line after line of computer programs, as they designed simulations for robot navigation techniques, as they "trained" algorithms they developed, as they went to other labs to pick up equipment, and joined

them during their semi-weekly lab meetings. I carried a thick notebook with me every time, and in the beginning made notes about the range of activities lab members engaged in, what they told me about themselves, what they said about me when I could hear them, and the ways they used their bodies to know about robotic technologies. On the first day of fieldwork in the lab, I made several notes about this. For example, on February 6 of 2012 I wrote "Juan says that their computers run Linux, which he says he is pretty good at, but that I 'should see Dr. DaSilva'…and then moves his 8 non-thumb fingers up and down rapidly and repeatedly in a typing motion to show me how skillful Dr. DaSilva is with Linux". Later on, I also wrote "Juan describes the sensors for this wheelchair using his right arm. He extends his arm out toward me while seated at his desk with his fingers in a fist, and then moves his hand up and down while his arm stays still. As he tilts his fist up and down, he points to the forearm of this arm and explains that sensors placed on the forearm would pick up on electrical signals emitted from forearm muscles". The ways they used their bodies to know, and to tell people what they know, became interesting to me early on.

When I only did fieldwork in the lab itself, my note-taking approach involved writing field notes in the lab whenever I could. Sometimes this happened when I had a sense that lab members were not in the mood to talk or answer questions. And sometimes this happened when lab members had to leave the lab to go somewhere. In both cases, I would treat the quiet time as an opportunity to write about what I had seen and what I had heard in the last few hours. Fieldwork in the lab meetings feels a lot different. Lab members tend to talk more, and for longer periods of time and so tracing the course of talk and interactions has been an ongoing challenge. To meet this challenge, I often jot

down in my notebook words or phrases uttered by lab members during the meeting, and then reconstruct the context later on the same day as I elaborate these jottings into field notes. I have found this to be a useful note-taking strategy because it has often helped me remember things I might have forgotten, and it helps me identify areas of confusion and curiosity.

The first strategy I relied on was to shadow Juan or Aref. Juan is a key informant for me. He was the first student lab member I met and I have always felt he was friendly and generous in his exchanges with me. And in the early days, this friendliness and generosity was warmly received. In addition to these, I perceived more advantages to treating Juan as an informant. One was that other lab members regarded as very smart, which meant that they asked him for help with their class and research projects. In turn, this served as an advantage for me because Juan had a strong working understanding of the lab's research projects at any given time. Another advantage of treating him as an informant was that he had been a lab member longer than many other lab members, and so he could be viewed as one of the lab's historians (along with the lab director), and a lab member who knew many others on campus such as the lab's associates.

I would go to the lab, sit next to or behind one of them and then watch what they did and listen to what they said to me or anyone else we encountered. For the most part, this amounted to watching Juan or Aref work on computers in the lab. Sometimes, Juan or Aref would leave the lab and go somewhere else like a class they were taking, a class they were serving as Teaching Assistants for, to submit some paperwork to some office on campus, or to go back home to eat some food or catch a nap. When this happened, I would switch who I shadowed by finding someone else who stayed in the lab or I knew

to be arriving soon. Rarely did I have no one to interact with, but on the occasions when the lab emptied out I would end fieldwork for the day. When I felt like I had a better sense of the range of activities lab members engaged in, I began to shift my attention to specific projects.

One project I followed involved shadowing Juan. Juan was and is interested in developing a "multimodal interface" system for controlling a "power wheelchair", or electric wheelchair. The system would enable a user with a progressive illness to switch how they control their wheelchair as they feel fatigued or as their illness reduces their bodily capabilities. And so a head gaze control could be switched to an EMG control attached to the user's pectoral muscle. I talked with Juan about this as he worked on it, helped him test it by hooking up my arm to an EMG sensor, watched as he tested it on a quadriplegic man, and watched as he engaged in practical reasoning to troubleshoot problems he encountered with it.

Another project I followed involved shadowing Aref. I learned that Aref was working on a simulation of robots in order to model and test techniques for robot "navigation". And so I sat with Aref as he wrote programs to simulate robot navigation techniques. I watched as he wrote lines and lines of computer code, activated the code, watched the simulation, (sometimes) watched as his computer crashed, made notes, made hand gestures in front of and on top of his computer screen, and made videos and screen shots to show his "results".

Another project of Aref's that I traced involved picking up where a group of undergraduate students doing a "capstone" project had left off. They had built a "quadcopter", a radio-controlled vehicle featuring four propeller-driven motors. I talked

with Aref about the challenges the project posed, including a heavy frame that impaired its flying ability. To meet this challenge, Aref told me he designed a lighter frame for it, the design of which he pinned up next to his desk. Then, I followed the project as he replaced the motors with more powerful ones, tested these motors, and tested the whole thing for stability.

I also did fieldwork in a number of other settings as I followed members where they went. Whenever I was invited to lab parties, I accepted the invitation. When I was invited to summertime lab parties at Dr. DaSilva's house, I joined lab members for some food and some talk. And after we watched Aref defend his MS thesis, he wanted to celebrate by going out for dinner and drinks. And so I joined lab members at a buffet style restaurant, and then later on for some beer. I went with lab members to a School of Engineering BBQ lunch.

By the fall of 2012, I decided to shift my strategy. I wanted to argue that using the body to construct knowledge was part of becoming an expert engineer. And I thought that if I could show that a robotics course professor (and the director of EARL) did this body work more often than students when students were his audience, I could effectively make the argument. But I also wanted to learn something about how the other students experienced the course. And so I recruited four students enrolled in the course to write journals describing their experiences and to do four interviews with me over the course of the class. The students who agreed to participate included two lab members, one student who later joined the lab, and one student. I described what participation would be like by getting up and talking in front of the class for a few minutes and saying that I was looking for anyone interested in keeping journals about their experiences in both lecture and lab,

and agreeing to be interviewed four times. I asked students who were interested to write down their name and email address, which I later used to set up a meeting where we all met together in my office. During the meeting, I offered more details and distributed a cover sheet that described what I wanted the students to do. In terms of the journals, I asked them to spend at least 15 minutes describing their experience after each lecture and lab. There were three lectures and one lab each week, and so I asked the students to write at least four journal entries per week. I also said that if they wished to write more than four entries per week, or if they wished to write about an experience that did not happen on a lecture or lab day, they were more than welcomed to write it and send it to me. The journal was a single page template I asked students to type in, and email me. It included a line for their name at the top right, and then space for students to write the date, activity, and participants on the top left hand side. The rest of the space on the journal template was divided roughly equally into space for students to write responses to 5 questions that appeared in this order from top to bottom: 1) What is the purpose of this activity from your point of view? 2) What is the outcome of this activity from your point of view? 3) Has this activity been straightforward or difficult? 4) What did you like most about this activity? 5) What did you like least about this activity? For this last question, I chose to word it in terms of the phrase "like least" rather than dislike because I was concerned that students would read this as a request for responses that could potentially make its way back to the professor, and thus potentially inform his academic judgments of them. Also during our meeting, I said that there would be four interviews – one near the beginning of the semester, two around the middle of it, and one at the end. To provide students a sense of what the interviews would be like, I also said that the first interview would be the

longest at about 1 hour and that the other interview questions would be developed as I studied their journals. The first interview was partially a survey interview and partially an open-ended interview. I posed survey questions about age, birthplace, race, military experiences, religious affiliation(s), major, and minor. And I also posed a number of open-ended questions asking students how they decided on their major, how they decided on their minor, how they decided to take this class, what their research interests are, what kind of work they want to do after graduation, whether or not they had experience with robotics, and how they understood robotics. In the second, third, and forth interviews with students in the class, I developed questions with three interests in mind. First, the experience of using the body to know about robotic technologies. Second, how the relations between religion, God, and robotic technologies were experienced by students. Third, how students in the other lab section experienced the lab. There were two labs associated with the class, and I only attended one of them. And so I saw the interviews as a way of following the steps taken by students who attended a lab I did not observe first hand.

The terms "participant observer" are sometimes used to describe the role the researcher takes in ethnographic research. Some have even described "theoretical social roles for fieldwork" in terms of a range stretching from "complete participant" to "complete observer" (i.e. Hammersley and Atkinson 1995; Junker 1960). My position is that observations always include participation, and so rather than make a definitive statement about a single role I played through participant observation in the social life of lab members, I'm going to try and describe some roles I played and some roles I worked to avoid playing and when I did these things.

Novice Role

One role I played a lot was the novice role, the newcomer who finds a setting and its people strange in some ways (Hammersly and Atkinson 1995). I often worked to sustain this role because it furnished a number of advantages. First, it supplied me with a useable license for asking questions that may be regarded by lab members as common sense. Since I was known to be in the process of learning, then, my questions were mostly met with acceptance, accounts, and explanations rather than impatience or confusion. Second, it supplied me with a license to make mistakes that may have otherwise been regarded as unacceptable. In other words, I could screw up in some ways without it counting against who lab members thought I was. For example, early on a lab member asked me how my research was going. I responded by asking him how he thought it was going. He responded that it was "stagnant". I got defensive about this, and told him that he could handle the engineering and I'll handle the sociology. Then, I agonized over this interaction and made notes about it. But I never heard anyone talking about it afterward, and no one brought it up again that I could hear, and so it was not counted against me in any way I could understand.

I was an observer in the sense that lab members knew that I was watching and listening to what they said and did in the lab, in the course I sat in on, during lab meetings, and during the other events we attended together. I participated in lab life in a number of senses apparent to me. First, lab members referred to me in their talk. They teased me, invoked the attention I paid to certain lab members to tease those lab members, talked about me with mutual acquaintances, asked questions about sociology and my life and then compared it with theirs, and occasionally asked me for help using

the English language such as how a sentence sounded to a "native" English speaker and what a English word unfamiliar to them meant. But I'm also confident that my participation was not the same kind of participation lab members expected from each other because I adopted a novice role in many ways.

Some of the questions I asked lab members were never or rarely questions lab members posed to each other. And I could not complete activities lab members regarded as a part of being competent engineers such as writing a computer program for a robot simulator in the class I sat in on. Lab members also continuously called attention to my note-taking practices. A student in the course I sat in on talked about how all the notes he saw me taking made him nervous, and then he repeatedly talked about what he saw as the extraordinary quantity of note-taking I did many times during my fieldwork. Other lab members called attention to this too. There was an ongoing joke among Dr. DaSilva that I would listen to them and then rapidly scribble down some notes as I stroked my chin and said "interesting!"

Avoiding an Expert Role

The flip side of the novice role is the expert role. By that I mean the image of me as someone who knew as much about robotic technologies as lab members did. I figured, and still do, that if I present an expert self my questions will be met with impatience and/or confusion. As a novice rather than an expert, my questions could be common sense to lab members without introducing impatience and I could ask them more questions. One example of this is how I dressed. During the second week of fieldwork, I made notes about how I dressed. "It rained as I walked to the lab today. I wore a hat so my hair and face wouldn't get too wet. Originally I was going to wear my Oxford

University baseball hat, but then I thought that it would bring me too close to the "expert" image I had been trying to avoid in my fieldwork. I figured that the academic and international prestige of Oxford was not a good symbol to associate with in only the second week of fieldwork…so I wore a Hot Rod Magazine baseball hat instead". In addition to how I dressed, my age served as a resource in avoiding an expert role. Since lab members knew me to be a twenty-something student rather than an older "professor", I could appear as though I was still learning the ropes rather than looking like I knew where they were and how to swing from them already.

Avoiding a Critical Stance

Another part of the impression management I did was to carefully work at avoiding a critical stance. By this I mean the image of me as someone who dislikes something lab members do or say. And this began early on. Dr. DaSilva asked me if I was interested in robotics in terms of displacing or eliminating jobs for humans. I responded that I wasn't and reassured him by elaborating that there was a lot written about that subject already. During interviews and fieldwork, I also worked to avoid the critical role by carefully choosing how I talked about my teaching experiences with lab members and what texts I had on display in my office. When lab members asked about my teaching experiences, I talked about teaching the sociology of deviance in broad terms such as the challenges of eliciting student participation, the number of students in my classes, and the challenges of grading rather than in terms of course readings, themes, and concepts. I thought the word "deviance" may give lab members the impression that I was trying to show how deviant they were, and when they joked about how I was going to write about how "crazy" they were, I felt that my suspicions were at least somewhat

confirmed. During interviews in my office, I also covered up or hid textbooks and syllabi about white-collar crime, deviance, and criminology for the same reason.

Marginal Membership

While I worked to avoid an expert role during fieldwork, I don't mean to imply that my novice role fundamentally set me apart from other lab members. I also worked hard at marginal membership, the semi-membership of being both the same as members and different from lab members. I was different in the senses I described above – the novice role, avoiding the expert role, and avoiding the critic role. But I also tried to be the same as lab members in some ways. I tried to dress to the same level of casualness that I felt lab members did, usually bluejeans and button down shirts. But I also tried to appear cleancut by appearing clean-shaven during field work in general, and especially when I expected to encounter the lab director. Since a lot of the early fieldwork was in the afternoon, I also carefully managed my lunchtime eating habits. I only ate my lunch when at least the lab member I shadowed began to eat his lunch.

In addition to the field notes and experiential knowledge I gained through my fieldwork, I also drew on other kinds of data. Early on, Juan had encouraged me to ask Dr. DaSilva if he could add me to the listserve, an email system that enables a email writer to send a message to many people without having to know and type the senders email addresses. And so messages on the listserve became data as well, including typed transactions between lab members and exchanges between lab members and others working on research projects together. Early on I viewed joining the listserve as a sign that I was becoming something like a member to the lab members. But later on, I also added another part to this understanding – that it was also useful as a way of receiving

news about things like lab member's publications and changes to lab meetings. Furthermore, I took some photographs of the lab with two goals in mind. First, as a visual stimulus potentially useful to me as I worked to describe the setting in my field notes, interview transcriptions, or dissertation chapters. Second, as a resource for supplying a sense of what life in this lab looks like to my dissertation committee members and academic conference attendees. In taking these photographs, I worked hard to choose shots that kept things that could obviously identify the lab out of the frame such as the lab's logo and some of the research posters pinned up on the walls. I also refrained from taking photographs of any lab members, at least the human ones. However, I did take many photographs of the computers, robots, wheelchairs, oscilloscopes, multimeters, amplifiers, cameras, and radio-controlled vehicles in EARL.

Interviews

My research has included both ethnographic interviewing and more formal interviewing. By ethnographic interviewing, I mean conversations I had with lab members in spaces being used for other purposes (Hammersly and Atkinson 1995). These spaces being used for other purposes included the space of the lab itself, the lab director's house during summertime lab parties, a conference room during an MS thesis defense, and a lecture hall in the School of Engineering during a robotics company recruitment session.

By formal interviewing, I mean asking a lab member for an interview, arranging a time and space for that purpose, and writing at least some of the questions before I ask them. And the formal interview settings were varied. When I asked lab members for an interview, I often let them choose between my campus office or the lab. And many times

they chose the lab as the setting. But there were other times where they chose to do them in my office. The formal interviews of students enrolled in the robotic vision class were all done in my office or in my department. Since I wanted student participants to feel like they could share their experience without much fear of judgment by the professor (and lab director of EARL), I avoided doing any interviews in the lab itself. Also, two of the student participants were not lab members and so using lab space to do interviews with some people who were not lab members may have been interpreted as inappropriate by some lab members or the lab director.

I made audio recordings of all the formal interviews I did, and then transcribed the recordings myself. The interviews ranged in duration from 5 minutes and 38 seconds to 1 hour and 31 minutes long. One of the things emergent in my fieldwork was humor, and so I marked the spots where the respondent and/or I laughed by writing [laughs] of [laughing] in the transcript. Some things in the interview situation also came to my attention as factors affecting my transcription efforts. One was background noise, by which I mean noise from sources other than me or the respondent. Transcribing interviews that were done in the lab itself was sometimes challenging because lab members chatted and swapped stories as we did the interview. The second one was what I regarded as the accents of lab members. Early efforts at transcription convinced me that it could be difficult to transcribe some of the lab member's talk, and so I began to repeat what they said after they said it if I thought at the time there was a possibility that what they said would be hard to hear during transcription. As a consequence, there are some spots where the talk is inaudible, but they are few and far between relative to the interview talk that is audible and transcribable.

In addition, I made notes on the gestures respondents made when I posed questions about projects in the robotic vision class I sat in on. I did formal interviews with two broad kinds of people: lab members and lab associates. Among the lab members were the lab director Dr. DaSilva, graduate student lab members, and undergraduate student lab members. I did four interviews with Dr. DaSilva. Dr. DaSilva was and is a tenured professor of electrical and computer engineering at a major public university in the Midwestern part of the US, and the director of the Engineering And Research Laboratory (EARL). The graduate student members of his lab that I interviewed included Juan, Aref, and Karthik. I conducted 6 interviews with Juan, who was and is working on a PhD in electrical and computer engineering. I also conducted 4 interviews with Aref, a lab member who was working on a Master of Science (MS) degree in electrical and computer engineering when I began fieldwork, but has since then graduated and moved to Kansas City to work for a business that does agricultural engineering projects. And Karthik was and is working on an MS in electrical and computer engineering. I conducted 5 interviews with Karthik.

And then there are the seven undergraduate students I interviewed, some of whom were lab members while others had worked on research projects with lab members. I did 1 interview with Lew, an undergraduate engineering student lab member who helped Juan on some research projects as part of a paid undergraduate research position administered by the honors college. Lew is no longer a lab member. I conducted 1 interview with Doug, an undergraduate student double majoring in electrical/computer engineering and computer science when I interviewed him, but has since graduated and moved to a different city. Peter was another undergraduate student I conducted 1

interview with, and he was triple majoring in electrical/computer engineering, computer science, and business who had also worked with a lab member named Jen on a research project. And Fred was a graduate student in electrical and computer engineering at the time we did our first and only interview. Fred had worked with a graduate student lab member on a research project back when he was still an undergraduate student. I also did one interview with Jen, who was an undergraduate student lab member at the time of the interview. And then there was Sam, a graduate student in engineering who was a lab member when we did our first and only interview, but is no longer a lab member. And finally, there was Glen, who was an undergraduate student lab member when I began fieldwork and who is now a graduate student lab member. I conducted 3 interviews with Glen.

Among the lab associates were two student members of a different lab and two people who worked with lab members on Robotic Assistive Technology (RAT) projects. Max was a postdoctoral researcher who belonged to a different lab run by a psychologist interested in how tool use in general and prosthetic limbs in particular affect the human brain. Neil was a graduate student member of this same lab who also had experience doing a capstone project with robots. Dan and his wife Debbie are also associates of the lab. Dan was cited as the reason for Dr. DaSilva's interest in RAT. He is a quadriplegic man suffering from a neuromuscular disease who uses an electric wheelchair to get around. He also earned a degree in computer science, and works in a campus office devoted to helping college students perform their academic duties with technologies. His wife Debbie more or less travels with him everywhere, which includes lab meetings from

time to time when lab members and Dan meet to talk about projects he can use or wants to use.

My strategy for developing interview questions was to use the ethnographic knowledge I had gained through my fieldwork experiences and field notes in and about the lab and the robotic vision course I sat in on to both write the questions and decide who to ask them to. I knew that the lab had several projects ongoing all the time with different members working on different projects. I also knew that members regarded themselves as having different interests and knowledge in some ways, and so I expected that not all lab members would feel that they could speak to all the questions I wrote. One broad label for several research projects which I expected many people to speak to was "Robotic Assistive Technology" (RAT) because I knew that many people, including both lab members and engineering students involved in lab research projects had worked on these kinds of projects recently or continued work on them now. And so I wrote questions asking how a respondent decided to work on RAT, what their goals were for their work on RAT, and about the challenges they faced working with RAT. I then posed this set of questions to Dr. DaSilva, Juan, Lew, Doug, Fred, and Jen.

A second set of questions I posed to many people were survey questions about age, birthplace, race, religious affiliation, military experience, major, minor, research interests, and understanding(s) of robotics. I posed these questions to the four students who agreed to keep journals of their experience in a robotic vision class. While two of these students were and are lab members, I nonetheless posed these survey questions to them in interviews because they were new lab members at the time and so I didn't know as much about them through ethnographic interviewing as I did about the other lab

members who I done fieldwork with longer. As for the other two students in the class who agreed to participate in journal-writing and interviews, I knew one but not the other. And so for the sake of consistency and learning about these two students I had done no fieldwork with at that point, I asked them the survey questions as well. I also used these questions to conduct interviews with Doug, Fred, and Peter. I knew from my fieldwork that undergraduate students, whether lab members or not, spent the least amount of time in the lab of all lab members, and so I have very few opportunities for ethnographically interviewing undergraduate lab members. Posing survey questions in interviews, then, enabled me to learn what I not been able to learn through ethnographic interviewing with the graduate student lab members who spent a lot more time in the lab.

A third set of questions I posed dealt with Engineer's Week activities and the use of St. Patrick on one of these activities – what is known as the "Knighting Ceremony". I posed used these two questions in interviews with Dr. DaSilva and Juan. My reading of the journals kept by students enrolled in the robotics vision class led to an interest in the relations between engineering and religion or spirituality. And since I knew from fieldwork that lab members were aware of, and sometimes attended a series of events celebrating engineering known as Engineer's Week, I wanted to use it as an opportunity to learn more about how lab members rendered the relations between engineering and religion or spirituality. And since I also knew from my fieldwork experience that both Dr. DaSilva and Juan were practicing Catholics, I expected them to have something to say about the use of a Catholic figure in a college campus engineering tradition.

A fourth set of questions I posed involved laughing and pranks in the lab. I used these questions in interviews with Dr. DaSilva, Juan, Aref, Karthik, Akmul, Nate, Basma,

and Tim. One of the things emergent in my fieldwork that surprised me was how much humor lab members used. They engaged in teasing, joking, and pranks. Dr. DaSilva told funny stories about himself and former lab members, and we laughed together about them. And so to learn more about the theories lab members had of humor, or what they thought it did for them, and to learn more about the humor that resonated with them, I posed questions to everyone I knew to spend time in the lab, either as a member or as someone assisting a lab member on a research project.

A fifth set of questions involved issues of how engineering experiences affected views of nature in general and the human body in particular. I used these questions in interviews with Dr. DaSilva, Juan, Karthik, Nate, Basma, Tim, and Akmul. I had been thinking about the use of bodies in robotics as early as the preliminary fieldwork I did to negotiate access to EARL. And so when bodies became a concern in the robotics vision class lectures, labs, and in the journals students kept, I followed the interactions they were constructed through. And since I expected lab members who had taken the class earlier to have something to say about these things, I posed these questions to them too.

A sixth set of questions dealt with nationality experiences and experiences with an engineering professionalization course. Another thing emergent in my fieldwork was nation. I had heard how lab members used nation as a resource to explain some things in the everyday life of the lab. But I was also curious if nations would be offered as explanations for things that I thought may be rendered as national things such as research projects with possible military applications. And so I identified lab members who I knew to have experience on these kinds of projects, and then asked them these sort of questions. I posed these questions to Juan, Karthik, and Akmul.

A seventh set of questions were about the possibility of starting a business such as whether or not the respondent was interested in starting a business, likes and dislikes about the idea of starting a business, and how being an engineering student compared to being a businessman. I used these questions in interviews with Glen, Nate, and Aref. I chose to use these questions in the interviews I conducted because I knew from my fieldwork experiences that some lab members had presented their research projects to entrepreneurs who visited the lab, lab members talked about high tech businesses often enough for me to take note of it, and some lab members entertained the idea of starting a business.

An eighth set of questions dealt with patents such as how many patents have you applied for, what were you trying to patent, how did you decide to file for a patent(s), likes and dislikes about filing for a patent, and the challenges of applying for a patent. I used these questions in interviews with Aref, Glen, and Akmul because I knew from ethnographic interviewing that Aref had applied for and received a number of patents in two different countries, that Glen had worked on a project that Dr. DaSilva had filed a patent for, and Akmul had helped write a patent application.

A ninth set of questions I used in several interviews posed questions about experiences in the robotics vision class I sat in on. I used these questions in interviews with Karthik, Glen, Aref, Juan, Tim, Akmul, Basma, Nate, and Sam. In addition to posing these questions to students currently enrolled in the robotic vision course, I knew from ethnographic interviews that many other students had also taken this course before. And so whoever had already taken the course was also interviewed with the same questions.

I wrote the other questions I posed in interviews as follow up questions to things I had heard or seen in my fieldwork. While these questions were usually very specific to an individual's experience or background, I asked them with the idea in mind that they related to using the body to make engineering knowledge, the relations between engineering and religion/spirituality, the relations between business and engineering, and the relations between nationalities and engineering.

Analysis

In the early days of my dissertation research, I used the analytic categories of surveillance, consumption, and technology to interpret my experiences searching for a field site and negotiating access. But after I began fieldwork, I used different categories to interpret my data. In particular, I relied on an analytic strategy of abductive logic where I relied on both inductive and deductive logics. In other words, I moved back and forth between my data and the theories in STS and the sociology of description.

One of the categories I developed after I began fieldwork is bodies. I learned through fieldwork that lab members used their bodies to construct knowledge about robotic technologies. I watched very carefully as they used their fingers, hands, arms, and torsos to enact parts of robots. And so this category was an important one I used throughout my fieldwork to interpret field notes, interview transcriptions, pictures in lecture notes and textbooks, and the names lab members assigned to equipment.

My reading of the journals written by students enrolled in the robotic vision class set the stage for another analytic category. Nate wrote about how his hard work programming a robotic arm for a lab assignment strengthened his belief that humans were not just an accident of evolution, but something divinely created because if it takes so

much hard work to get a robot to do a simple thing we taken for granted, there must be something divine behind it. Curious if other lab members construed their course experience in similar ways, I wrote questions about this and posed them to Nate, the other students, and also other lab members in formal interviews. Early on, I used the category "religion" to interpret this talk about God, but eventually set this aside in favor of "spiritual" because I learned that many lab members and students talked in similar ways without sharing the same kind of commitment to a specific church.

Another category I used to interpret my data emerged in the early days. I had been following some of the speeches and meetings of the Obama administration dealing with the relations between Science, Technology, Engineering, and Math (STEM) education, economic development, and US nation-building. I read transcripts of speeches Obama made about using high tech to reduce unemployment. I read transcripts of US Senate hearings where military leaders and scientists employed by the US federal government urged congressmen to sustain and increase funding for state science and technology since, they believed, it would be central to defending "the nation". And so I was curious if lab members expressed awareness of this discourse, and if so how? I found that this discourse is at best remote and at worst irrelevant to the concerns of lab members. And so instead of trying to depict the lab in terms of how it contributed to nation-building, or how it contributed to the military-industrial-academic complex, I tried to follow what lab members did with nation as a narrative resource.

I have also used the category business to interpret my data. In the early days, I usually only used this category to consider how the lab was funded. But as I spent more and more time doing fieldwork and studying my field notes, I identified a number of

ways the lab was tangled up in business things beyond mere funding. I considered the descriptions offered in their articles, manuscripts, and newspaper articles written about lab projects, finding that they explained the value of their projects in terms of business categories like cost, speed, and efficiency. And I also considered the business people who visited the lab, who to the lab members sometimes represented possible funding opportunities and job opportunities. And so I appropriately shifted my fieldwork strategy. I listened for news from lab members that may serve as opportunities to study how they construe categories like business, cost, speed, and efficiency. And so when I heard that a man from a business that developed software being used in an embedded systems class was going to drop by and help students in the class troubleshoot some problems, I tagged along. But rather than just follow all the connections between the lab and business things that I could identify as a marginal member, I followed the lab member's theories of these connections in order to trace the social ordering they performed for them.

With the 4 categories of bodies, spiritualties, nations, and businesses in mind, I began to study how these were patterned by studying when lab members used them. To do this, I noted what kinds of situations lab members recognized them in as well as who participated in the situation. To highlight the work lab members did in using these categories, I found the term "activation" to be a useful analytic concept (Holstein and Gubrium 1995; Gubrium and Holstein 2009). And as I studied the situations certain descriptions tended to emerge in, I began to wonder why lab members talked about some things in elaborate ways in the interview situation, but rarely if ever in everyday lab life. Setting aside the question of why, I instead settled on the question of how because I thought I could provide something like an answer to a how question: how do lab

members limit certain descriptions in everyday life? But I also didn't want to imply that when these descriptions were not being activated by lab members, that lab members were being passive. And so I paid careful attention to situations where I suspected that some descriptions would be activated but turned out not to be or were only briefly activated as a means of studying how lab members avoided certain descriptions. I wanted to show how lab members also have to work to avoid talking about certain things. And I found the term "delimitation" to be a useful analytical concept for tracing how lab members place limits on certain descriptions.

PART I: TRANS-LOCAL DISCURSIVE RESOURCES

The use of discursive resources varies. Some are commonly used in many different settings, while others are limited to a narrower range of settings. I refer to discursive resources used in many different settings as "trans-local" in order to emphasize that they are commonly used across many settings. These kinds of resources include the body, and business. And since I have found these trans-local discursive resources at EARL, my findings are general.

One trans-local discursive resource is the body. We are all embodied subjects who experience the world with and through a body. Studies of different kinds of labs illustrate this. Scientists, engineers, and researchers in biology, medical, and robotics labs use their bodies as discursive resources.

Myers (2008) has shown how protein crystallographers in molecular biology use their bodies as a resource to learn about, work with, and communicate molecular structures, and in the process do a kind of "body-work" (p. 163). Drawing on observations and interviews with surgeons, medical students, medical technology engineers, and educators, Prentice (2013) argues that surgeons are made through bodies acting in the world (p. 6). In contrast to dominant models of knowledge that frame knowledge in terms of mental models and seeing, Prentice (2013) offers a more complex model of knowledge drawn from studying the practices in medical labs and surgical suites. In addition to biology and medical labs, other studies have examined engineers. Lucy Suchman (2000) has shown how engineers designing a bridge replacement engaged in the embodied practices of using a pencil to foreground parts of a visual representation

on a computer, scrolling through the cross-sections of a road on a computer, and using the hand to model the slope of a particular road. While Suchman (2000) explored the embodied practices of engineers working on a bridge replacement project, more recent studies have investigated robotics researchers. Those investigated are robotics researchers in the sense that they research robots themselves, or in the sense that they use robots to research some other object of inquiry. Morana Alac's (2009; 2011) work explores robotics researchers in the first sense – those who work in the field of "social robotics" and see applications for robotics in tourism, mass media, health services, and education. Alac (2009) mobilizes the term "body-in-interaction" to argue that bodies are not just single and physical, but also emergent in both subjects and objects because robotics researchers become one with the technology in the accomplishment of laboratory work (pp. 495-496). The body, then, is a trans-local discursive resource used across many different settings, including labs.

Like the body, business is also a trans-local discursive resource. And lab studies provide evidence of this. Latour and Woolgar (1979), for example, touch on the economic metaphors lab members used as they participated in "cycles of credit" wherein they converted money into data and data into prestige. Knorr-Cetina (1981) has also argued that scientists make themselves accountable to a "transscientific field" in their reasoning. This transscientific field spreads beyond scientific disciplines to include university administrators, funding agencies, journal editors, and government workers. Furthermore, a more recent study of a plant pathology lab illustrates the ways that business discursive resources inform academic science. Kleinman (2003) finds that a number of indirect effects of the chemical industry on agricultural pest-control research

such as in the ways scholarly writing in the field is framed, the ways experiments are organized, the measures of success that are used, and the tools that are available (p. 88). In sum, business is also a trans-local discursive resource which is used in a wide variety of settings, including neuroendocrinology (Latour and Woolgar 1979), plant protein (Knorr-Cetina 1981), and plant pathology (Kleinman 2003) labs.

CHAPTER 4: USING AND DELIMITING THE BODY

Experiences working with robots and robotic vision technologies rework people. By rework, I mean that people learn to use their bodies in ways that they would not have otherwise. One of the ways people are reworked involves bodies. Learning robotics and robotic vision technologies includes learning to use bodies as resources to plan, complete, and describe work in everyday life as well as how to communicate these forms of knowledge to other people. Engineers, then, use their bodies to plan, complete, and describe the sizes, shapes, and motions of robots, and inscriptions as well as how to communicate these forms of knowledge to other people. Professors communicate these forms of knowledge to engineering students, engineering students communicate this knowledge to themselves, engineering students communicate this knowledge to their lab partners, and engineering students communicate it to observers like me. And the settings for this communication include lectures in a robotics class for upper classmen and graduate students, the lab room of this class, and a robotics laboratory.

In this chapter, I draw on observations and interviews with members of a robotic vision laboratory and engineering students enrolled in a robotics class to explore the practice of engineering work and how it relates to discursive resources (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). Building on important work in the sociology of description (Gubrium 1986; Gubrium 1993; Gubrium and Buckholdt 1982; Mol 2002), I will analyze how engineers use the body as a discursive resource. In institutional environments like schools and rehabilitation hospitals, multiple discursive resources are available for people to use because multiple audiences are known to people

in the environment, local culture supplies resources, and trans-local culture provides some resources. One of the discursive resources available to many people, including engineers, is the human body. Recall that discursive resources are culturally intelligible and prototypical storylines or clusters of categories available to us for constructing our experience as meaningful (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). Experience is not only constructed through talk though. We also use our bodies to construct experience. And so experience is also constructed with and through the body. In a robotics lab, lab members' experiences involve constructing knowledge about robots and robotic vision, and in this way the body is used as a discursive resource. Inspired by Foucault's (1977) work on the production of "docile bodies" through the disciplinary knowledges of discourse, which suggests that discourse supplies rules and instructions for how people ought to use their bodies, I show how the body is a discursive resource in this chapter. And so in this chapter I show how this discursive resource is used in the practice of planning, completing, and describing work. Bodies, then, become descriptive resources when they are used to describe work.

One of the analytic assumptions I make is that knowledge about things in robotic vision engineering is significantly related to how things are described. Knowledge about robotic vision, then, is as much a feature of engineer's practices as it is a feature of the robots and robotic systems themselves. And so I deliberately use the analytic term "description" rather than "representation" because representation smuggles in a connotative distinction between an object and its expression, which implies that an object exists independently of expressions about it. In contrast, I assume objects are not independent of expressions. Descriptions of objects construct objects by constructing

objects as real. Objects, then, are accomplishments of descriptive resource use in everyday life. Gubrium and Buckholdt (1982) argue that the activity of describing has 4 parts, which include the things being described, the descriptions themselves, the descriptive circumstance, and the audience that received the description (p. 3).

In this chapter, I focus on the descriptions themselves, the descriptive circumstance, and receiving audiences. The descriptive circumstance, or conditions where bodies are used to describe work with professional terms that construct it as machine-like and depersonalized include lectures in robotics classes for upperclassmen and graduate students, the lab room of this class, and a robotics laboratory. Audiences for describing work in professional terms are the self, other engineering students, lab partners, engineering professors, and observers like me. However, professional descriptions are not the only descriptions engineers use in practice. And so I also analyze humorous descriptions of bodies and the descriptive circumstances they emerge from.

Learning robotics and robotic vision technologies includes learning to use the human body as a resource to describe the sizes, shapes, and motions of robots, and inscriptions as well as how to communicate these forms of knowledge to other people. Professors communicate these forms of knowledge to engineering students, engineering students communicate this knowledge to themselves, engineering students communicate this knowledge to their lab partners, and engineering students communicate it to observers like me. Although two of the engineering students I interviewed said that they had experience using their hands to understand physics or electrical engineering knowledge in classes before taking the robotics class I sat in on, I argue that they also learn to use their bodies to construct engineering knowledge through their experiences

with robotics in the robotics engineering class I observed. Their embodied modes of knowing cannot be simply accounted for by referring to experiences before the robotics class because in the robotics class I sat in on the professor and more experienced students exposed them to other embodied techniques of knowing that went beyond hands and involved arms and torsos. And in the process of constructing engineering knowledge, objective-selves are enacted.

Engineers use human bodies to describe things in 5 different ways. First, they anthromorphize machines, or assign human characteristics to many of the non-humans around them. Second, they technomorphize people, or assign non-human characteristics to them selves and others. Third, they construct an affective assemblage by learning to be affected by the same things as the machines, and assuming that what is good for the machines surrounding them is also good for them. Forth, they use their hands, arms, heads, and torsos to construct knowledge about the size, certainty, shape, and motion of robotic vision technologies. Fifth, they use talk and imagery to depersonalize human bodies.

Anthropomorphizing Machines

One way in which bodies are treated as resources to describe things happens when human bodies are used to describe machine bodies. And one way to do this is to emphasize what they share with machines, and something they shared for the engineers was human-like characteristics. Boundaries between machines and humans were unsettled by anthropomorphizing machines, or attributing characteristics often associated with humans to machines. The most common way this was done involved describing

machine parts as human body parts. For example, computers and robots were said to have the same body parts in both everyday talk and the lab's website. On the lab's website, the computers with two monitors were referred to as "dual headed". In addition, each computer in the Engineering and Research Laboratory (EARL) was assigned a name that more often than not was drawn from eye anatomy language. Most of them featured small white signs with black letters expressing names like "Iris", "Cornea", and "Fovea". In the robotics course lecture and it's lab as well as in EARL, we regularly referred to the "joints" and "arms" of the robots. I even took this for granted for a long time, until I spent less time doing fieldwork for a period and it dawned on me that none of the lectures, labs, or research projects at EARL included humanoid robots. It is especially interesting, then, that this kind of language was in common usage despite no humanoid robot projects. But describing machine body parts as human body parts wasn't the only way machines were anthropomorphized. They were also rendered human-like through talk that accorded them some sort of agency, even if the agency paled in comparison to the agency of engineers. In one lecture, we learned about the "kidnap problem" where a robot is kidnapped, transported to a new place, and has to figure out where it is from scratch. Only things that have some kind of agency can be "kidnapped" because if a thing is only understood as passive, it is not possible to be kidnapped, but any one of a number of other verbs such as moving, transporting, carrying, or shipping.

Technomorphing Humans

Engineers also described the human body as a machine body. Boundaries between machines and humans were unsettled by "technomorphing" humans (Vertesi 2012:400), a

process where engineers described humans as machines. This process began right away for me. The first time I met with the student members of the lab, Juan informed me that if I wanted access to the lab computers, I should ask DaSilva about it. Later on, I acquired a user ID and password to access the lab computer system. This constitutes a kind of technomorphing of humans because like Downey's (1998) study of engineering students learning CAD design, we had to agree to constrain ourselves to the role of user (p. 150). Becoming a user involved extending personhood into the computer so that a kind of electronic personhood is constructed. This process begins with two parts. First, we gave up our human names in order to gain access to the computer system (Downey 1998:150). I became "mc88" instead of Matthew Cousineau, Matt Cousineau or simply Matt. Second, we had to pick a small icon to represent our electronic personhood. When I noticed these icons displayed on the log-in menu of the lab's computers, I wrote in my field notes:

> The icons are tiny simple pictures of a faceless human form from the shoulders up. The figures all have green or blue shirts, and brown or black hair. The haircuts are all short, and look to me like icons gendered male, and even the only female lab member – Jamie – has an icon with short hair.

These icons resemble human forms, but only standardized human forms: There are no obvious clues about the race and age of these icons, and we are only provided 2 choices for hair and 2 choices for shirt color. Every lab member and I picked one of these in order to access the lab's computer system. In addition, logging into the lab's computer system demanded that we search a drop down menu for our user ID, and so we forfeited our human names every time we logged in, and over time this became taken for granted.

Technomorphing also occurred very often in interviews, course lectures, and lab meetings. In these settings, human body parts and capabilities were very often described in terms of the machines we studied. In interviews, engineering students regularly said that human brains were like computers, human vision was like computerized camera vision, and the human body constituted a "system". And during course lectures and lab meetings, human body parts and capacities were often described in these ways too.

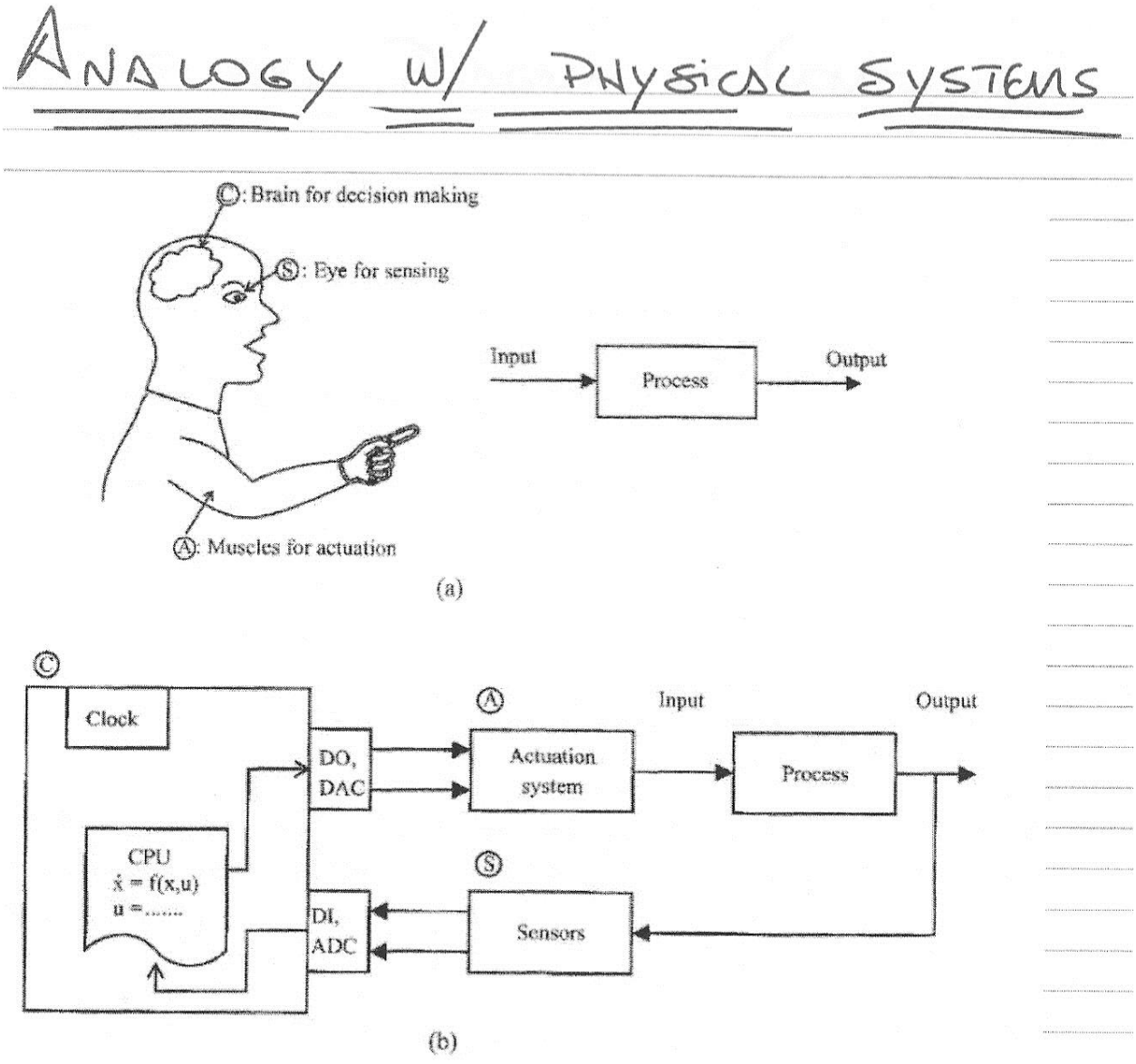

FIGURE 1.2: Manual and automatic control system analogy: (a) human controlled and (b) computer controlled.

Figure 1: Image from our lecture notes offering analogies between people and computers as well as part of a human body that has been transformed into a technoscientific object through depersonalization.

Depersonalizing Human Bodies

Engineers deploy impersonal pronouns to describe human bodies, even when they are gesturing to their own bodies. They refer to "the body", "the arm", and "the brain" rather than "my body", "your body", or "Tim's body". In the lecture notes of a class I sat in on, the human body was also depersonalized by constructing a standardized technoscientific human body. Figure 1 is drawn from the lectures notes of our class, and compares "manual" and "automatic" control systems by comparing a human figure with a flow diagram of a computer. It draws analogies between "actuation systems" and "muscles", "sensors" and "eyes", and "CPUs" and "brains". But the image we learn from in these lecture notes also renders the human body as a standardized technoscientific object through its presentation of a human body and the labels assigned to the body's parts. An arrow pointing to the head is labeled "brain for decision making" rather than a specific person's brain like "Aref's brain". Likewise, an arrow pointing to the eye and then an arrow pointing to the bicep are labeled "eye for sensing" and "muscles for actuation", respectively, instead of "Aref's eye" and Aref's muscles". The way the image is presented also standardizes the body: an image of a human from the side is presented to us without any distinguishing symbols like gender, race, and age – specific traits that

subjects typically display (Gusterson 2004:70). Finally, the image is a black and white drawing rather than a photograph, and so it isn't designed to look like any person in particular we may know, but rather a standardized human.

Constructing an Affective Assemblage

Another way in which the boundaries between machines and humans were redrawn happened through the conditions in EARL. I argue that the lighting and temperature conditions in EARL were described by lab members in a way that constructed an "affective assemblage", a network of humans and non-humans that redrew boundaries such that human lab members feel and sense the same things as the non-humans, or what they assume to be what the non-humans sense. Although this affective assemblage is so subtle that I rarely thought about it beyond the early days of fieldwork, and during those rare times when the room temperature felt different than usual, I argue that it is a powerful means of blurring the boundaries between machines and humans. It is powerful because it registers in the embodied experiences of senses, and was taken-for-granted most of the time by lab members and me. One strategy of constructing this affective assemblage included calling attention to the temperature in the room, and then assuming that what is a "bad" temperature for the machines is also a "bad" temperature for the humans. In my field notes, I wrote:

> Juan then opens the windows in the room. The windows pop open with hinges at the bottom. This leads us to a conversation about the micro-climate of the room.

> Juan tells me that he decided to open the windows because it is “uncomfortable” for us, and “bad” for the “equipment.” He tells me that it is “bad” if the equipment gets too warm because if it gets too warm they could “lose” equipment from overheating. He tells me that they have lost a “multiprocessor” in the past from overheating. I then ask at what temperature he worried about the servers in the ceilings and the equipment in the room, and he says about 80 degrees Fahrenheit. As he tells me this, he looks over at the digital thermometer sitting on a shelf behind the electric wheelchair. It reads 79 degrees Fahrenheit. We also talk about the fan noise I hear. Juan tells me that this noise comes from a “multiprocessor” that has a built-in fan to stabilize the temperature of the processors. I also use this opportunity to ask Juan about a piece of paper towel pinned to one of the ceiling tiles above the door in the room. Juan explains this, but I can’t remember the whole explanation. From what I do remember, he pointed at a small, white, and circular object mounted to the right of this paper towel as he told me that it was a motion detector linked to the heating and air conditioning system. He tells me it helps stabilize the temperature in the room. I understand this to mean that with more motion in the room, comes more heat, and so the motion detector helps adjust the room temperature as needed and in variance with the motion in the room.

Juan begins by calling attention to the temperature in the room: he describes it as “uncomfortable” for us, and “bad” for the equipment. It is “bad” for the equipment, I learn, because when the temperature reaches about 80 degrees Fahrenheit, Juan worries about the servers and equipment in the room overheating – a problem he says damaged a

"microprocessor" in the past. To prevent this sort of thing in the future, he relies on a digital thermometer and a motion detector that activates the temperature control in the room to stabilize the room temperature. Likewise, the room temperature in EARL's other room is also monitored by a digital thermometer. Aref told me this was done for the cameras and servers mounted in the ceiling above the Holodeck, the lab space encircled by cameras. While it may seem obvious that electrical equipment should be kept from becoming too warm, this assumption that what's good for the machines is good for humans is an underdetermined cultural assumption intelligible in description. For example, an equally reasonable way to make sense of this might deal with a thought I jotted down in my field notes: why should what's good for machines be good for humans when they are made of different materials?

An affective assemblage was also constructed by regulating the lighting conditions in EARL. On one day in February of 2012, the EARL room that Aref worked in felt particularly dark. In my field notes, I recounted what happened next:

> Next, I ask him why they keep the blinds closed in the lab. He explains that they carefully manage the amount of light in the lab for all the cameras around the Holodeck. Aref says there is another layer of paper under the blinds, which explains why the Holodeck is dimly lit, and the only light in the whole room comes from fluorescent lighting above the computer terminals abutting up against the Holodeck.

Many of the lab member's research projects include computerized camera vision technologies, and so carefully managing the light in the room makes it possible for them to conduct research with and on cameras. Part of this involves maintaining tight limits on

the amount of sunlight that enters the room through the windows because this kind of light is not easily standardized and made stable; it's intensity and angle of entry may change across time. And so, the lab members maintain tight controls on it: they keep a layer of paper over the windows, and then closed blinds over that. Like the temperature conditions, it is assumed that what's good for the cameras is good for the humans.

While carefully managing the lighting and temperature conditions may seem like activities that only make the environment more comfortable for humans, these activities also do other things. First, by assuming that what's good for the machines in the lab is good for the humans in the lab, they take on the standpoint of the machines in a way. They embody them in the sense that they learn to feel the temperature the servers experience and they learn what it's like to be in a room with very specific lighting conditions. Second, since it is taken for granted that the lighting and temperature conditions good for machines are also good for people, everyday life in the lab includes redrawing boundaries so that humans and non-humans are affected by the same things. And learning to be affected by the same things as machines helps reinforce the embodied work of robotics and robotic vision engineering.

Doing Size

Engineering students use their arms to describe the size and shape of robotic arms. This understanding was made possible when students compared the size of the human arm to the size of the robotic arm they worked with in the class's lab, and found them very similar. When I asked Tim if he gestured with his fingers, hands, arms, shoulders, head, or other body part to model the robotic system, he responded:

> Yeah, I mean I guess hand gestures just in general. I think I do, but then to model, it's an easy way to show, especially the robot arm in the lab is about the size of our arm, so to show what we want to do, if I'm talking to Andy or trying to understand something, it's a lot easier then we can't do it with the robot anyways, you know try to tell them what we want to do, you know that's an easier way to do that.

He says gesturing to model the robotic arm is helpful because it is about the same size as his own arm.

Doing Certainty

Engineering students also used their hands and fingers to describe axes and gain confidence in their understandings of the axes of robots. In this way, certainty was an embodied accomplishment: they accomplished certainty by using their fingers and hands to understand robots. One situation in which gaining confidence became important happened when the professor sought to challenge knowledge in a textbook. In my field notes, I wrote:

> LD notices a mistake in an example he has reproduced from the textbook. He studies a set of equations representing the positions of a robotic arm. He is curious about one in particular because he reads it as indicating that the 5^{th} joint of a robotic arm does not affect the position of the end effector. Then, he scrolls through his laptop to an image of the robot with joint angles overlaid to represent the joint angles. He uses his right hand to model and enliven the motion of each joint on the robot beginning at the bottom. He says that the 5^{th} joint should affect

the position of the robot's end effector. He tells us that the authors of the book may have a mistake. He tells us he will "take a look" at it later on. He then tells us that he may write a letter to the publisher to inform them of the mistake.

To reach a point in space, the end effector – or hand – of a robot needs to move, and this movement is typically made possible by the movement of other joints on the robot. When LD studied the mathematical descriptions of the robot, he interpreted them as indicating that the 5th joint did not influence the end effector. Next, he displays a projected image of the robot to us with axes overlaid on top of it, and then beginning at the bottom of the image uses his right hand to enact how each joint ought to move. The hands are such a powerful tool for knowing that they can help challenge knowledge in a textbook, and perhaps even help him articulate his case in a letter to the publisher.

One student, a woman named Basma, preferred to use her hands because it helped her avoid mistakes that come from knowing in alternative ways. An excerpt from one of our interviews illustrates this:

Matt: So you have more certainty when you can use your hand to gesture…?

Basma: …yeah instead of…

Matt: …than you would otherwise…

Basma: …yeah for example, if we had to use it for formulas and developing programs, you can mix up things, and it happens with me a lot so I am the kind of people who misses minuses you know?

Matt: So one little detail like that messes up everything?

Basma: Yeah, messes up everything.

Alternative ways of developing confidence in knowledge of the axes of robotics is very detailed work because computer programs and formulas depend on details. In computer programming, the program, or set of instructions to a computer, have to be very specific and consistent because computers do not tolerate ambiguity, omissions of characters, or typos if human users wish to complete a task successfully. In mathematics, details like the sign of something can make the dreaded difference between a proof and something that "messes up everything". Rather than risk making a mistake with the details of these ways of producing knowledge, Basma can rely on her hands to build up confidence in her knowledge of the axes of robots.

Another student, Akmal, also liked using his hands and arms to describe robots. But in his case, it was also useful as a means of making sense of transformations and rotations. Rotations are the angles of change when a robot's joint moves from one point to another. Transformations are matrices that mathematically describe a series of angle changes. Rotations can become very difficult to understand for two reasons. First, all joints on a robot do not move independently. Often, in order for the joints near a robot's gripper - or hand - to reach a point, other joints on the robot also have to move, and so one rotation is accompanied by the rotation of other joints as well. Second, the more joints a robot has, the more difficult it becomes to keep track of all the changes occurring in their rotations. Akmul liked to rely on his hands so much to make sense of these things that he joked he wished he had more hands:

Matt: Okay, I want to follow up on one part of that. When you for instance use your fingers like we just talked about, gesturing for

the axes, does that provide you with more certainty about transformations, rotations, that sort of thing?

Akmal: Yeah, actually it helps because you just see how things are doing. Sometimes you feel less number of hands, if you had more hands then it would be easier, but…

Matt: …sometimes you wish you had more hands?

Akmal: [laughs] Yeah like many axes right?

Akmul uses his hands to boost the confidence he has in his knowledge of rotations and transformations. Both human arms and robots arms have several joints, and so the human arm provides a useful model to describe robots. Note how Akmul remarks on the limits of human hands – that there are only two of them – but does not frame this as a reason for relying on some other means of knowing. Instead, he says he simply wishes he had more. The hands and arms are so important in this work that having only two of each builds up a demand for more.

Doing Shape

Engineering students also used their arms to describe the shape of robotic arms. Comparing human arms to robotic arms helped them describe them as similar in terms of shape because both human arms and robot arms feature parts that enable one segment to pivot from another segment. Engineering students also use their arms to describe 3D shapes. Several of the lectures I observed were devoted to learning about the "coordinate frames" of robots, objects, and cameras. And each of these coordinate frames included a length, height, and depth measure. Thus, we learned to think and see things in terms of

3D views so that 3 dimensions of an object are simultaneously perceivable from a single point of view. This is also common in other kinds of engineering work. However, representations of 3D objects on 2D mediums like images can pose a challenge in engineering work because the clutter of 3 dimensions bunched together in a single point of view may conceal parts of an object. We learned this first hand in class. The professor had projected an image of a robot onto the whiteboard in our classroom, and he was drawing coordinate frames over the projected image. But in this image, it looked like two axes from two different joints intersected with each other. I couldn't tell what he was talking about. Then, he crossed his arms making a big plus sign shape with them, but with a gap between them so that they didn't touch each other. Seeing this I suddenly understood what he was referring to. One of the joints was set back, and so the axes didn't cross because one was behind the other. In the image this was virtually impossible to see, but once he enacted the axes with his arms it helped me make sense of the image. And so, we made sense of a 3D model by using the body as a resource to describe the axes of the model, and then studying the spatial relations between the arms. A student who was in attendance during this lecture also talked about the importance of using his hands and arms to describe 3D models. When I asked him if the axes are harder to visualize in 3D, he said "Yeah because I can see, you can see 3 dimensions, but I can visualize only 2 easily – the x and y. You have to visualize another frame, sorry axis, so this makes it easier sometimes". He says he can visualize "only" length and height "easily". But depth is more of a challenge for him. Just like the above example from lecture, the depth dimension is a challenge because it is difficult to depict depth in a 2

dimensional medium like an image or drawing. Hands and arms help make that depth dimension more visible, and help us make sense of 3D models.

Doing Motion

Motion can be important to robotics and robotic vision engineers for several reasons. In the class and lab I observed, it was often important because lab assignments and research projects were aimed at engineering a robot to accomplish a task, and this task was to be accomplished through some kind of motion. One way in which motion can become important is as a means of learning about the complexity of robots in general, and how they can reach the same positions in more than one way in particular. The professor showed us this in class by using his body as a resource to describe a redundant robot. In my field notes, I wrote:

> DaSilva then talks about "redundant robots". He enacts a redundant robot with his body. He stands facing a side wall with his left arm raised and outstretched, and tells us the robot can reach the position in front of him as he clenches his fingers. Then he tells us that the robot can even twist 180 degrees. He also uses his body to enact the redundancy. He turns around so that he's facing the opposite direction, and then reaches backwards with the same arm. He says the robot can reach the same position when the joints enable it to do so, and it can turn. The capabilities of the robot are demonstrated through the capabilities of the human body.

A redundant robot is a robot that can reach a position in more than one way. The professor uses his left arm as a resource to describe the robotic arm's motion of reaching

a point in space. Then, he clenches his fingers to signal to us that this is the final position to reach. Next, the rest of his body is called into action as he tells us that the robot can twist 180 degrees, and then turns around to face the opposite direction. Finally, he reaches behind him with the same arm to show us how the same initial point can be reached through a different series of joint positions and motions.

Another way in which motion became important to the engineers was through their experiences working with simulations. These simulations relied on computers to model how a robot moves to accomplish a task such as moving through a space with obstacles in it or picking an object up and carrying it somewhere else. Although some of the engineers expressed dissatisfactions about simulations to me, experiences with them were common to all. The robotics class I observed called on us to write a program for a simulation as one of the lab assignments, and all of the graduate student lab members had taken the course. In addition, one of the graduate student lab members worked on a simulation research project. And I focused on this project for about 1 month during my fieldwork, tracing the steps he took as he worked on the simulation. One part of this project included making a computer program that would simulate a robot or electric wheelchair making curved turns on its way to a destination point. Curves were deemed important because the lab members envisioned the application as a technique of controlling an electric wheelchair, and angular turns were assumed to make for a bumpy and uncomfortable wheelchair ride. Although the lab received a donated electric wheelchair, we never worked directly with it. Instead, we focused on a simulation. We did this for a number of reasons. First, the consensus among lab members was that simulations were safer and cheaper than working with real robots. Second, the graduate

student lab member I shadowed added that simulations provided several advantages that would be more difficult to accomplish through filming a real robot: the simulation provides an aerial view of a robot's path, colored lines tracing the path of the robot enabling a visual depiction of the whole path in a single screen shot, and these screen shots depicting paths can then be compared to each other for analyses and publications.

Although it may sound straightforward to identify curviness in a path, the lived experience of this work is much more complicated than that. Aref worked on a "rubber band" model of path planning. His strategy was to make the turns curvier by reducing the quantity of points in the path, and then reconnecting the remaining points together into a new, curvier path. But a short and small path depicted on a computer screen made it difficult to evaluate this curviness. Aref adjusted his code in the computer program to reduce the number of points in the path, and then made a screenshot of the path so that we could compare it with the path created by the code without the adjustment. When we opened the screenshot and then zoomed in on it, many tiny lines appeared that looked more like curves when zoomed out. But Aref was not happy with this. He wants it curvier. And so, he continues to adjust the computer code. As Aref works on incorporating his technique of making the simulated robot's path curvier, he uses his body to describe the angles made by the red dot in the simulator. He uses his right hand to model the angles of the path. He holds the knife of his right hand up, and then points it to the right, which is the red dot's first angle in the simulation he has been running. Aref then takes the knife of his right hand, moves it closer to the computer screen, and then points it left, which is the angle the red dot in the simulator makes as it moves past the obstacle in the simulation. Aref also makes a few drawings by hand on a sheet of paper

between his body and the keyboard. He draws paths with dotted and solid lines. At about 2:30, Aref runs the code in the program again. It works this time. He shows me that it works by showing me that the first turn made by the red dot in the simulator is now less of a sharp turn, and looks more like a curve. He jokes that it took him about 3 hours to make this single turn more of a curve shape.

While knowledge of motion was communicated to us as robotics students, and to one's self to make sense of one's research project, it was also communicated to another audience. Engineering students used their arms to communicate it to outsiders, outsiders in the sense of people who were not students in our class or members of the robotics lab. Instead, they were outside the lab or the class, but inside in another way such as being friends with one of the students. In one of our interviews, Nathan recounts how he described the lab's robot to a friend who was majoring in mechanical engineering and considering taking the class in the future:

Nate: Yeah, like just today there was a non-robotics student in, and asking me questions about it. And he asked what were the degrees of freedom basically, and I just showed him with my arm. It goes this way, this way, this way, so…

Matt: …interesting, so what was this person doing in there?

Nate: He's a mechanical engineer, and so he's taking some mechatronics classes more from the mechanical side. So he was just curious. He was asking about the mobile robotics sims [simulations], and the Puma, and he was thinking about taking this class so we talked over it a little.

Another way in which motion can become important is in mobile robot navigation. Mobile robots are robots that are capable of moving under their own power, and navigation is the term engineers use to refer to the technologies and techniques the robots use to find their way through space. During one lecture, I wrote in my field notes:

> DaSilva talks about map-based landmark tracking where a robot navigates by searching for a particular series of landmarks, and finding these in an order, the robot makes its way through a space. As he explains he takes a few steps toward the door, and then gestures like he's found an imaginary object, and says when "we" find this landmark, and then the next one, and continue like this.

We learn about "map-based landmark tracking", moving through space by identifying landmarks in the space, and finding these in a certain order. Since we are sitting indoors and inside a classroom, there is very little in the way of "landmarks" such as monuments, signs, stores, or intersections to help us visualize this. And so when LD treats his body as a resource to describe the body of the robot by taking steps toward the door and gesturing to an imaginary landmark, he presents an effective visualization of the robot by becoming the robot.

Doing Inscriptions

Latour (1987) has developed the concept of an "inscription device" to refer to "…any set up, no matter what its size, nature, and cost that provides a visual display of any sort in a scientific text" (p. 68). Although Latour (1987) supplies examples of inscription devices such as telescopes and graphs, I argue that these visual displays are not only articulated in journal articles or images. Instead, they are enacted through

embodied practices: they are described through words and gestures, and I now turn to how they are done.

During a meeting with another research team (including a computer scientist and a psychologist) they were considering collaborating with on a research project, DaSilva used his hands and arms to enact a coordinate frame. A coordinate frame is a set of three axes that are employed to make sense of a robot, camera, or object in space. Each of these things may have a different coordinate frame, and one axis signals height, one length, and one depth. The psychologist and computer scientist were interested in using robots to learn about the "neural basis of tool use" rather than something about robots themselves, and so DaSilva at one point in the meeting used it as an opportunity to summarize robotics engineering. In my field notes, I wrote:

> During the meeting, I also notice something as DaSilva uses his right arm to describe how the Kawasaki robot moves. He uses his right hand to show us the axes the Kawasaki robot moves along. He does this by raising his arm to where his elbow makes about a 45 degree angle with the armrest on the chair he sits at, pointing his pointer finger upward, pointing his thumb towards his body, and pointing the finger right of his pointer finger parallel with the floor. As he does this, he refers to "X", "Y", and "Z" axes. The pointer finger refers to the Y-axis, the next finger to the X-axis, and the thumb refers to the Z-axis of depth.

DaSilva transforms his right hand into the coordinate frame, and in doing so he enacts a coordinate frame for the Kawasaki robot looming large next to us in the lab. Since each finger can be made straight, it provides an effective visual display of each axis. And because each finger on his hand can point in different directions, they also provide an

effective visual display of how the axis spatially relate to each other. He points his pointer finger away from his body and it enacts the y-axis which signals length, the thumb is pointed upward to signal the x-axis or height, and he points his third finger parallel with the ground to signal the z-axis or depth.

Inscription devices are also done through embodied practices as a means of describing tiny bits of time. Although historiographical accounts of time often assume that the linear clock time of modernity is equally shared across all social groups, ethnographic work challenges this assumption by showing different constructions of time (i.e. Masco 2004, Mirmelak 2008, Traweek 1988). Robotics and robotic vision engineering is no different. Students learn specific cultural categories for making sense of time. They learn to think about time in infinitesimally small bits that are virtually impossible to imagine without computers or gestures. This construction of time was especially striking to me as I observed an introductory electrical and computer engineering class. The professor was talking about how long it took the MATLAB software to perform calculations she entered into it as we watched her work on a big overhead screen. In my field notes, I wrote:

> Dr. Sutton says that a calculation with "pre-allocation" took .002 seconds, and a calculation that took .06 seconds makes the "pre-allocation" method "considerably faster". We learn to measure "fastness" in hundredths and thousandths of one second.

We learn that "faster" is a matter of hundredths and thousandths of one second, and we know this because MATLAB has timed the calculation. We don't know this because we counted the duration on our fingers, or we used some other unaided sensory experience to

make sense of time of this order. It is virtually impossible to describe hundredths or thousands of one second without the software and the computer display.

And so when engineering students lack a computer at hand to make a visual display of these tiny bits of time, they literally use their hands to describe it. When talking with the highest ranking member of the lab about his hand gesture control system for an electric wheelchair, I wrote in my field notes:

> We also get to talking about the kinds of time important in this work. He tells me that the electric wheelchair system samples the electrical signal from the human body it is linked to at 500 millisecond long samples, or half of one second. I remark that it seems like a "challenge" to "imagine" time in these terms. He agrees, and then tells me that he used the oscilloscope "offline" to study the characteristics of the EMG signal, including time. He also used the index finger of his right hand to draw signals on imaginary graphs in front of him.

Electrical signals constitute so much energy that sampling them for fractions of a second is a challenge to imagine without a resource. Since he told me this in the hallway outside of the lab and away from his computer monitor, he resorts to his hand for a descriptive resource. Using his pointer finger, he draws a sinusoidal wave to help me visualize what a signal looks like in that tiny window of time.

Engineering students construct time in a way that underscores the speediness of the computer programs they have written. In my notes about one lab meeting, I wrote:

> Near the end of his presentation, Aref presents several "examples" to us where he shows us how quickly the program can run. The measurements are displayed in

microseconds, and the members say things like “wow” to display being impressed with the speed of the program.

The Uses of Humor

Robotic vision engineers construct engineering things by describing those things to themselves and others. And they do this by describing machine bodies as human bodies, human bodies as machine bodies, as what is good for machines is good for humans too, by describing the sizes, shapes, motions, and inscriptions of robots, and by describing bodies in impersonal ways. But this does not mean this is all they do in everyday life. Sometimes human bodies and their use as resources for knowing about things are described differently. They are described by lab members not as machine-like, but instead personalized as bodies that belong to a person. And in treating these bodies with humorous descriptions, lab members also place limits on the use of the body as a discursive resource. Funny stories about King Henry the 8th provide an example. In my field notes, I wrote:

> I arrive at the lab today and run into Dr. DaSilva, Juan, and Karthik in the hallway. DaSilva tells me that they are on their way to the “machine shop” to shave some metal off a piece of metal for the wheelchair. Dr. DaSilva asks me if I want to join them. I confirm that I do. And so, we walk across the street and into a basement machine shop where a tall skinny white man takes the piece of metal and shaves off “25 hundredths” of it using a lathe. He hand cranks the lathe to shift positions so that each side of the piece is narrowed down. As he tightens the piece down, the subject of the “metric system” and the “imperial system” comes up. Juan says he likes the metric system because he is used to it. The machinist

says he prefers the imperial system, but for the same reason. This leads to DaSilva joking that the imperial system was developed by "a guy with a big head". I ask who? He replies that one of the King Henry's developed the units of the foot, inch, and yard using his own body. Dr. DaSilva says that he thinks the yard was invented as the circumference of King Henry's head.

The lab director also talked about this in the mechatronics class I sat in on. And in both settings, he called our attention to King Henry the 8th as self-centered for devising a measurement system with his own body: above as "a guy with a big head" and as a "narcissist" in class. The body described here by Dr. DaSilva is very different from the body described in a different "descriptive circumstance" (Gubrium and Buckholdt 1982:3). It is not machine-like and depersonalized. The body is described as gendered: it is attached to "a guy". And describing the body as King Henry personalizes it by implying that it belongs to a person.

Humorous descriptions of bodies were not evenly sprinkled across lab life. They occurred in a specific "descriptive circumstance" – the "…concrete conditions…in which [people] find themselves describing" (Gubrium and Buckholdt 1982:3). And these descriptive circumstances occurred outside of, or during the transition periods before and after important events in lab life: class lectures, and the research presentations in lab meetings.

Important studies of staff in a rehabilitation hospital (Gubrium and Buckholdt 1982) and engineers employed by commercial corporations (Kunda 2006) have carefully shown how the situations humor emerges from contribute to the orderliness of social life. In his interesting study of engineers employed by commercial corporations, Kunda

(2006) argues that managers give presentations to engineers where "…organizational ideology – the managerial version of…[the organizational] culture and the member role it prescribes – is dramatized and brought to life" (p. 93). And managers expect engineers to embrace the member roles prescribed during these situations, which involve public displays of agreement with cultural knowledge about profits, technological accomplishment, loyalty, and excitement (Kunda 2006:106). During the presentations, Kunda (2006) suggests that engineers display agreement through laughter, applause, nodding, note taking, and questions (p. 106). But before and after these presentations, Kunda (2006) found transitional stages where engineers engage in role distancing: "…effectively expressed pointed separateness between the individual and…[a] role" (Goffman 1961:108). They distance themselves from the role proscribed to them through "…creatively exposing hidden meanings, debunking explicit intents, parodying conventions, and conveying an instrumental interpretation of events and an awareness of their theatrical nature" (Kunda 2006:107). And since these role distancing activities are done before and after the presentations of management, Kunda (2006) argues that they protect the cultural knowledge of the group and expressions of role embracement from challenges and contradictions (p. 107). Gubrium and Buckholdt (1982) make a similar point in their study of staff in a rehabilitation hospital. In a descriptive circumstance where occupational therapists do paperwork, Gubrium and Buckholdt (1982) show therapists joking and laughing as they describe ordinary things with professional terms. They describe cones as "range-of-motion conical therapeutic devices" and peg boards as "developmental learning materials" (Gubrium and Buckholdt 1982:99). While they describe these things with professional terms when physicians and families are their

audiences, in this descriptive circumstance the descriptions are treated as realities in and of themselves rather than words that describe some things. But because they only engage in these "deprofessionalizing asides" among audiences of other therapists and they do this in humor, the therapists frame the situation as non-serious (Gubrium and Buckholdt 1982:101). And so the disruptive idea that words do not refer to any thing is understood as non-serious, which supports the description of things in professional terms and a sense of hope for patients by not counting alternative descriptions as serious. Ethnographic studies of other settings like medical hospitals has confirmed this observation – humor reveals a danger to social order while simultaneously minimizing the threat it poses to social order (Goffman 1961; Prentice 2013).

EARL is no different. By drawing on body resources in humor and describing bodies in humorous ways before and after course lectures and the research presentations during lab meetings, Dr. DaSilva protects the cultural knowledge of robotics vision engineering and expressions of embracing the role that this knowledge prescribes. In this case, cultural knowledge includes descriptions of how human bodies resemble machines and how this relates to the problems of robotic vision engineering.

Conclusion

In this chapter, I have analyzed the descriptions, descriptive circumstances, and audiences invoked when engineers make professional descriptions of bodies and when they make humorous descriptions of bodies. Professional descriptions work up machine bodies as human bodies and human bodies as machine bodies, construct an affective assemblage to describe what is good for machines as also good for humans, treat human bodies as resources for describing robotic vision technologies, and depersonalize human

bodies. The descriptive circumstances for these include lectures in a robotics class for upperclassmen and graduate students, the lab room of this class, and a robotics laboratory. The audiences, then, are composed of lab partners, engineering professors, and other engineering students.

But lab members do not feel that the body is always the appropriate discursive resource to bear on their activities. Humorous descriptions of bodies do not construct them as machine-like, but instead personalize them as bodies with a gender and a name. And these descriptions were not uniformly given across lab life. They were offered in particular descriptive circumstances: during transitionary periods before and after important events in lab life: class lectures and lab meetings. By only offering these kinds of descriptions outside of lectures and lab meetings, and then using a non-serious frame to understand what is said about bodies, the professional descriptions of bodies are protected from role distance.

CHAPTER 5: USING AND DELIMITING BUSINESS

Learning robotics and robotic vision technologies includes learning to use business as a discursive resource to plan, complete, and describe work in everyday life as well as how to communicate these forms of knowledge to other people. The business discursive resource is a framework for the communication and description of activity in terms of categories of, and references to, money and competition. In this chapter, I analyze how lab members use business as a discursive resource in everyday life. Drawing on observations, open-ended interviews, articles written by journalists about lab activities, and the articles written by lab members, I show how and when lab members use business as a discursive resource. I argue that lab members use business as a contrast structure that illustrates who lab members take themselves to be through a comparison of who they do not take themselves to be, when they signal that they are talking to one or two specific individuals rather than all lab members, when they describe their activities to journalists, when they develop written descriptions for their website, and in the conference and journal articles they write.

One way lab members work to describe who or what they are involves what they do with events. And one common thing people do with events is organize them into an account, a description of what happened during the event. Dorothy Smith (1978) has argued that these accounts are "...not just a record of events as they happened, but of events as they were seen as relevant to reaching a decision about the character of those events" (p. 25). Speaker and writers, then, actively work at organizing their observations of events in order to define people and events in certain ways.

In July of 2013, some people interested in selling lab research projects to consumers paid the lab a visit. And lab members distinguished themselves from business through the interpretive practice they brought to bear on the visit. An interview I did with Aref illustrates this:

Matt: ...you didn't like them?

Aref: No, not at all.

Matt: Why not?

Aref: First because I thought they came here to steal our ideas. If you are here, if you come to a lab to talk about something, to talk about some project, you should say "okay these are my ideas also. I'm working on this, so you want to help with that also?" They came here and said "okay what are you doing? What do you want to do now?" Okay, and then they started "oh that's a good project. We can do that". I don't care about that. Glen should care about that, but I didn't like that. Okay, you go somewhere and you just want to do what they are doing now, you know so what are you doing? If we can develop that product, we can sell that by ourselves. You know, so I didn't like that. And I didn't like how, how, you know their view about engineering project and about, about robotics project, you know that, that they, they were expecting to have something by December – a product. You know, they came here in June, July, and they said in 6 months, by the 6th month they wanted to have some product. It's usually, it's, you know it doesn't work like that. You know it's research, if it was that easy, everybody does that. So I thought that they have no idea about

this, they just want something that will make money as soon as possible. You know, and usually you don't like this.

In his account of the visit, Aref uses what Smith (1978) has called a "contrast structure" to distinguish business from engineering. These narrative devices include a two part structure. One part is a statement that supplies instructions to the reader or listener for how to view the behavior as anomalous. These instructions do this work by establishing social norms for the context that is described. And a second part supplies a description of the behavior. In Aref's account, he establishes norms for the lab by saying "If you are here, if you come to a lab to talk about something, to talk about some project, you should say 'okay these are my ideas also. I'm working on this, so you want to help with that also?'" The norms he establishes are that people who visit the lab ought to contribute their own ideas, and that people who visit the lab ought to contribute their own projects. Aref's description, then, supplies the violation of these norms. He says "They came here and said 'okay what are you doing? What do you want to do now?'" Okay, and then they started 'oh that's a good project. We can do that'". By contrasting this description with the norms Aref supplied earlier, the visitors are distinguished from lab members and business is distinguished from engineering.

Akmul also offered a contrast structure in his account of the visitors. He said:

And I think it's, their, their, because they are business people, their idea was, they had one product. What was that? You have a virtual class, like Google and then you get some virtual thing. For example if I see this, then something will project on the table in this shape, and they are not very easy to do. But their idea was it can be done very quickly, so they were more into these products. We are into, we

> are into, we are into research, we are a research laboratory. So they, they didn't understand that it will take a lot of time. They were like "oh it will be quick. It will be quick". To take some of the problems from the things that they said, and the problems are unsolved, they are not up to a level where you can put in a product. To make a product, you need perfect, almost 100 percent you need, you should have accuracy, but so, so if you ask me in my opinion they were, they had some ideas and they had, they had a kind of plan, but they were restricted in time. So, so that's my perspective on that.

In Akmul's account, he offers social norms by saying "For example if I see this, then something will project on the table in this shape, and they are not very easy to do. But their idea was it can be done very quickly, so they were more into these products. We are into, we are into, we are into research, we are a research laboratory". One social norm he supplies is that tabletop projection technologies for classrooms ought to be understood as challenging. The second norm he issues is that who lab members are is members of a research laboratory and what they do ought to be regarded as research. Akmul then delivers descriptions of the behaviors of the visitors by saying "[b]ut their idea was it can be done very quickly, so they were more into these products". And later on, Akmul repeats this by saying "[t]hey were like 'oh it will be quick. It will be quick'". Akmul's interpretive work distinguishes business from engineering by establishing social norms for viewing the behaviors of visitors.

Another way lab members work to distinguish themselves from business relies on how they account for the activities they do that are related to business activities. One kind of this activity is the career fair – a large gathering of businesses and government

agencies who set up tables or booths in a large indoor space with the goals of meeting, recruiting, and eventually interviewing students looking for jobs. In September of 2013, an engineering career fair was organized on the university campus EARL resides on. Several lab members talked to me and other lab members about their interest in attending the career fair, and ultimately four members attended.

Before the career fair, the lab director told me and other lab members that one of his son's would be attending the career fair as a representative of Microsoft. This son – Tim – had graduated in 2012 from the same university his father worked for, and began working at Microsoft in the summer of 2012. Many lab members had met Tim before, and this familiarity along with plans to graduate soon among a few lab members were understood by the lab members to be reasons for attending the career fair in general and for approaching Microsoft in particular. The lab director, then, offered his support to lab members. He described it by writing and sending this message to the lab's listserve: "I hope you know that I will always help as many of you to get a job *wherever* you want -- whether I personally think that job is for you or not". But he didn't stop at describing his support. He organized two of the lab meetings before the career fair to focus on topics understood to be important to employers at the career fair. In these lab meetings, lab members talked about who would be attending the career fair as representatives of Microsoft, what these representatives plan to do during the career fair, and how the career fair relates to what they called "technical interviews". In the lab meetings before the career fair, lab members also talked about "linked lists" – lists of data that are related to each other through programming. Lab members understood linked lists to be important to Microsoft representatives and thus likely to emerge in interviews. And so to prepare for

this, the lab director gave lectures about linked lists while lab members listened, took notes, and asked questions. While what counts as business and what counts as engineering were not straightforward in practice, these categories were stabilized in the accounts lab members gave for the meetings after the lab meetings had happened. One way to stabilize these categories was to describe the meetings as "technical". In an interview with Nate after he attended the career fair, he told me "[t]he, in meetings, he gave us more technical advice, like what would Microsoft be asking us..." And another lab member who attended the career fair – Glen – also described the meetings as "technical" An excerpt from an interview we did after the career fair illustrates this:

Matt: What advice did Dr. DaSilva offer you for the career fair and how did it affect you?

Glen: He gave us some lectures about technique, technic things like...

Matt: ..technical things...?

Glen: ...yeah, like as software engineers, what kinds of algorithms and data structures you should know.

Lab members talked about a number of things in the meetings before the career fair as potentially understandable as not only or purely engineering, including who would be at the career fair, what employers wanted to do at the career fair, and how they wanted to arrange interviews. But the interpretive work they brought to bear on these experiences as they retroactively accounted for them constructs them as "technical", and this does the work of separating engineering from business.

Lab members also separated business from engineering in their accounts of interviews with employers from the career fair and accounts of participating in a lab

programming competition. The lab-hosted programming competition was scheduled before two programming competitions. One of these was administered by the company Carfaq, and the other by the Institute for Electrical and Electronics Engineers (IEEE). During a programming competition organized by the lab director, the lab director administered a programming problem to lab members and then asked them to solve it. To do this, all participating lab members made notes about the problem and how to solve it. And this event was known as a "programming competition" before and after lab members participated in it. At the end of the programming competition, the lab director asked each participating lab member to give a brief description of his or her approach. And afterwards, each lab member described their approach as the rest of us listened. And Dr. DaSilva described the activities of the competition as a "problem" in "graph coloring" and "bipartite graphs". And this was a common way lab members used inscriptions, or the means to solve a problem in order to do the work of separating engineering from business. Rather than describe their activity in the competition as a business problem, efficiency problem, or client needs problem, they describe it in terms of an inscription. And so they avoid describing the activity in a way that would imply that they are working on business problems or towards business goals.

Lab members also separated engineering from business by describing note-taking differently when it happened in the context of interviews with employers. When lab members constructed accounts of note-taking in interviews, they worked hard to distinguish note-taking from programming. My interview with Karthik supplies an illustration of this. Karthik attended the career fair, had experience doing programming

competitions outside the lab, and planned to compete in both upcoming programming competitions.

Matt: ...in what ways do you think doing an interview like that would affect you?

Karthik: Most of the chances I will get rejected because I cannot write in front of them. If they ask me to solve some problem. They will say, "okay solve it", I can solve it. And if they ask, I can say "okay I will do this, do this" because I have done programming in the past couple of days, the last couple of, in the past four semesters, I have done a lot. So I can tell this, but if they want me to write a program, so I am sure I cannot write because I always refer in Google. I search in Google, what is the syntax? And I always forget syntax. So that is a tough job for me. So if they ask me to write a program in a computer, that's it.

Matt: So if they just ask you to write it with a pencil and pen or paper, you'll be fine...

Karthik: ...means they will ask "okay why don't you write the steps you do?", I can write. And I can also do, give idea that I will do, I will take this, okay I will take this and I will follow these libraries. I can say that one. But exactly how to, like print f statement, we have a print f statement to print on the screen. So we have a print command, so if you give something it will print on this screen. But

> if you ask exactly what is the syntax, I don't know. I always look through Google [laughs]...

Karthik makes a number of distinctions in his account. First, he invokes a distinction between solving a problem and writing a program. Second, he elaborates by distinguishing writing steps, giving an idea, following libraries from statements, commands, and syntax. And so when Karthik accounts for interactions with employers, he makes distinctions between writing steps and writing programs. And this sort of account does the work of separating engineering from business by constructing activities in interviews as different from lab activities.

One lab member, Glen, who participated in the programming competition shortly before the Carfaq-sponsored programming competition also made distinctions between programming and steps. He put it this way:

> Yeah we make notes, but those notes are not a program. They are just ideas about the steps, like the first step will do this, the second step will do this. But when you're programming something, you need to pro, type line by line.

Glen makes distinctions in his account. First, he makes a distinction between "notes" and a "program". The notes, he tells us, are "just ideas about the steps". In contrast, "...when you're programming something, you need to...type line by line". These distinctions, then, enable Glen to view activities in interviews as separate from lab activities. In the lab, it is understood by members that they are doing programming whereas in interviews, they are only making notes that "...are just ideas about the steps". And so rather than construct interviews with employers as talking business, working on client needs, or improving the

efficiency of a real or hypothetical client, lab members construct these activities as ones where they are engaged in note-taking, ideas, and steps.

Lab members use the business discursive resource when they signal that they are talking to one or two specific individual lab members rather than all lab members, when they describe their activities to journalists, on their website, and in the conference papers they write. Take a series of projects lab members work on as an example. Several lab projects involve developing technologies for people who use electric wheelchairs, and these projects are loosely understood in some descriptions of lab activities with the label "Robotic Assistive Technologies". During an interview in August of 2012, the lab director described the project's goal by telling me: "I think the goal is to devise technology that makes people's lives better. You know, somehow better." But on a large laminated poster mounted outside the lab for other audiences to read, a different description of Robotic Assistive Technology I have never heard lab members talk about appeared. And this description was not made in terms of betterment, but instead through a reference to the business discursive resource. The poster features the sentence "The Robotic Assistive Technology (RAT) team is aimed at helping persons with disabilities compete academically and professionally with their non-disabled peers". During the course of doing the research projects known by lab members by the name "Robotic Assistive Technology", they described their activities in different ways. For example, I followed the steps Aref took in designing and testing algorithms that would recognize objects in the path of an electric wheelchair and then turn it to avoid collisions. As I followed Aref, I never heard him describe these activities as helping wheelchair uses to

"compete". Instead, he talked about making the path that the wheelchair takes more "convenient" by making it curvier.

Lab members also activate the business discursive resource in the descriptions they give to journalists, which journalists in turn report. One area lab members maintain an interest in involves agricultural uses for robots and robotic vision technologies. And they describe their activities in this area in lab meetings and in interviews with journalists. In one lab meeting where Karthik presented his research about building 3D models of root structures, the lab director offered an explanation for using robotic technologies to measure plants. In my field notes, I wrote:

> DaSilva talks about the application of this snake approach. He says that this is a method to measure the growth of leaves and roots. DaSilva tells us that now some plant scientists use tape measures or their eyes to measure the growth of roots and leaves over time. He holds up an imaginary root, and then gestures like he is visually inspecting it. He tells us that plant scientists can rely on this snake approach method to be "more accurate".

Like the explanation offered for introducing many technologies, DaSilva says that robotic technologies will make measurements of leaves and roots "more accurate". But when the audience changed, the descriptions did too. In a magazine article published by the College of Engineering that houses EARL, a project to automate the field work of measuring plants was described differently. A picture of a collaborating computational biologist, 3 members of EARL, and a robot appears in the magazine article. And a caption below the picture states: "TALON robot being used as a prototype in DaSilva's lab to electronically ease the labor-intensive collection of field data in Katz's and others'

research". The business discursive resource is further activated at the end of the article where the journalist quotes DaSilva as saying "[e]ven simple market gardening scale tasks could be a great market for this technology". Using robotic technologies to measure plants, then, is described with the business discursive resource. And so measuring plants is described in terms of labor, labor saving, and ultimately efficiency on the one hand, and markets for the technology on the other hand.

But lab members do not feel that business discursive resource is an appropriate discursive resource for all situations. And so to place limits on the business discursive resource, lab members treat some descriptions with humor. Jokes and teasing of lab members do this work by constructing a distinction between language and the objects to which they refer. Words are often used to refer to things because according to our common sense "that's what it is". But sometimes, engineers make a distinction between words and things. When they do this, words take on a reality that is distinct from things (Gubrium and Buckholdt 1982:100). And so words understood in this way are not understood as statements about objects in the world. Distinguishing words from things, then, does the work of delimiting the business discursive resource by using words to construct a reality not about objects in the world like the human bodies and nature I analyzed earlier, but about something else. And there are two ways lab members use jokes and teasing to make distinctions between language and objects. One is to joke about people who are not engineers. In a robotics vision course I sat in on, I heard an example of this. In my field notes, I wrote:

> DaSilva tells us that the Kawasaki robot in the lab was given to him while his lab was in Australia in exchange for helping Kawasaki develop a fast PC controller

> for it. He recalls that when he talked with some Kawasaki representatives, he was expecting a "bureaucrat". He says he was surprised when the guy from Kawasaki – who was a VP for the US division – sounded like he knew more than DaSilva. He says "I was like holy crap, this guy knows more than I do". He laughs about this, and a few people also laugh about it too.

The Kawasaki VP may be described as knowing better or as being more knowledgeable about the donated robot than DaSilva because the business he works for built the robot, and part of his job is to know about the robot. But this would introduce the possibility that these descriptions should be treated as serious – that is without any humor. And so to preserve the fact members know to be true – that engineers know robots better than "bureaucrats", DaSilva and some students in the class treat it with humor. And this enables them to place a limit on the use of the business discursive resource to describe their activities.

Lab members use the business discursive resource when lab members are known to interact with employers and people treated as representatives of businesses. And these circumstances include engineering career fairs, large gatherings of government agencies and businesses seeking to meet, recruit, interview, and hire engineering students looking for jobs. Lab members, then, construct these experiences in written messages sent to EARL's listserve, during lab meetings, and during interviews. One way lab members constructed these experiences was by using them to define the lab. And they defined the lab by what it was not. The lab director provides this definition in a message he sent to the listserve during the career fair:

Dear EARLers,

I hope you know that I will always help as many of you to get a job *wherever* you want -- whether I personally think that job is for you or not.

Also, I can certainly understand how appealing it can be to work for Microsoft (or any other big company). But I would not be doing my "job" if I didn't warn you that finding a high-profile, well-paid job should NOT at all be the highest priority in your life.

This is NOT a philosophical statement, as in "money doesn't bring happiness". This is a VERY practical statement: There is nothing more frustrating professionally than going to work every morning hating doing so -- no matter how much money you make. It will affect your success professionally; your personal life; your relationship with your spouse and children; and it will ultimately drive you bitter or insane.

I have always been blessed with the possibility of moving out as soon as I noticed a glimpse of the above. So I can't really say that I have 'hands on' experience of the above. But I have indeed witnessed many people (ex-students, friends, colleagues etc...) who did just that (i.e. hated their jobs). I can't think of anything else in their lives that made these people more bitter and frustrated.

> You are all studying robotics, computer vision, and their 'variations' and I always assumed you are doing so because you like it! If there is *one* thing I learned in my professional life is that we should always dream high, pursue our dreams and seek to work on whatever makes us happy. So, if you allow me one moment of intrusion in your lives: please, find a job in the area that you love! Do NOT seek a job just because it is "appealing" financially; it will bring you "status" before society; and such. In five years (or less) this will all be gone and all you will have left is 25 more years ahead of you -- or the decision to make a change, which is definitely my second advise if you don't listen to the first one above. :-)
>
> Cheers, (and good luck to you no matter what you decide to do)

The lab director has worked hard in his message to define the lab by setting it up in a comparative relationship with what it is not. First, the lab is not “high-profile” and it will not “bring you ‘status’ before society”. Second, the lab is not “well-paid” or “ ‘appealing’ financially”. And so unlike working for a financially appealing company that improves your status, lab members take the lab to be something different. For them, it is often a place of sentiments – opinions colored by emotions. An excerpt from an interview with the lab director illustrates how he defines the lab in terms of sentiments.

Matt: Do pranks, horseplay, teasing, laughing, funny stories, or fooling around help reduce or eliminate boredom or monotony in lab work?

Dr. DaSilva: I think so. Boredom and monotony and pranks also, because they are not pranks to humiliate people. They are not, I don't think Dave [former lab member] was that kind of person at all. People knew that, you know I don't think Chao [former lab member] got humiliated. I don't know. Anyway, I don't think he was the kind of person like that. And I never thought anyone was getting upset. It was very interesting to create this atmosphere, which is something I always try to keep in the lab. I always try to keep people relaxed, you know keep people engaged, you know they can trust each other right? So, so I don't think it was at all, I know because we had these you know meetings and barbecues and lab meetings and we would always talk and tell those stories, and people would laugh. And I never saw anybody getting you know, when the story was about him or, it was always a good laugh and a good you know. I don't think it was to humiliate, it was very good to, not boredom, because I hope they are not bored. But definitely to, to break the ice and to, to you know make a boring afternoon, you know more entertaining, to break the monotony and you know, again I hope it wasn't a bore you know…?

Matt: …[laughs]

Dr. DaSilva: But, but definitely I think it was good to create friendship and it was probably the time too. You know, we've got a very good group right now also. I'm not going to compare and say what was the best, but that was definitely a very good group back then, you know very cohesive, and, and friendly. I think everybody was, you know I think they went to dinner together and they would have parties together. They were very – Ethan, Dave, Chang-Su, they were all very friend and with each other, help each other. There was a student Chao that, I know they helped Chao a lot, even with his research. So I think definitely that helped them become good friends and good coworkers because I know Ethan and Dave, they both helped Chao a lot. A little too much actually because they, they kept from me that Chao was not doing so well because again, they were protecting him so at least as a friend it showed that you we're doing well. And again, I, I prefer that over you know one is screwing the other and trying to jeopardize each other's work. It never happened. I prefer that they hide from me that someone is not doing so well and try to you know, help him then try to make bad things, you know, try to be mean to each other. That never happened. So yeah, definitely I think that it helped the lab be what it is and you know, and again, I like to think that the lab's like this because of this, things like that and things like that happen because

the lab's like this, right, so anyways I think we have a good atmosphere in the lab. I wouldn't change it.

The lab director organizes the lab in terms of sentiments. The lab here has a light-hearted "atmosphere" where members meet pranks with laughter rather than humiliation. And these pranks and laughs help "to keep people relaxed" and "engaged" so that they can trust each other. Trust, then, is understood as providing a basis for "friendship" ties among lab members, which is treated as "good" because it makes for a "very cohesive" "group" of lab members. But DaSilva also adds a cautionary note. Too much help between friends can be a bad thing. Too much help between friends becomes a bad thing when lab members hide the fact that another lab member is "not doing so well" from the lab director. For DaSilva, then, lab members should trust other lab members enough that they don't hide the deteriorating wellness of a lab member from each other. But the lab director is not the only member to describe the lab in this way. Aref described it as including "nothing formal". Glen described it as "relaxed". And Juan described the light-hearted atmosphere as "nice", "good", and "healthy".

Like the lab director, lab members also defined the lab by what it was not. It was not a business. An excerpt from an interview with Karthik shows how he defined the lab in this way:

Matt: What advice did Dr. DaSilva offer you for the career fair and how did it affect you?

Karthik: He always says "okay you guys have a different job, go ahead and do the job, but do something you are interested in". So do something, so I believe you people are interested in computer

> vision so if you go to a job and every Monday you think "oh terrible day", means Monday is going to be a terrible day. Every Sunday, you think Monday is going to be a terrible day, then you should quit and move on. So that's what he advised and I agree with him because that's why I stopped working on my previous company. I was getting some good money and money was the only thing which made, made me decide for a lot, means, which I took a long time to decide to quit...

The company he worked at before becoming a lab member did not provide Karthik with "interesting" work. And this provides him with a resource for defining what the lab is by setting it in comparison to what it is not. Nate also defined the lab relative to his work experience. During his undergraduate years, Nate worked as an intern at Texas Instruments while on summer break from college, and after he graduated they made him a job offer. When I asked Nate how the advice DaSilva gave lab members affected him, he said:

> *Nate*: Yeah, it's good advice: just basically make sure you're doing something you like. Not doing something to make a salary so, and that's, that's what I try to do. That's why I'm in grad school in the first place because I had a job offer after I graduated with a nice salary and it was home where I'm from and all that, but I didn't feel like I was doing something that I would get fulfillment out of. So I stayed on here to give myself some time and see some other options.
>
> *Matt*: Yeah I was going to ask you about that. So TI gave you an offer?

Nate: Yeah they did...

Matt: ...and then you said "okay I'd rather do something more fulfilling and stay in school"...?

Nate: ...yeah yeah and it was tough I liked, I really liked the people I worked with, I had a lot of fun there, I was home, and I was making really good money, but at the end of the day we were making parts that would go into like a coffee maker or a vacuum, and I wanted to feel like I was making a little bit more of a difference than that so I stayed here. And the other thing is I really want to start my own business if I can. And that's something that Dr. DaSilva kind of brought me on to do...

Nate begins by saying that working a job to make a salary is not the only or most important part of work, and that he accepts this critique of financial motives. And he elaborates on this by saying that he received a job offer after he graduated with a "nice salary", but that this would not provide him with "fulfillment". Then, he adds that he "...wanted to feel like I was making a little bit more of a difference than..." making parts that go into coffee makers and vacuum cleaners. He defines his internship and job offer in terms of "really good money" and it's "home" location. And then he compares this with the lab, which takes on its meanings by not being about money, a salary, or home. In contrast to the instrumental value of money or a salary, Nate defines the lab in terms of the expressive value of sentiments like fulfillment and making a difference.

Atrocity Stories

Lab members also worked at placing limits on the business discursive resource by using what Dingwall (1977) has called "atrocity stories". According to Dingwall (1977), atrocity stories express complaints or slights about attempts to control the life of an individual or group. The storyteller regards the justifications for the attempts at control as illegitimate, and so telling the story supplies a kind of redress by providing conditions of mutual support between the teller and the hearer. And the use of these stories helps define colleague groups among people who regard themselves as members of the same occupation or profession when they serve as both audience and storyteller of these stories. Atrocity stories, then, are one kind of resource people use to construct a kind of folk occupational taxonomy – a folk theory of where one's occupation stands relative to the other occupations that people recognize.

Lab members used these stories to place limits on the business discursive resource. A favorite source of these atrocity stories was Microsoft in that both the lab director and lab members swapped atrocity stories about Microsoft's products, people, and workplace policies. The first day of observations in the robotics class provides an illustration of how an atrocity story about a Microsoft product. The lab director, who was also the teacher, struggled to connect his laptop with the projection system in the classroom. After walking in the classroom, he immediately began to hook up his laptop to the classroom's projector. After a moment and no luck getting the projector to display his laptop's desktop view, I noted:

> DaSilva says that he uses Windows, "the best operating system in the world". He also elaborates that they "employ" his son, and that "if it wasn't for that, I would hate it".

He then quit for several minutes and switched to lecturing. He informed us of his office hours, what the concept "mechatronics" refers to, and what approach we will take towards understanding robotics in this class. Trying again to hook them up, he utters "unbelievable", and yet again gives up on it for several minutes. He lectures more. We learn about prerequisites for the class, the different expectations for graduate students relative to undergraduate students, the lab assignments, and how we can gain access to the class' lab room with our student ID's. Then he returns to the challenge of hooking up his laptop. I noted:

> DaSilva then tries to connect his laptop to the projector again. It still isn't working. He says "if my son didn't work for Microsoft, I would curse them out". We laugh about this.

But the robotics class and Microsoft's products were not the only targets. Lab members also told atrocity stories about people understood as representatives of Microsoft. A lab meeting right before the career fair provided one situation for the articulation of atrocities. In my field notes, I wrote:

> DaSilva also talks about one of the Microsoft representatives. He says that based on how she has treated his son Tim and also how she treated Aref that she is a "bitch". He laughs as he looks at Basma and jokes about plugging her ears or giving her earplugs so she can't hear him say "bitch". DaSilva explains that this woman "makes trouble" because she ignored Aref's question about how to apply

for a hardware engineering job with Microsoft, and because she spoke badly about Missouri. He says that Tim told him a story about this: after she went on a trip to the University of Missouri to recruit students for jobs at Microsoft last year, Tim asked her how it went? She told Tim that "the students weren't as good as he ones in Minnesota". Tim then said "you know I went there right?"

In addition to robotics courses and lab meetings, lab members also offered atrocity stories about Microsoft in interviews. Aref offered an atrocity story about Microsoft's workplace policies. An excerpt from an interview I did with Aref after he attended the career fair provides an example of this:

Aref: For example, in Microsoft they have some rooms with some beds.

Matt: So sometimes they sleep there...?

Aref: ...sometimes they sleep there because they don't have time to go back home and come back home to [the] project...

Matt: ...oh yeah that reminds me too, I remember you guys were talking about how they keep medicines there...

Aref: ...exactly, First Aids for example. So because of that I say they expect too much because you always have deadlines, deadlines, okay the release date for Windows 8 is that time. You cannot, because the company forces you, you cannot, it's not easy to work there. You know you can have it with salary, but you will work harder than anyone else. The same with Apple, every year they have a new iPhone, poor engineers there, because finally the CEO comes and they say "oh we have the iPhone". They don't say

"okay we punished all our engineers so we could get this done" you know? That's the problem with Microsoft.

Matt: Okay.

Aref: They torture engineers...

In sum, lab members used atrocity stories to call attention to perceived differences between them and people, products, and policies taken to represent Microsoft. And in suggesting that the speaker should be understood differently than the people, products, and policies described in terms of the business discursive resource, lab members suggest that they should be understood without the business discursive resource. Instead, they should be described in terms of the ability to recognize a high quality operating system, to give a good impression to others, and for maintaining an accurate view of how long an engineering project will take to complete.

But things that symbolized computer companies were not the only target in atrocity stories told by lab members. Insurance companies were also targeted. For example, when a car crashed into DaSilva's fence, atrocity stories about the event were told and retold by him and lab members. At one lab meeting, I pieced together what happened from the questions posed by lab members and DaSilva's responses. A driver insured by State Farm crashed into a fence behind DaSilva's house, knocking down some posts and panels of the fence. State Farm then offered to replace the posts and panels with new materials. DaSilva, I learned, had refused this offer on the grounds that these new materials would be a different color than the rest of the fence. State Farm, then, responded that in about 2 years, the materials would be about the same color as the rest of the fence as they fade with age and weather. He tells us this is not good enough, and that

this is what he told State Farm. He reasons that the estimate on the damage was only $350 and so "it's not about the money". Instead, he tells us it's about the "principle". Then, DaSilva put up a sign next to the hole in his fence which reads "State Farm has not been a very good neighbor". Next, the sign was torn down and torn into pieces.

While it may be tempting to view this story as a story only about DaSilva, it is more than that. Other lab members referred to it. I only learned about it because Aref asked about it during a lab meeting. And the day after the lab meeting I heard the story in, Juan sent out an email where he wrote about a change in the lab meeting. Also in this email, Juan made a reference to this by offering a very short atrocity story. He wrote: "[y]ou may take your complaints to State Farm, maybe they'll be a good neighbor to you".

Again, lab members use an atrocity story to call attention to perceived differences between them and someone taken to represent an insurance company. And stories like these help lab members place limits on the business discursive resource when they call attention to the speaker and someone else who is described in terms of business. And in suggesting that the speaker should be understood in terms different from people who are taken to symbolize State Farm, lab members suggest that they should be understood without the business discursive resource. Instead of the business discursive resource, they should be described in terms of someone standing up for what they believe in, in this case a "principle" of consistency – restore the fence to how it looked before. And so, articulating the atrocity story in this way casts DaSilva as a rational actor in stark contrast to the insurance representatives who only wish to rush the job without listening to the victim of their client.

PART II: LOCAL DISCURSIVE RESOURCES

Not all discursive resources are common across a variety of settings like biology labs and medical research labs. Some of them are common to the lab in focus and a limited number of labs that are like it in some ways. I call these kind of linguistic devices local discursive resources to suggest that they are less widespread than trans-local discursive resources and common to the lab in focus. The national is one sort of local discursive resource that I found, and the spiritual is another one. My findings, then, are particular. In addition to my general finding that trans-local discursive resources were used by lab members, my findings are also particular to the lab in focus.

EARL lab members often used national discursive resources, and this is related to something that makes EARL distinctive in a way: the lab director and vast majority of the lab members were immigrants. Some labs may have members like this, and others may not. Most student lab members were citizens of other countries studying in the US on student visas, and the lab director was born outside the US. In addition to labs with members from many different countries, labs that are distinctive in other ways share an ongoing concern with national discursive resources. Certainly one thing that distinguishes a lab from other labs is nuclear weapons projects. Gusterson (1998; 2004) has studied this sort of lab by studying the Lawrence Livermore National Laboratory (LLNL). Drawing on observations and interviews with scientists, engineers, and other personnel at LLNL, Gusterson (1998) found lab workers accounting for their self-surveillance both inside and outside the lab in terms of national discursive resources when they feared that they were being watched by FBI agents. In his later work, Gusterson (2004) examined national

discursive resources by exploring the "nuclear Orientalism" that depicts nuclear weapons as only dangerous in the hands of third world countries, which suggests by contrast that the US nation is a safe and rational nuclear power. Gusterson (2004) also suggests that pictures of maimed and dead bodies are suppressed and left out of journalistic accounts of US war efforts, which enables them to function as national discursive resources that work to distance the US nation from images of it as a bloody, merciless mass murderer. Without pictures of dead and injured bodies, Gusterson (2004) argues, the US can be constructed as a nation effective at waging bloodless, humanitarian, hygienic, and disembodied war.

Spiritual discursive resources are also common to EARL, but perhaps less so in other lab settings. The spiritual receives little or no attention in the lab studies literature. For example, Gusterson (1998) includes a small section about "the Churches and Nuclear Weapons" in his study of the LLNL. In this section, Gusterson (1998) focuses on the religious habits of lab members and on the local clergy's views of the ethics of nuclear weapons. We learn that about two thirds of the lab members Gusterson (1998) spoke with identified themselves as members of a church and went to church at least part time (p. 59). We also learn that local religious leaders play a part in the moral world of the lab by either endorsing or not challenging the lab's construction of nuclear ethics, a construction that works through the privatization of moral thinking on nuclear weapons, and the idea that nuclear weapons provide the best way of preventing war and saving lives (p. 67). While we can assume these religious leaders play some part in the moral lives of lab members, we cannot specify what that part is in more detail because Gusterson (1998) did not study religious, spiritual, moral, or ethical talk in the everyday life of lab

members. And other lab studies neglect this form of talk as well. Spiritualities, then, are also local discursive resources.

CHAPTER 6: USING AND DELIMITING THE SPIRITUAL

I showed how robotics and robotic vision engineers learned to use their bodies to plan, complete, and describe work about the sizes, shapes, motions, and inscriptions of robotic vision technologies. In this chapter, I draw on observations and interviews with members of a robotic vision laboratory and engineering students enrolled in a robotics class to explore the practice of engineering work and how it relates to discursive resources (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). Building on important work in the sociology of description (Gubrium 1986; Gubrium and Buckholdt 1982; Mol 2002), I will analyze how engineers use one discursive resource in the everyday construction of engineering knowledge. Building on important work in the sociology of description (Gubrium 1986; Gubrium 1993; Gubrium and Buckholdt 1982; Mol 2002), I will analyze how spirituality is used as a discursive resource in everyday practice to plan, complete, and describe work. Spiritualties, then, become descriptive resources when they are activated in everyday practice.

Engineers use the spirituality discursive resource when they offer transforming motives, distancing motives, and assign speaking roles to people in their stories. And these forms of talk supply engineers with reasons, explanations, excuses, or justifications they can offer to group members like lab members and engineering students as well as semi-members like me. But over the course of my fieldwork, I was struck by how much engineers talked about spirituality in interviews and how little they talked about in the everyday life of the lab and coursework. And so the spirituality discursive resource is not uniformly activated across different kinds of situations. Rather, it is activated mostly in

the interview situation. Interested in how talk varied so much across these situations, I turned to the delimiting of the spirituality discursive resource to explore how engineers work to place limits on the spirituality discursive resource in everyday practice. My argument is that the spirituality discursive resource is delimited through philosophy-in-use, treating religious symbols in the lab as non-religious symbols, recounting religious experiences in personal terms rather than general terms, and using humor to limit talk about spirituality to very brief temporal episodes.

Activating Spirituality

Boundaries are constructed and reconstructed through language. And the language that does this work constitutes what C. Wright Mills (1940) calls "vocabularies of motive". According to Mills (1940), motives are reasons, explanations, excuses, and justifications for chosen courses of action that social actors use to satisfy themselves and others. Groups, organizations, and societies often have their own "vocabularies of motive" that supply members with ways of making sense of what they do and what they say that will be acceptable to other members.

Engineers use three strategies to activate the spirituality discursive resource in a way that they feel is compatible with the presumed understanding of a specific audience – other engineers and knowledge workers like myself. And these strategies include offering transforming motives, distancing motives, and assigning speaking roles to other people in their stories. I argue that engineers sustain their identities as engineers when they talk about god, nature, and religious texts in ways that offer situated motives and by assigning speaking roles to other people in their stories.

The motives engineers use include "transforming motives" (Sharp 2009) and distancing motives. Shane Sharp (2009) has argued that transforming motives "…change nongroup motives into motives that conform to the culture of social groups…" (p. 268). The second type of motive is what I call "distancing motives" because they reason that humans cannot fully understand god, and so they make distinctions between humans and God by calling attention to the limits of humans. I find that they use three strategies to cross the boundary and call attention to their objectivity. The first strategy relies on offering transforming motives that transform nature and human bodies into the technical accomplishments of God, and that transform religious texts into ideas that are compatible with evolution and scientific literature reviews. The second strategy hinges in the use of distancing motives which work to articulate differences between engineers and God. And the third strategy depends on assigning speaking roles to people or hypothetical people in storytelling, which helps align speakers with the professed scientific value of skeptical questioning.

Transforming Motives

Engineers gain a greater appreciation for nature in general and the human body in particular through their experiences working with robots and robotic vision systems because nature and humans are performing complex tasks all the time which take much longer to program a robot to do. And this appreciation often leads engineers to view human bodies and nature as superior to robots, and so superior that they are viewed as the result of God's work. But this introduces a dilemma because it invites engineers and their engineering (and knowledge worker) audiences to understand what they're doing in ways

that are potentially incompatible with engineering culture. And so in order to convince the self and others that one is a member in good standing who shares the same knowledge as other group members, engineers offer what Sharp (2009) has called "transforming motives". He suggests that these motives serve to "…change nongroup motives into motives that conform to the culture of social groups…" (Sharp 2009:268).

Many different view of nature may grow from an appreciation of nature as God's work, including appreciating it as a gift from God. And so explaining appreciation of nature only in moral or religious terms is presumed by engineers to be an inadequate explanation for expressing appreciation. An inadequate explanation is one that does not conform to engineering culture. Engineers, then, work to change motives like these into motives that do conform to engineering culture by elaborating on their explanations for why they appreciate nature. I use the phrase "mechanizing nature" to refer to the process of defining nature in general and humans in particular as mechanisms for solving practical problems in everyday life. What counts as "problems" is defined according to engineers themselves, and often includes values like efficiency and speed.

To view nature as a mechanism is to view nature in terms of its abilities to solve practical problems in everyday life. But these are not just any problems. They are problems that make sense in terms of engineering work: distinguishing one object seen by a camera from another object seen by a camera in computer engineering, and moving through space in robotics engineering. And because it takes an enormous amount of time, energy, and labor to get robots and robotic vision systems to do these things, these engineers often grow a deep appreciation for the ability of the human body to do these things. In pointing to what they appreciate in nature, engineers mechanized nature in

general and human bodies in particular. One common thing the engineers pointed to was the ability of human bodies to multitask. Juan pointed to this in recounting his experiences working on a multimodal interface control system for an electric wheelchair that involved both EMG sensors and a head gaze system. In an interview, he said "…it gives you a sense of appreciation or amazement at humans, and their ability to do things". But the human body wasn't the only multitasking agent invoked by students. They also narrowed it down to the brain. The brain was constructed as a multitasking agent. Basma invoked the situation of our interview to show how the brain multitasked. She said "Yeah, but for our brain it does everything all at the same time. I'm looking at you, I'm [inaudible], I'll be able to think about something else". For Basma, her ability to distinguish me from the background of my office while thinking "about something else" suggests that the brain can multitask. Troy compared a robotic vision system with the human body to invoke a distinction. In an interview, he said:

> Yeah I mean definitely, and just maybe like, you're maybe like movements in general and everything that your brain is doing all this at once basically fluidly whereas a robots will take pictures, and then move the arm, and you can do that all at once, I mean your brain can do that all at once.

The view of the brain as a multitasking agent here depends on the distinction between sequential and simultaneous. The robot performs tasks sequentially: it takes pictures and then moves. The human sees and moves "all at once".

Related to this appreciation for the "multitasking" of bodies and brains is an appreciation for complexity. Nate expressed his appreciation for the complexity of the

human brain by specifying how its complexity grows. He said "To me it's just everyday in class, the complexity of it grows…". Basma relied on a comparison between a project using MATLAB and neural networks on the one hand, and the human brain on the other to tell me in an interview that the brain "…does much more complicated tasks, you know, so we're the best". Juan also articulated this appreciation in terms of his multimodal interface project for electric wheelchairs because the project called on him to study the ways that humans move through space. And a sense of complexity emerged from this study. According to Juan, "We have a lot of sensors, we have a lot of, humans I mean, ways of adapting, or changing the path, adapting to different situations". There is complexity here in many senses of the word, including that there is no one way that humans move through space, the ways may change because humans draw on "a lot of sensors" to make decisions about how to move, and the movements chosen may change in "adapting to different situations".

The engineers also appreciated the speed of the human brain. In an interview, Juan referred to the human body's ability to react to information "fast". In addition to Basma's appreciation for the speed of the human brain, Nate also expressed this appreciation by comparing how long it takes a human to do something with how long it takes a robotic system to do something. In my second interview with him, he did this by saying "You know, we're going to spend hours programming, and at the end of the day, we pick up a black rectangle, when I can do that in five seconds myself". This comparison between a robotic system and a human casts humans as speedier because a human can pick up the black rectangle in five seconds, which is much faster than "hours". Nate also uttered this appreciation by invoking a relatively incompetent human –

a toddler. In our third interview, he said "…I keep coming back to it, but it just always blows my mind, how intuitively we're able to do things once I have to program a robot to do the same thing because you could tell any human, like you could tell a four year old to follow that guy in the red shirt, but these robots, I mean it's taken three weeks, and they're essentially two dots moving across a screen". Implying that an incompetent human could follow another human more quickly than simulated robots suggests that not only are humans faster at performing tasks, but even the least among them is faster than robots.

Another thing these engineers appreciated was how "automatic" humans seem to do things. For engineers, making sense of human bodies as doing things "automatically" provides a means of accounting for the taken-for-granted such as the ability to visually distinguish foreground from background in everyday practice. Nate reported in an interview that "…like everyday I'm a little more amazed that our human system does it automatically, and like the amount of stuff you have to do to have a robot recognize a black square is insane to me". Troy also expressed this appreciation for the ability of the human brain to perform tasks automatically by recalling seeing a man who looked like one of his old high school classmates, and how this sight led him to reflect on the ability of the human brain to remember what people look like without intentionally trying to remember their appearance. In the interview, Troy said:

> Yeah that kind of made me think about it just a little bit because I mean your brain does that all the time I guess. Faces are something people remember, that's a pretty, it's a pretty big deal I guess. If I think about all

> the people I've met in the past 4 years, and all the faces I would see and recognize, that's a lot of people.

The view of the brain as performing the task of remembering automatically depends on the brain doing this independently of people. Troy renders his brain independent of himself, and therefore "automatic" by talking about brains in impersonal terms – "your brain" rather than "my brain", "Troy's brain", or "Matt's brain". And then by implying that he hadn't seen the man who looked like his high school friend in 4 years, he suggests that the brain has "automatically" remembered many faces he didn't set out to remember. And so, since these things are often taken-for-granted in everyday life, the automatic operation of remembering faces that the brain performs becomes very impressive.

Engineers also offer a transforming motive when they work to make sense of religious texts, and this enables them to cross the boundary between religion and engineering in a way that invests them with scientific creditability. They carefully make sense of religious texts like the bible and the Koran in ways that call attention to their detachment from these texts. This is accomplished by calling attention to a limit in a religious text so that it is rendered compatible with science or evolution, and by approaching religious texts as literature reviews. Since attention to the limits of these texts highlights their detachment from them rather than their commitment to them, interpreting religious texts supplies these engineers with an opportunity to perform objectivity.

Calling attention to a limit in a religious text so that it is rendered compatible with science or evolution worked in two ways: by applying a folk theory of metaphor to religious texts, and specifying an omission in the bible. A folk theory of metaphor is a

theory developed by the engineers of what counts as metaphor. Interpreting some things in the bible as metaphorical and others as not is useful for the engineers because it provides them with a means of communicating that some bible passages do not represent historical or evolutionary events without discrediting the bible as a whole as inaccurate or revisionist. Treating some bible passages as metaphor is especially effective at doing this work because treating some passages as metaphor enables these engineers to communicate that some passages are not literal representations of history or evolution, but rather analogies that are better understood as stories about the authority of God.

The lab director, who is a practicing Catholic, relied on this strategy. In an interview, he talked at length about treating the story of Adam and Eve as metaphor. An excerpt from an interview we did illustrates this:

Dr. DaSilva: …yeah I think people look at the original sin as a, as a I'm not sure if that's what you're saying, but anyways, a lot of people look at original sin as the first sin right? As the first one, as the first one that happened right? I don't know if, anyways, my interpretation of the original sin is not the first one. It's the start of every sin. It's the origin. It's the point of origin of every sin. It's not like it was the first one. Again, it's the reason why all the other sins exist. And the reason being, Adam and Eve they want to be Gods, they want to have the knowledge of God, so it's not that they ate the apple of course. It's all figurative or…

Matt: …metaphorical…

Dr. DaSilva: …metaphorical right?

Matt: Yeah…

Dr. DaSilva: …The, the teaching of the original sin and even the existence of the original sin and not through eating an apple right, but again the fact that men sometime think that they can be better than God, that they know better than God, that they can decide better than God, that they can make decisions without, and that's the origin of all the sins. And that was the origin of eating the apple right? As it's the origin of adultery or the origin of stealing, right, all this are rules that if you think of it, they're very reasonable rules. They're very of social interaction, of respect, they don't need to have a religion connotation to be reasonable, to make sense right? But yet every now and then, we believe that we know better than the rules. And we can rationalize not following the rule or, and we think that we can decide, and I think that's the origin of all the sins, that is to think we are you know superior, we are better, or we own our destinies or our fate or anything that we decide and so, so anyways I think I lost the question sorry.

It is noteworthy here that among the voluminous stories the bible offers, the lab director chose this story to treat as metaphor. The story of Adam and Eve he refers to is the Abrahamic origin story which suggests that Adam and Eve were the first man and first

woman, that these humans were created by God, and that all other humans are descended from these two people. Since this origin story ignores the Big Bang and evolution in favor of a creation by God, it is incompatible with the chief scientific account of history. And so the lab director works to make the Adam and Eve passage compatible with science by treating the Adam and Eve story as a metaphor for the moral risks of playing God and breaking rules rather than a literal representation of the first humans.

Juan also relied on this strategy in an interview we did. Juan told me that the creation passages in the bible should be understood as metaphors. An excerpt from our interview shows how he did this:

Juan: But it's not like the literal creation passages of the bible. It's, that's like more, more literature and symbolic…

Matt: …like a metaphorical kind of thing?

Juan: Metaphorical, yeah, exactly, I do you know believe in God and I do think that evolution and everything, that was, it's possible because at first God created the universe and then he sort of made it possible for evolution and for, for everything to follow it's path, and then eventually get where we are right now. So, so yeah, everything is good, perfect, nice, I used to say that right? There had to be a greater being for creating all this perfect universe, so, so yeah, I believe that.

Matt: Is it fair to say that maybe, maybe from your standpoint, there's God, then there's the Big Bang, and then evolution takes over from there?

Juan: Exactly, exactly, exactly so again, the bible, some of the passages, it's a metaphorical way of, the creation and all that. Of course there's proof of evolution and all that so it wouldn't be like oh I created the animals and humans and everything just like that, and there's no change in evolution, no, there are proofs of it, there are proofs of evolution right? But again, it's just a metaphorical way of viewing the, the creation and everything. So, so yeah at first God, and then he made it possible for a collision in the, the, ah, the whole creation, and again, the evolution of the universe. And again, leading us to where we are right now.

Note how Juan works to make the creationist passages of the bible compatible with evolution by suggesting that "…it's just a metaphorical way of viewing the, the creation and everything". Juan interprets the bible's story of creation as metaphor. It is "just" a metaphor. It is not a literal representation of the development of the "universe" and humans. For Juan, God "…made it possible for a collision in the, ah, the whole creation, and again, the evolution of the universe". This renders the bible compatible with science by suggesting that although God may not have literally created humans directly, this doesn't mean he had no role. Instead, Juan locates him as the cause of the Big Bang. God makes it possible for the Big Bang, which creates the universe, and then evolution takes over. In Juan's narrative, God sets things in motion by making the Big Bang possible, and this invites roles for both evolution and God in a way that makes them compatible with each other.

Offering transforming motives can also be done through interpretive work performed on religious texts. And engineers did this interpretive work by approaching religious texts as literature reviews. Rather than committing to views espoused in a particular religious text or by a particular religious author, this technique places religious texts in a framework where they can be compared with other religious texts and authors. And in adopting a comparative approach to interpreting religious texts, engineers gain an opportunity to perform objectivity because they can emphasize their detachedness from the views espoused in any particular religious text or by any particular religious author, and therefore appear more interested in Truth than commitment to any specific religious dogma, text, or author. An excerpt from an interview I did with Karthik illustrates how he approaches religious texts and authors as a literature review. Karthik was interested in religion and spiritualism, but was also skeptical of it. His background included attending Hindu temple with his father while growing up in India, and adopting his father's habit of reading religious texts written by religious authors and "gurus". Like his father, Karthik also learned to supplement his religious readings with religious talk. He told me he talked about Islam and Hindu with friends and neighbors. An excerpt from an interview we did illustrates how Karthik approaches religious texts:

Matt: So when you were working at the internet service provider company, you started reading about Buddhism?

Karthik: Yeah.

Matt: Interesting. Why do you think you started reading about it then?

Karthik: I watched one of the videos of Buddha, the man who is behind this religion. So his thinking is a little bit different. He thinks that okay, there are no rebirth and in Hinduism, we believe in rebirth. So some things are there, so I thought okay, I should, what do you say? I should critically analyze rather than accept what is written there. If I go through 2, 3 religions, then I can analyze, compare, so what's going on? If I go through only 1 religion, then I am biased to that one.

Matt: It gives you something to compare it to?

Karthik: Yeah. I don't want to be biased towards one religion. If I get time, then I can learn about Christianity or Muslims. I am also interested in that. My friend, she is from Pakistan, I used to have a lot of talk with her in terms of Muslim religion so, so we share our thoughts. It's not like we are, we are sticking to only one religion. So she shares something, I share something.

Matt: Interesting.

Karthik: In this winter break, we used to have a lot of discussions.

Matt: Oh yeah?

Karthik: Yeah.

Matt: With your roommates and with your friends?

Karthik: No, she's my friend so, she's my neighbor also so we used to talk a lot about this.

Matt: What's the most striking similarity or difference between Islam and Buddhism or Hinduism?

Karthik: For me, all are the same because whenever a religion is created, so it's somebody told something and everybody has written them in the books. But the problem is that nobody is reading that book, everybody is following some guy. So that guy can manipulate a lot of things. He, if a lot of people are following you, then you are the powerful. If you have the power, then you have; we have a saying in Hindu philosophy, power is blind so if you have the power, then you will ultimately become blind. So to have that power, you should have that much power to control that power. So, so it's just like that. So it's better to follow someone, better you should read and critically analyze even if he never signs also, we do the same. Somebody writes it and we do not accept it, okay. You have written this, show me some tests, show me some results. Okay, so some guy has written this, some other guy has written this. In science we also do the same. In, in sociology you do also the same. So you read a lot of literature and then compare conclusions…

Matt: …absolutely…

Karthik works to make sense of rebirth by comparing Hindu texts with Buddhist visual texts. When he learns that Hinduism includes rebirth and Buddhism does not, he uses it as an opportunity to learn more about each religion's texts rather than immediately passing judgment on one as right and the other as wrong. He calls this process of learning more as he "gets time" to study these texts a process that "critically" analyzes religious texts "rather than accept what is written there". Karthik says that assuming one religion is right about rebirth amounts to a "bias", and so comparisons shield him from bias. Then near the end of his narrative, Karthik explicitly links this comparative approach to the approach adopted in "science" and "sociology". He points out that when one religious author writes one text and another writes a different text, these texts can be made sense of by comparing their conclusions, and so religious texts can be approached as literature reviews because they both involve reading literature and comparing conclusions. Making sense of religious texts is the same as writing a literature review for an article. And literature reviews are rarely out of mind for Karthik and the lab members: they write them to summarize and make sense of previous research that relates to their research projects, and they write literature reviews for class projects and Masters and PhD research.

By articulating his interest in religious texts in terms of a comparative approach, Karthik calls attention to his commitment to this approach rather than any specific religious text, dogma, or author. And this detachment from he views espoused in any particular religious text, dogma, or by any particular author enables him to perform a kind of objectivity where he appears more interested in "critically" analyzing the claims of

each text or author in search of Truth rather than an unquestioning acceptance of one particular text.

A Distancing Motive

Engineers attribute the speed, multitasking, complexity, and automatic traits of human bodies to God's work. The vast amounts of time, energy, and labor that it takes engineers to get robots to perform simple tasks humans often take for granted often suggests to these engineers that speed, multitasking, complexity, and automaticity do not emerge from work that has no centralized order to it. And since engineers assume that the theory of evolution has no centralized order to it because it doesn't account for human development and the development of nature in terms of will, intent, or purpose, they often assume that evolution implies that humans are an accident. And so, rather than attributing these things in nature to evolution or some other process or actor, they attribute them to God's work. But this introduces a dilemma: if God created nature in general and humans in particular, and human bodies are appreciated for their speed, multitasking, complexity, and automaticity, then God becomes engineer-like. And God as an engineer presents a dilemma for the engineers because it suggests god is human or human-like, and so perhaps less like a deity and more like a colleague, lab member, or engineering professor.

These engineers, then, rely on distancing motives to manage this dilemma. Distancing motives call attention to differences between humans and God by casting God as superior to humans. Engineers use what I call distancing motives to articulate differences between humans and God, and one effect of using these motives is that God is

distanced from engineers. This distance is constructed through the motives when the motives suggest that humans cannot fully know god. The lab director and one of the students in his class both used the word "can't" as they told me in our interviews that humans "can't" fully understand God. Using words in this way calls our attention to the impossibility of fully knowing god rather than misunderstanding or ignoring god. Using words like "can't" rather than "don't" or "won't" constructs limited human knowledge of

And talking about their limited knowledge of god in these ways does important cultural work. First, they can assume that god plays a role in the natural order or in everyday life without having to develop ways of talking about it that are compatible with scientific values and principles. Second, by rendering their limited knowledge of God as independent of human agency, engineers can claim they don't understand God without jeopardizing their intellectual capabilities. Their limited knowledge of God is rendered independent of human agency when the limits are talked about in terms of "can't" rather than misunderstanding, ignorance, or indifference. It's not just that they misunderstand God, but that they are incapable of understanding God. And since God created humans, it stands to reason that God created humans as or to be biologically or intellectually incapable of understanding Him. The distancing motive, then, enables engineers to distance themselves from god so that god doesn't become only a synonym for engineer, and allows them to avoid jeopardizing their intellectual skills. By suggesting that human knowledge of God is limited by something biological or natural rather than by some deficiency, engineers preserve their intellectual competency. In addition, by suggesting humans "can't" fully know god rather than misunderstand or ignore god, engineers invite this explanation to be good enough instead of other explanations that threaten to

potentially undermine their intellectual competence by signaling to other engineers that they lack a detailed understanding of the natural order – prized cultural knowledge among electrical and computer engineers.

Engineers also rely on features of storytelling to cross the border between religion and technoscience. And they do this by assigning speaking roles to people in stories. In the stories they tell about religion, the engineers assign speaking roles to types of people or hypothetical people. These speaking roles often include questions, and by including typical or hypothetical questioners in their stories, engineers align themselves with the professed scientific value of skeptical questioning. This also helps perform objectivity for engineers because it shows that engineers can step out of one self and into another skeptical self. An excerpt from an interview with DaSilva illustrates how often assigning speaking roles to hypothetical people and types of people in a story can be used when the speaker crosses the borders between religion and engineering. I asked him "Why can't science prove or disprove the existence of God?", and he responded:

> I think there are two different answers. Why it cannot prove is because I don't think we achieved the level of understanding and the level of intellect that would be required to prove that. So I don't think that basically in that sense, we are like the agnostics right? Our brain cannot understand, prove or disprove the existence of God. I think the difference between an agnostic and me is that I agree with them when they say that again, 'we don't have the capacity to prove or disprove God, so why bother?' And that's a difference. The difference is, yeah we can't prove and disprove, but I faith you know? And I still think that we should

> believe, and that's faith. That's nothing rational. So as far as rationality of agnostics go, yeah I agree with them we can't prove or disprove. The conclusion is different. Their conclusion is that 'if we cannot prove or disprove, then why bother?' And my conclusion is that yeah, we still should believe. 'Why?' Again, it's not rational. It's not rational. Now why, now at the same time, why we cannot prove, I don't think we are ever going to be able to prove, even if we have the ability and the capacity because then it would not be faith anymore. It would be science. And there would be no matter in believing. And I think God's plan is for us to believe. It is part of his plan for us to believe, it is part of his plan that we have this leap of faith. And despite not being able to prove or not, which again I don't think we can prove, we should always have faith.

The first speaking role he assigns is an "agnostic" who asks "we don't have the capacity to prove or disprove god, so why bother?" The second speaking role he assigns is also an agnostic who asks "if we cannot prove or disprove, then why bother?" The third speaking role he assigns is a hypothetical questioner who asks "why?" and might be a substitute for me since I used the word "why" in the preceding question. While assigning speaking roles to others in storytelling is very common for its ability to emphasize that someone "really" was where they say they were and with who they say they were. But in this case I argue that the speaking roles work differently because the speaker has crossed the border between religion and engineering. To maintain scientific creditability throughout this border crossing, he assigns speaking roles to types of people and a hypothetical questioner. The speaking roles enable him to maintain scientific creditability because

they illustrate how he can step out of a Catholic Faithful self and step into a Skeptical Self. In addition, by giving agnostics a speaking role where they can express a rationalized question rather than an irrational and emotional condemnation of believers, he demonstrates his ability to embrace the skeptical questions of a rational hypothetical observer. And so, when he crosses the border into the land of God, he also aligns himself with the Mertonian scientific norm of "skepticism" – among the most important of the values professed in science.

While it might be expected that an experienced an engineer like the lab director may use speaking roles in his stories as a means of maintaining creditability because he has the most creditability to lose by talking about god and religion, people with different experiences also used this strategy.

While people charged with representing the university in some ways might be expected to work to maintain creditability when they talk about religion because they work at a secular university, students also used the same strategy. One of these students expressed her religious faith in ways that were very obvious to us. She wore the Muslim headscarf called a "Hijab" whenever she worked in the lab, and performed elaborate prayer rituals including washing her hands, face, nose, ears, and feet before praying 5 times per day. And so, to perform objectivity in the face of these demanding religious commitments, Basma assigned speaking roles in her story about praying. When I asked her where she usually prayed, she told me "We can pray anywhere, but I don't like people looking at me like 'what is this weirdo doing?' I usually do it either at home, or at the mosque". Basma assigns a speaking role to some hypothetical person who asks "what is this weirdo doing?". Assigning this speaking role enables Basma to step out of her

Muslim self and into a Skeptical Self that doesn't see prayer as normal, but instead as abnormal. An excerpt from an interview with Nate also illustrates how he relies on this strategy. When I asked Nate if appreciation for the human senses led him to believe that nature in general and/or humans in particular were designed, he responded:

> Right, yeah and it has lead me to think about that because, and especially like recently we've had to propose our projects, I'm getting into ant, I'm trying to do robots that mimic like an ant hive type of behavior, and just like the way things work together so well points to me design or creation just because, I don't know, you're going to tell me that all of this happened by accident. It just, it's too well, like the human system, even animals in nature seem too well designed to have been an accident of nature I guess. So yeah it has gotten me thinking about that a lot.

In telling me how he treats "the way things work together so well" as a sign of "design or creation", Nate also assigns a speaking role to a hypothetical observer. This observer states that "all of this happened by accident". Since this utterance is not a question, the use of "you're" helps distinguish the utterance as that of a hypothetical observer rather than Nate himself. Again, including this hypothetical observer enables Nate to perform objectivity by showing that he can step out of his Christian Self and step into a Skeptical Self who asserts that natural developments were only accidents. And so rather than understanding Nate as making the child-like mistake of anthropomorphizing nature by insisting that natural processes have will, intention, purpose, or planning, Nate shows how he aligns himself with the scientific value of skepticism.

Delimiting Spiritual Discourse

While offering situated motives and assigning speaking roles to others in storytelling provides a means of activating the spiritual discursive resource in everyday practice, engineers also sometimes place limits on the spiritual discursive resource. And although engineers spent much time in interviews using the spirituality discursive resource to plan, complete, and describe their work, they also carefully worked to delimit the spirituality discursive resource in interviews and in the everyday life of the lab. For lab members and engineering students, elaborating the spirituality discursive resource can become excessive. It becomes excessive when members feel that it pays unjustified attention to the fact that their work is engineering. And it is unjustified in the sense that that it raises questions about a reality that is known, referenced, concrete, and objective for engineers. The fundamental reality for them is that their work is engineering. But this reality is not fundamental in the sense that it is tacit or wholly taken-for-granted. It is a reality that is constructed through concrete descriptive work.

Engineers engaged in this descriptive work during interviews when I posed questions about God or spirituality. Sometimes the lab director as well as Basma and Karthik named my questions "philosophical" immediately after I posed them. An interview with Basma demonstrates this:

Matt: You said in the last interview that you don't want to picture God as a human being. Since God is not human, does this mean that he is not designing humans by mimicking himself, but rather making something from scratch?

Basma: That's a very philosophical question.

In addition to this interview with Basma, the lab director and another lab member also named some of my questions about God or spirituality "philosophical" immediately after I asked them. But this was not the only situation where lab members named something "philosophical". As we ate a big dinner celebrating Aref's Master's thesis defense, I heard the lab members use it amongst themselves. I asked if anyone had plans for winter break, and the responses of the lab members illustrates this. I wrote in my field notes:

> And Karthik says he may go to a "Buddhist meditation" program in Texas. He tells us that the program involves going to sleep at 9 pm, and waking up at 4 am in the morning. I ask him if it will be at a Buddhist temple. Aref adds "is it at a Buddhist prison?" Juan, Amit, and Aref laugh. Aref then asks if the program is called "Guantanamo Bay?" Juan, Akmul, and Aref laugh again. Aref laughs as he says Karthik likes to "torture himself". Karthik responds that everyone feels pain, but it is a choice to "suffer". Akmul looks at him, and says "he's getting philosophical". Juan, and Aref laugh and they quickly change topics by talking about something else.

Lab members used the term "philosophical" to do some work, and it is what Gubrium (1986) has called "philosophy-in-use". And it is used to do two kinds of work. First, it is used to locate a border which contains the objects and concerns important to engineers (Gubrium 1986:203). Second, it brings a certain reality into focus as this border is constructed. Sometimes when lab members sense that the spiritual discursive resource is being activated or will soon be activated, they place a limit on ongoing concerns by naming them philosophical. And so, they are effectively describing the spiritual discursive resource or its objects as unimportant or impractical to the focal reality – that

what they do is engineering. When engineers do this descriptive work amongst each other they can also warn each other that this border should be stopped short of or that if crossed, one risks being understood by lab members as a philosopher rather than an engineer.

Humor also provides engineers with a means of delimiting the spiritual discursive resource. Jokes and teasing of lab members do this work by constructing a distinction between language and the things the objects to which they refer. Words are often used to refer to things because "that's what it is". But sometimes, engineers make a distinction between words and things. When they do this, words take on a reality that is distinct from things (Gubrium and Buckholdt 1982:100). And so words understood in this way are not understood as statements about objects in the world. Distinguishing words from things, then, does the work of delimiting the spiritual discursive resource by using words like God to construct a reality not about objects in the world like the human bodies and nature I analyzed earlier, but about something else. Engineers use words like God to construct the personal realities of individuals. And so even though there is often 2 or more people listening and lab members know that some lab members maintain some kind of spiritual life, lab members limit the spiritual discursive resource that may emerge in situations where this background knowledge is felt to be relevant.

And they do this by constructing the context that listeners should hear them in. One way engineers do this is by indicating who they are talking about. And so instead of indicating that they are speaking as "we" or "us", they sometimes use words like "you" and "me" to signal that their speech should be understood as speech about "me" not "us" as a lab or "we" spiritual people. For example, on Good Friday, as Aref and I were

talking about a project he was working on, the lab director entered the room and my field notes illustrate how language constructs the context for how we are to hear the lab director's speech:

> I tell him [lab director] Juan went to church. I ask if he is going today too. He says he plans to and that "God won't be mad at me" because he'll go at 7 pm.

Telling the lab director that a lab member has already gone to church for a Good Friday service may be interpreted as an invitation to talk about Catholics, Christians, or the spiritual lives of lab members, but it is not. The lab director's talk is talk about something in particular. We understand it to be talk about him, and he directs us to hear him in this way by saying "me" rather than treating my comment as an invitation to talk about "us" Catholics, "us" Christians, or "we" lab members.

Lab members also constructed the context for how they should be heard in the interview situation. My third interview with DaSilva provides an example:

> *Matt*: …okay, I know in the last interview you said that you prefer to work on peaceful research when we talked about the history of the lab. So was your Catholic faith part of your decision to get away from military funding?
>
> *Dr. DaSilva*: Probably, yeah, but also it's also, I don't know, it's also a humanitarian point of view. I don't need to be Catholic to dislike wars or, right…?

The lab director, like us all, has multiple selves and so there are multiple ways of understanding what he says and what he does. He is the lab director, but is also a

husband, father, mentor, professor, gardener, Brazilian, and an American. When I ask him "...was your Catholic faith part of your decision to get away from military funding?", he issues instructions for how to hear him. He does not want to be heard as a lab director – or as a Catholic - , but instead from a "humanitarian point of view". And in providing this context for making sense of his talk, he places limits on the spiritual discursive resource. Disliking war for a spiritual discursive resource rationale that conforms to engineering culture such as that war destroys models engineers can use for solving problems by damaging nature are not felt to be adequate here. While war may seem remote from the comfortable environs of a college campus, the lad director also constructed a context for hearing him when speaking about something very local – a college-wide celebration of all things engineering. An excerpt from our interview illustrates this:

Matt: Okay. As a Catholic or a Christian, how do you feel about the St. Patrick in E-Week's knighting ceremony? And also all the promotional materials they use?

Dr. DaSilva: I don't mind. I think he's the Patron Saint of the engineers right?

Matt: Yeah.

Dr. DaSilva: I don't mind. I think it's appropriate. What I don't like is when they have these students dress like St. Patrick or something. I think it's really gross, it's really, it's borderline disrespectful because, but silly, mainly. I don't think it's because I'm Catholic, it's just because I think it's

silly, you have this guy in a long white beard, walking with a staff and…

Matt: …yeah a shillelagh I think they call it…

Dr. DaSilva: …yeah that's what they call it. Yeah but I remember for a long time it was borderline disrespectful because nobody cares and it just becomes you know "hahahaaaaa", you know so it becomes disrespectful. Again, mostly because it is silly.

Matt: Have you gone to any of these knighting ceremonies they have at the end of E-Week?

Dr. DaSilva: No.

Matt: No.

Dr. DaSilva: The one I'm talking about was actually the new building, what do you call, it was a celebration of the new building…

Matt: …oh when they opened it up?

Dr. DaSilva: Yeah it was opened up for a while already, but they officially, right, had this celebration and they invited the sponsors, you know the donors, the people who helped build the foundations and, so they had this big party. And one part of the ceremony was they had this big student dressed like St., St. Patrick coming from one door and then getting on stage and then I think there was a blessing. He would recite a blessing, or the student next to him would

> recite a blessing. But it wasn't done as a, it wasn't a blessing. It was more like a wish, you know, a wish of good, a good wish for the building. It was weird, it was really weird. But yeah I did say, I do remember saying to James [another engineering professor in his department], he's Catholic, and I remember looking at him and saying "this is strange isn't it?" And he was like "oh yeah, no but that's tradition". But it's weird, it's just silly, it's you know a little disrespectful. But it's no big deal [laughs].

In this interview excerpt, DaSilva also constructs a context for hearing what he says. He begins by saying that he finds the use of St. Patrick in the engineering celebration to be "gross", "borderline disrespectful", "but silly, mainly", and explains this by saying that this talk should not be understood as a Catholic's talk. But how we should hear him remains a bit vague until later on in the excerpt. He emphasizes that the stakes are not Catholic by repeating himself, saying "you know so it becomes disrespectful. Again, mostly because it is silly". He then further distances how he wants to be heard by saying that the building did not undergo a "blessing" at the ceremony, but instead a "wish". It is noteworthy that he edits himself and substitutes "blessing" for "wish". Describing the ceremony in terms of silliness and wishes, then, constructs a secular reality for the event rather than a spiritual reality. And then near the end of the excerpt when he says "I do remember saying to James, he's Catholic, and I remember looking at him and saying "this is strange isn't it?" And he was like "oh yeah, no but that's tradition", we are supplied with some more developed instructions for how to hear his story. Giving

speaking parts to someone else, as I showed earlier, can do a lot of work for speakers. In this case, DaSilva tells us that what the other speaker says should be understood as a Catholic voice. And so by showing us that another Catholic agreed that the ceremony was "strange", he can construct a fact. The fact is that this was not a spiritual or religious ceremony, but something else. And what was it? It was a university "tradition" at a public school, and the secular language of wishes, silliness, and respect provide the background knowledge that constructs the coherence for this story. It is also important to note that by giving another speaker the line that the event is part of "tradition", DaSilva makes room for multiple motives without necessarily compromising his sense of the event as silly, gross, or disrespectful.

Whether through the use of statements that specify who is talking and how listeners should attend to the story, or through giving speaking parts to others, all these things have something in common. They are all forms of what Holstein and Gubrium (2000) call "narrative editing". Storytellers engage in narrative editing when they perform the dual role of editor – monitoring, modifying, and shifting perspectives in displays of reflexive agency (Holstein and Gubrium 2000:113). I have focused on shifts in perspective where DaSilva shifted from Catholic perspectives to other perspectives he wanted to be heard through – humanitarian and university tradition. And by supplying instructions for how to hear him, he also placed limits on the spiritual discursive resource. Peaceful research and the presence of St. Patrick in a local engineering event should not be understood with the spiritual discursive resource. Instead, it is believed that they should be understood in humanitarian and university tradition terms.

The final means by which robotics engineers delimited the spiritual discursive resource relied on how they used the journals they wrote. As part of the research, I sat in on a robotics vision course for graduate students and advanced undergraduate students. And at the beginning the semester, I enlisted 4 students to keep journals about their experiences in the course throughout the semester. The way the students wrote in the journals as well as how they talked about their approach to the journals illustrates how they used the journals to delimit the spiritual discursive resource.

And they did this by constructing a context for reading them. This context, then, supplies some instructions for how the writing should be understood. One way to construct this context is for a writer to describe how they "use" the journals. For example, Basma told me in our third interview that "[t]he journals help me in reviewing what we did in class...". At the beginning of the semester, I had described my research as a project about the "field of robotics", which made available one name for the context they could be heard in. But this was the not only one they could invoke. The course included a lab component, Basma was a lab member at the time, and told me in our first interview that she prayed 5 times a day to God, and so any of these may have also been invoked as contexts. For example, the journals could have been said to help in reviewing the place of God in the world or the relationship between God and humans. By constructing the context in terms of "class" rather than in terms of God, Islam, or religion, Basma constructs a context of understanding that renders the class distinct from her spiritual commitments. While the spiritual discursive resource can be delimited through the approach engineers take to journals, it can also be delimited by how they write journal entries. Nate's journal demonstrates this. In a journal entry he labeled "Lecture", Nate

wrote: “I like learning about the complexities of robotics; it makes me appreciate the human system that much more. It also strengthens my belief that we were designed. We weren’t just an accident of nature”. Note how Nate writes that it “strengthens” his belief that humans were designed. He implies here that this belief existed before his experiences in this class. By writing in this way, Nate attributes some history to his belief that humans were created. The belief is depicted as if it is not emergent in the course or emergent in his writing, but independent of these things. Instead of depicting this belief in terms of transforming motives, distancing motives, or assigning speaking roles to other people in storytelling, Nate implies that his belief existed before these experiences, and the explanation is adequate enough for him that it comes to rest there. And so rather than writing in the journals about the place of God or approaching the journals as an opportunity to make sense of God, writers constructed contexts where the course and the journals can be made sense of as distinct from spiritual concerns like God.

Conclusion

In this chapter, I have shown how engineers activate and delimit the spiritual discursive resource. A discursive resource is a culturally recognizable and prototypical storyline or cluster of categories available to us for constructing our experience as meaningful through speaking and writing. The spiritual discursive resource is one in which experiences are talked about and known about through and with reference to categories like God, Catholic, Christian, Atheist, and Agnostic. I argued that engineers activate this discursive resource through transforming motives, distancing motives, and assigning speaking roles to other people in storytelling. Transforming motives transform

non-group motives for behaviors potentially interpretable as spiritual into the group motives acceptable to engineers such as complexity, multitasking, and automaticity. Engineers use distancing motives to place distance between engineers and God. And assigning speaking roles to other people in storytelling enables engineers to align themselves with the professed scientific value of skeptical questioning by posing questions through these speaking roles when they talk about God or spiritual concerns.

But the spiritual discursive resource is not felt to be equally adequate across all situations. Sometimes engineers feel it is excessive, and when they do, they work to place limits on its use. It becomes excessive when members feel that it doesn't pay enough attention to the fact that their work is engineering. This is a reality that is known, referenced, concrete, and objective for engineers. And so to construct the fact that they're work is engineering, they rely on philosophy-in-use, humor, the use of pronouns like "me" and "you", and the construction of contexts. Engineers use the term "philosophical" to describe things that they feel do not pay enough attention to the fact that they're work is engineering, and so talk about religion or spiritual objects is named philosophical to indicate that it is impractical and of marginal interest to engineers. Humor is used to invoke distinctions between words and the objects they represent, which helps frame talk in terms of the speaker rather than the world. This limits the spiritual discursive resource when listeners understand the humor to be about a person rather than some abstract object a collectivity is said to share such as "religion" or spiritualism". Using pronouns like "me" and "you" to talk about God and religion works in a similar way by signaling to listeners that it is speech about a person rather than about "us" religious people or "we" believers. Finally, engineers construct contexts for hearing what they say and reading

what they write. In interviews, these contexts were constructed by specifying that the speaker was not speaking as a “Catholic”, but as somebody else like a “humanitarian”. In the journals lab members and members of a robotics class wrote, they also constructed a context for reading their writing. They did this by treating journals as opportunities to review for the lecture, and by depicting potentially spiritual objects as existing independent of the class and as independent of the writing in the journal about the potentially spiritual object.

CHAPTER 7: USING AND DELIMITING THE NATION

I showed in the first chapter how robotics and robotic vision engineers learned to use their bodies to plan, complete, and describe work about the sizes, shapes, motions, and inscriptions of robotic vision technologies. In this chapter, I draw on observations and interviews with members of a robotic vision laboratory to explore the practice of engineering work and how it relates to a discursive resource (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). Building on important work in the sociology of description (Gubrium 1986; Gubrium 1992; Gubrium 1993; Gubrium and Buckholdt 1982; Buckholdt, and Lynott 1982; Gubrium, Buckholdt, and Lynott 1989; Mol 2002), I will analyze how engineers use one discursive resource in the everyday construction of engineering knowledge. I will analyze how the nation is used as a discursive resource in everyday lab life to plan, complete, and describe work. Nations, then, become descriptive resources when they are activated in everyday practice, used to describe experiences in terms of categories of, and references to, nation, nationality, and citizenship.

Activating the Nation Discursive Resource

Engineers activate the nation as a discursive resource when they use it to explain why they engage in less teasing and joking than other lab members, when they use it to offer explanations for a lack of familiarity with some technology, and when they use it to frame an experience as extraordinary. But over the course of my fieldwork, I learned that the nation discursive resource is not uniformly activated across different kinds of situations. Instead, lab members worked to place limits on the nation discursive resource.

My argument is that the nation discursive resource is delimited through describing experiences potentially meaningful in terms of national pride, civic pride, or patriotism with the terms of "career" and "making a difference in people's lives" instead.

Explaining Less Teasing and Joking

In some situations, lab members activated the nation discursive resource to explain something. One kind of thing that seemed to require an explanation was less teasing and joking than other lab members expect from each other. As I wrote in the chapter about the business discursive resource, lab members described who they were as lab members in terms of teasing, joking, and sentiments. And everyone – from the lab director to the student lab members shared this working understanding of what it was like to be a lab member. The students, then, who are regarded as too serious by other lab members are called on to account for not teasing and joking enough.

Explaining Lack of Familiarity with Some Technology

One situation in which lab members activated the nation discursive resource is when other lab members raise questions about their knowledge of technologies deemed relevant to lab work. On a trip to study the house of a quadriplegic man in order to build technologies to help him in everyday life, I caught a glimpse of this. In my field notes, I wrote:

> DaSilva talks about how lab members should be "familiar" with technologies. A little later, his wife Lorraine quizzes us on which technologies we use. We learn that Juan doesn't use Facebook, and continues to use burned CDs. Juan also says

> that he doesn't use Twitter. DaSilva responds that technology like Facebook is useful for keeping up with people from "high school". Juan agrees, and recounts how when he goes back home, someone tells him how they will reconnect on Facebook, but he has to tell him they can't because he doesn't have a Facebook account. Lorraine then asks me if I have a Facebook account, and I tell her I do, but hardly ever use it. She then asks Glen if he uses Facebook. He responds by saying that Facebook is "blocked in China". When I ask him if I heard him right when he said it is blocked, he confirms that I have and adds that "YouTube" and "Google" are also blocked there. I ask why. Glen says that "people in China have a bias against critical judgments of China". And so to discourage critical judgments of China, the Chinese government has blocked these websites. DaSilva adds that Aref told him that although [the middle eastern country he comes from] also blocks some websites, people have set up proxies in other countries so that people in [middle eastern country] can access these websites.

In a lab where the lab director expects members to be "familiar" with technologies, lab members who come to be known as unfamiliar with some technologies are sometimes called on to explain why they do not use them. And lab members explain why they do not use them by constructing a context where this lack of familiarity can be viewed as a routine and taken-for-granted fact of life rather than an anomaly. Activating the nation discursive resource, then, effectively transforms the anomaly into a fact when the context of Chinese censorship is constructed along with it. But this does not mean that Glen believes this fact should be treated with complacency. Instead, Glen develops a critique of this by saying that "people in China have a bias against critical judgments of China".

By terming Chinese views of others views as having a "bias" and the views of others toward China as "critical", Glen demonstrates a kind of rationality where he can imply that Chinese views are inadequate.

Framing Extraordinary Experiences

Lack of familiarity with a technology was not the only thing that lab members expected explanations for. They also tended to honor requests for explanations from me about extraordinary experiences. These experiences took on their extraordinary quality when lab members constructed them through a context. And then they became extraordinary in this context when lab members activated the nation discursive resource to describe the experience. For example, an excerpt from an interview I did with Basma illustrates this:

Matt: So when was the first time you came across this right hand rule?

Basma: In high school.

Matt: In high school really? That early? Okay, was that…

Basma: …compared to here in the US we do much more things in high school. I mean our high schools classes, our high school classes are much more difficult than what you do here. But when it comes to, I mean everyone, even undergrad. But in undergrad we focus more on theory as compared to here in the US as I told you before.

Matt: Yeah.

Basma: For example, in high school we do much more complicated things. For example calculus, what you do once you're here, once you

enter the college of engineering, we have already done them in high school.

Basma activates the nation discursive resource by using it as a resource to explain how comparatively early she learned the "right hand rule". The experience that comes with knowing the right hand rule is transformed from an ordinary thing to an extraordinary achievement by activating the nation discursive resource. Once the nation discursive resource is introduced, it can be "compared to here in the US". And this comparison provides a basis for viewing the timing of learning the right hand rule as extraordinary because it is learned earlier in Algeria. Basma then elaborates on other skills that can also be understood as extraordinary because of how early they are learned, including "calculus". Activating the nation discursive resource in this way enables Basma to enhance her self-presentation without sounding like she is bragging.

In one of our interviews, Karthik also activated the nation discursive resource to explain an extraordinary experience – in this case, an extraordinary performance on an examination. The following excerpt demonstrates this:

Karthik: ...so and another case also happened with me. So we have a very tough exam, gate, we call it gate so yeah, it's an entrance exam, normally they ask all the technical questions in the exam...

Matt: ...university entrance exam?

Karthik: Yeah. For masters, you have to appear for that...

It is noteworthy how Karthik talks about the entrance exam in terms of "we". He says "we have a very tough exam, gate, we call it gate". The exam can be viewed as "tough" through the interpretive work Karthik does to construct a context for it. It is tough for

more people than just him. It is tough for anyone who wants to attend a graduate program in India. And Karthik's use of the term "we", along with the background knowledge that he comes from India that he expects me to use to hear his narrative, constructs the context in which his experience can begin to be understood. Later on in the same interview, he described his performance on the exam by saying "...a lot of people appeared in the gate exam, and I was the only one who got qualified in my final year". And so his performance can be viewed as extraordinary when activating the nation discursive resource with the word "we" instructs us to distinguish India from the US.

Delimiting the Nation Discursive Resource

In some situations, lab members felt that the nation discursive resource ought to be delimited. And so they worked to place limits on its use in these situations. They worked at placing limits on the nation discursive resource when they felt that using it to interpret their CVs would undermine valued opportunities in some way, and when they felt that a language of sentiments was more a more appropriate way of describing experience than the nation discursive resource.

Discounting

One of these situations occurred when lab members felt "tyrannized" by their curriculum vitae-writing activities. The curriculum vita, or CV for short, is a long, academic resume. Gubrium, Buckholdt, and Lynott (1989) have argued that form-completers in human service settings feel tyrannized by the paperwork they are required to complete. The descriptive demands of paperwork, Gubrium, Buckholdt, and Lynott

(1989) suggest, include chronological, stylistic, and interpretive demands which all frame how people and activities are described on paperwork. The form-completers, then, sometimes resent and complain about this paperwork when they feel it is incompatible with what they know to be true. While Gubrium, Buckholdt, and Lynott (1989) focus on forms, I argue that CVs, can be treated the same way because their users treat them in the same way as human service workers treated forms. And one of the descriptive demands that CVs make has to do with education. In general we expect some details about education to be included, and lab members in particular expected that readers would learn about their citizenship by reading about where they went to school. But lab members expressed resentment about the use of the nation discursive resource to describe who they were and what they had done. They talked about their resentment for the nation discursive resource in terms of how it can block or delay access to valued opportunities like winning a student visa and securing a job interview. And so lab members engaged in what I call *discounting*, narrative work that prevents some things from being counted as important for understanding the narrative worker. And so lab members engaged in discounting in two ways. First, lab members omitted the names of organizations they had worked with when the project dealt with something deemed "sensitive" and when the lab member presumed that the organization would sound like a national entity to someone reading their CV. Second, lab members raised questions about media stereotypes of nationality.

Gubrium and Buckholdt (1982) argue that the activity of describing includes two important parts, the "descriptive circumstance" and the audience. The descriptive circumstance includes the conditions in which, and through which descriptions are

constructed. And the audience is the individual or group that receives or will receive the description. The descriptive circumstances of discounting by omission include two conditions. First, when some experience with a national entity is expected to be described in some way. Second, that experience is also associated with something viewed as "sensitive". And finally, the audience includes not only a reader or employer, but also the geographic location of the employer. Akmul furnishes an example of this. He had worked on a camera surveillance system for a nuclear research center run by the government of India, and had also helped build a robot for the Indian Army. While he said he was "happy" to work on the robot project, he also said that this project may be regarded differently by some US audiences. An excerpt from one of our interviews illustrates this:

Akmul: ...there are some fields in the US, US government, before, before 9/11, they were not too strict, but after 9/11 I read a document that had some fields. Those fields were, these are sensitive fields. It was a US government document. I think I got it from their website also...

Matt: ...oh was it the TAL, Technology Alert List by any chance?

Akmul: Ah this I don't, I don't remember the name. But yeah they had this list and in that they had nuclear and all this stuff and in that, there's one, one called robotics or something like that. So they have that. So when you apply for Visa, like when I apply for Visa, if I tell them its, people say it's not a good idea when you apply for a Visa to say that you work in robotics, that you are coming here to work

> on robotics. And maybe UAV, oh and they have UAVs on that list. Ah yeah aerial vehicles...

Akmul tells me he used a "US government document" to make sense of scientific and engineering fields, that some of these fields were "not too strict" before the 9/11 attacks, and that after 9/11 robotics was included as a "sensitive" field. Described as sensitive, experience with robotics became a moral issue for Akmul when it was combined with his experience working with Indian government agencies. Later on in the same interview, Akmul explained how including these Indian government agencies on his CV may delay access to valued opportunities:

> ...it's not that they reject [your student visa application] outrightly, but if they sense that it is kind of a sensitive, sensitive area, then they would give you a Visa, a Visa on hold and they will do your background check. And in that they figure out where you worked and the kinds of things you did and all that stuff. So that's why, and that again, is the reason why I don't write that I worked for Indian defense 'cause maybe here I would have some problem or something.

Akmul complains that including his work for "Indian defense" on his CV may introduce "some problem", including a "hold" on his Visa application and a "background check". And when students are admitted only at particular points in time such as fall semesters and when new hires are expected to only begin working at particular points in time, a delayed student visa and a background check threaten to undermine graduate school and job opportunities. Anticipating this, and working to avoid it, Akmul omits references to Indian defense by describing his experiences in different terms. In the same interview, he said:

> ...and in that project, on this, on the atomic center one, I can write what the project did, what the project did on an application, what the final application did, that [the surveillance camera system]...would rotate and it would stich, but on the second one I can write that you can lock and the robot would follow, but I don't write that it would have a gun and all that stuff.

Akmul makes a distinction between "what the project did" and who it was for. This makes it possible to include some details about his work experience without describing the Indian defense agencies the projects were on contract to. In addition, describing what the project did supplies Akmul with an opportunity to demonstrate his knowledge of a robot or robotic vision technology.

Another way lab members expressed resentment about using CVs happened when lab members felt that the nation discursive resource readers of their CV would bring to bear in reading it would undermine their access to valued opportunities like job interviews. For example, Aref had applied for a number of jobs online and attended a career fair organized by the School of Engineering that houses EARL. And like Akmul, he presumed that readers of his resume would learn that he was not a US citizen. Aref complained about the nation discursive resource he presumed readers would bring to bear on his CV:

> *Aref*: ...for example, the media in the United States, what people know about [the Middle Eastern country] you know?
>
> *Matt*: Not much.
>
> *Aref*: Not much, and whatever they know, it's about war and nuclear problems, they, they've never seen a...[Middle Eastern] student. So when they read

> [Middle Eastern country], they don't think about a nice person, a knowledgeable person. They think about troubles you know? The troubles, you know, maybe 50 percent is true, 50 percent is totally a lie, they lie, the media you know? They inject into people's minds you know. That's the problem with being international, specifically [Middle Eastern country]. You know, I know that if I get to the interview and I talk to them, they say "okay, he's a normal person like everybody else, anybody". So that's the problem with resume...

Aref fears that readers of his CV will bring a nation discursive resource to bear in general as they interpret his CV, and a media stereotype of the Middle Eastern country he comes from. Aref constructs a context through his narrative where the nation discursive resource can be viewed as an inadequate resource for understanding him. First, he introduces the idea that people in the US at least partially rely on "the media" to make sense of the Middle Eastern country he comes from. Second, he says that the media frames his Middle Eastern home country in terms of "troubles" like "war and nuclear problems". Third, Aref tells me "50 percent is true, 50 percent is totally a lie". And so although Aref has citizenship with this Middle Eastern country, he can nonetheless be viewed as a "nice", "knowledgeable", "...normal person like everybody else..." Attributing lies about his Middle Eastern home country to the media rather than US citizens or American people also enables Aref to criticize descriptions of this Middle Eastern country without assigning authorship for these depictions to the very people he works with or wants to work with in the future– US employers and your sociological interviewer.

In sum, lab members omit organization names from their CVs and work to discount what they see as media stereotypes of nationality when they feel that readers and potential employers may use these stereotypes in interpreting their CVs. And these things are done strategically when lab members are up against blocked and delayed access to valued opportunities like job interviews and student visas. In the process of omitting information and discounting media stereotypes of nationality, lab members also delimit the nation discursive resource. They place limits on its use. Instead of work experience with an Indian government nuclear agency framed in terms of the name of the agency, the work is described on the CV in terms of what the surveillance system itself did. And when lab members felt that readers would learn about their citizenship, they worked hard in interviews with me to explain not receiving interviews in terms of media stereotypes of nationality before working to discount these stereotypes.

Sentimental Vocabularies of Motive

In a previous chapter, I analyzed how lab members used "transforming motives" (Sharp 2009) to activate the spirituality discursive resource. But motives are always motives-in-use, and so they can be used for many other different kinds of projects. One of these is placing limits on the nation discursive resource. Recall that transforming motives serve to "…change nongroup motives into motives that conform to the culture of social groups…" (Sharp 2009:268). And one set of motives which is honored by lab members includes sentiments. These motives change nongroup motives into motives that appeal to sentiments. These motives appeal to things like service, peace, helping, and happiness. Thus, when lab members are called on for an explanation of what they have said or done,

these sentiments are often treated as good enough, which in practice means that the explanation can rest with these motives – additional explaining is not called for or expected. One way this often worked was by offering motives which transformed non-group motives like national pride, nation-building, civic pride, or patriotism into motives honored by lab members. In this case, lab members honored motives which appealed to sentiments. One of the motives which appealed to sentiments invoked "service".

One way in which lab members delimited the nation discursive resource involved describing experiences working with technologies that are potentially explainable in terms of national or patriotic motives instead in terms of motives that appeal to sentiments. Experiences working on research projects with possible applications for soldiers and veterans, then, were often described without the nation discursive resource, or as opposed to the nation discursive resource. Instead, lab members often used a language of sentiments to describe these experiences. One way lab members did this was to use transforming motives to describe work experiences they had before becoming lab members. For instance, Karthik worked at an Indian government owned telephone exchange before becoming a lab member, and an excerpt from an interview we did illustrates how much he relies on a transforming motive to describe his experience working there:

> So it's not like just follow the economics to wherever you get maximum profit. So, maybe my thinking is because I worked in a government organization in India. They, they work for profit as well as they work for service. So in one of our, in few of our places, we got a lot of laws, but the argument to continue business in those places is that okay, we are not only doing it for profit, we are

> also doing it for service. We are also doing it for service even though there are laws that we have to obey that so that's what I think.

Karthik begins by telling me that this ostensibly "government organization in India" engages in "work for service". He continues by telling me that the government organization is not only providing phone services "for profit" but also for "service". Then, he repeats himself again, emphasizing this by saying "we are also doing it for service" a second time. There are many possibly ways of describing this experience, including in terms of motives that appeal to national pride, civic pride, nation-building and patriotism. But Karthik ignores a motive that construes his experience working for a government organization in India in terms of these motives, and instead offers the transforming motive of service.

Akmul also had work experience potentially interpretable as national. He worked for a subcontracting company in India that built a surveillance system for an Indian government-run nuclear research center, and helped build a robot for the Indian Army. But rather than offer motives for this work experience that appeal to patriotism, national pride, or civic pride, he used a transforming motive to describe them. An excerpt from one of the interviews we did demonstrates how he did this:

> Like, like it was not atomic research or anything, but still I can write that I did a project at BARC [Bhabha Atomic Research Center], it's called BARC. So I had a project there. So I thought it will help. It may help. So that's why I was happy to be part of that project. But to me, I don't think I ever [laughs], means it doesn't sound good, but I don't think I ever weigh things by these three prides that you, that you told. Just if I am happy with it and I think it will help my career and it's

> in the line of what, what I am doing and I am getting paid, I think that's, that's enough to be included in a project.

Akmul worked on a project to develop a panning surveillance camera system along the perimeter of BARC. While BARC is owned and operated by the federal government of India and nuclear energy is often associated with modern nation-building, Akmul does not offer a patriotic or nation-building motive for his work experiences. Instead, he tells me he was "...happy to be part of that project". Later, he repeats this, saying that he uses "...if I am happy..." to make decisions about work. The "three prides" of national pride, civic pride, and patriotism are transformed into happiness, an utterance that enables Akmul to transform the nongroup motives of nation into motives honored by lab members. And in this case, lab members are willing to honors appeals to happiness.

And the other way lab members did this was to use transforming motives to describe work experiences they had or continue to have as lab members. For example, DaSilva used transforming motives to describe his experiences receiving research funding from the US Department of Defense and the US National Geospatial Intelligence Agency. An excerpt from an interview we did illustrates this:

> But anyways, what you're doing was to replace those Patriots, replace those Predators. To use cameras to locate targets. But then you see those news of people being killed in Afghanistan, in Iraq, and sometimes they get the right target, they kill someone that is a terrorist, sometimes they kill families, and they kill kids. So I don't want to be part of that. So I said, nah, I don't think my system is going to get there because, because, I mean it could, I mean it could be there. Not the one we did with Chang-su, but if we continued it could. It could end up in a Predator

> or something. And then I would hear the news that you know, ah we missed the target, but we almost got this, and this guy. But next time we will, but this time, we missed so I don't want to [laughs] know that. So I decided to get away from any military related, ah, if there is something that's peaceful, it's for the military, but it's more peaceful, or support the troops. There was a time they were talking about, there was some guys in the medical school, they wanted to develop these robots to go either provide assistance on the field to you know soldiers, or to remove the soldier. Sometimes they get killed, or they get wounded inside the enemy lines, and people can't go there to pick them up. Ah, sometimes they are alive, they have to go there, they sacrifice their own lives to get there, so that I wouldn't mind. So we were talking about these guys in the medical school, how to develop a robot that could go, and you know, provide some medical assistance, you know on the field. So we talked about that, that I wouldn't mind because I know it's peaceful, even though it is support for the war, but I mean there are wars that are good wars. Wars that are, not good, but necessary. So that I don't mind. So if it's giving support to the soldiers and helping the soldiers, things like that, that's fine even though it's in the context of war, at least it's to help people right? But the ones that can be used to kill people either because my system had the mistake, or somebody decided that right, or whatever it is, I helped kill the person, so [laughs], that I don't want. That one, I don't want.

DaSilva and a former student published some papers on using passive sensors to locate targets from a UAV – Unmanned Aerial Vehicle. Instead of relying on active sensors like lasers, they tested how well some camera systems could locate targets on the ground. And

as he tells me about this, he sets the stage for the transforming motive by saying he decided to "get away from any military related" things. The transformation begins. But he wants to do more than get away from it. He wants to take on "peaceful" projects that "support the troops". Peace is one motive offered here. And the distinction he makes between "the war" and "the troops", then makes it possible for him to attribute his research to the troops rather than the war. This supplies an important resource, then, because it enables him to frame his research in terms of additional motives of sentiment such as providing "assistance" like "some medical assistance", which will give "support to the soldiers and help...the soldiers". Finally, he repeats this again, eliciting some support from me, by invoking "help" in the question "...at least it's to help people right?"

But the lab director was not the only lab member to offer a transforming motive that introduced an appeal to sentiments. Consider Juan's experience working on multimodal interface control technologies for an electric wheelchair and his experience working on technologies to identify Improvised Explosive Device (IED) technologies. An excerpt from an interview we did shows how he set aside descriptions of these experiences as national or patriotic in favor of motive appealing to sentiments:

Matt: Well that leads me nicely into my next question. Is national pride, civic pride or patriotism part of the reason you decided to work on the EMG and head gaze control electric wheelchair projects? Why or why not?

Juan: Again, more than national pride or patriotism I would say it's making a difference in people's lives. Something that would be helpful, yes of course for any nation, for everybody right...?

Matt: ...um hmm...

Juan: ...for any group of people and in particular I would say yes, back home. Meaning that there is a lot of things that could be done in this area, assistive technology and all those things, not only here but especially back home. And definitely there's a lack of technologies. If we still have a lack of certain technologies and more advanced and smart and intelligent technologies for people here, you can imagine underdeveloped, poor country definitely there's a need as well right? So, so yeah, I think it was important. It would be a nice thing that I could bring back home. And continuing with the plans that I have, which are to go back and work at the university and doing some research and maybe helping, getting students involved in projects related to this, then I would say, again I don't know if I would call that patriotism or national pride or civic pride, but I would say it would be a nice thing for helping people in general. I don't know if that's the answer. It's a little bit...

Juan tells me that part of the reason he decided to work on EMG and head gaze control systems was "more than national pride or patriotism", which triggers the process of transforming the motives expressed in my question to motives honored by lab members. He reasons that it is more than this because it "would be helpful for any nation" – not merely his home country Guatemala or his adopted country – the United States. Here the sentiment of "help" works to delimit the nation discursive resource because it is expressed through an international context rather than a national context. He then repeats himself, saying "...I would say it would be a nice thing for helping people in general". Since envisioning Guatemalans or US citizens as the recipients of these technologies may

be tightly linked to national pride or patriotism, Juan avoids this implication by emphasizing that "people in general" are envisioned as the recipients.

Lab members, then use transforming motives to transform nongroup motives into motives honored by lab members. In this case, nongroup motives include motives of national pride, civic pride, and/or patriotism. And motives honored by lab members include ones that appeal to sentiments like service, peace, helping, and happiness. While lab members re-produce their statuses as lab members in good standing by offering motives honored by lab members, there is more work going on here. By offering these transforming motives, they also place limits on the nation discursive resource.

More Atrocity Stories

Here again, lab members worked at placing limits on the nation discursive resource by using "atrocity stories". According to Dingwall (1977), atrocity stories express complaints or slights about attempts to control the life of an individual or group. The storyteller regards the justifications for the attempts at control as illegitimate, and so telling the story supplies a kind of redress by providing conditions of mutual support between the teller and the hearer. And the use of these stories helps define colleague groups among people who regard themselves as members of the same occupation or profession when they serve as both audience and storyteller of these stories. Atrocity stories, then, are one kind of resource people use to construct a kind of folk occupational taxonomy – a folk theory of where one's occupation stands relative to the other occupations that people recognize.

Lab members used these stories in two ways. One way was to describe an experience in first-hand terms where the storyteller himself was directly and obviously involved in the event or experience described. For example, Akmul worked at developing a camera surveillance system to monitor the perimeter of an Indian government owned nuclear research center. Although employed by a different company, he was subcontracted to work on this project for the Indian government. And so he told me spent about 3 days at the government research center, working with government employees to install the surveillance system. An excerpt from one of our interviews illustrates his complaints about these government employees:

> ...for instance, in government, I don't know if it happens in everywhere outside India and maybe in US government also, but like people tend to be relaxed because they have, the job is fixed. Because once you are employed by the government you cannot be fired just like that. You just don't get promoted or you might get demoted. But you are in a stable situation, while in the private sector you can get fired anytime right? So because they are relaxed, they don't work too, too hard. Some people I can say because I worked with them, but maybe there are also good people in there. But they take coffee break, this break, this break after every little bit of time. So you don't get to work, like in my office, I used to work continuously, if I sat for example at 12 pm, I would work 5, 6 hours on this stuff. But there, okay, two hours I worked, the person I was working with "okay let's go and have coffee". "I don't want to have coffee. Let's go". [laughs]..

Akmul recounts his experience working with government employees by complaining about them, saying that they take breaks "...after every little bit of time". Then, Akmul

constructs what Smith (1978) has called a "contrast structure", which effectively works to supply instructions on how this story should be heard. In Akmul's case, he tells me "I would work 5, 6 hours on this stuff", and this provides the norm by which the next part of the story can be understood as anomalous. At the research center, Akmul tells me, government employees would interrupt him after only two hours, saying "okay, let's go and have coffee". Akmul's narrative, then, testifies to his social worth as a hard working engineers in contrast to the lazy government workers.

The second way lab members used these stories was to describe an experience in second-hand terms, as something that happened to somebody else or as something someone has heard. An excerpt from an interview with Glen illustrates how knowledge about other people can be used to construct atrocity stories:

Matt: Have you ever tried [to apply for a patent] in China?

Glen: No, but I know in China that it would be much more easier...

Matt: ...much more easier?

Glen: Yeah.

Matt: Why is that?

Glen: I don't, I don't know exactly the reason, but I guess Chinese government are trying to, like, how do you say that? They want people to come up with something new, so they didn't set that, so apply for a patent is not that hard because if it is too hard, people won't try to do that. So the government put the standard a little bit lower, and the checking process may not be that technic[al]. So if

you have something kind of new, I don't know, because I know a lot of people that doesn't have a degree they have their patents...

Matt: ...oh really...?

Glen: ...yeah so it's not really a technical thing as you see here. So it's really a poor and low standard.

Matt: So, so they set the bar a little lower there to encourage people to apply for patents, but also to receive patents?

Glen: Yeah, but I don't know if that's their purpose. I just guess because I saw too many people have patents and those patents are really nothing and so I guess that's what they are playing.

Matt: So it sounds like you know a lot of people back in China who have patents or...?

Glen: ...no you watch on TV and some guy saying, he has a biography about himself and saying he has patents and when the, the other person asked him what it is, he shows you some really stupid things. You will feel like "what? That's a patent?" [laughs].

Matt: They don't look into the technical aspects as much to see if this is a original design or...?

Glen: ...maybe I guess, or maybe they don't apply for a technical patent. Maybe they just apply for a really weird category so it's really easy to get through. I don't know. And in China, law is not that powerful so even though you have a patent, other guys steal your idea, pretty much you can get anything.

Glen begins his narrative by telling me that he “knows” it would be “much” “easier” to file for a patent in China. He reasons that the Chinese government wants Chinese citizens to come up with something “new”, and so they provide an incentive for people to do this by maintaining a “checking process” that is not “that technical”. And by “not technical”, he seems to mean that the person applying does not have a college degree. This amounts to what he calls a “really poor and low standard”.

But the application process itself is not the only problem for Glen. He also complains about the outcome of this. He says “...too many people have patents and those patents are really nothing...” In addition to his complaints about the patent application process and its outcomes, he also complains about Chinese laws. And so even if a patent is awarded in China, the “idea” associated with it can be stolen because “...law is not that powerful”. While he has not himself applied for a patent in China, he marshals knowledge from living in China and knowing Chinese people who have applied for them in constructing his atrocity story. The story, then effectively testifies to Glen’s social worth as a rigorous engineer who can recognize the high technical standards of innovative technologies as against the poor and low standards of the Chinese government.

In sum, lab members used atrocity stories to place limits on the nation discursive resource. These stories help place limits on the nation discursive resource when they call attention to differences between the speaker and some other who is to be viewed in terms of a nation or state. And in suggesting that the speaker should be distinguished from others who are described in national or state terms, lab members suggest that they should be understood without the nation discursive resource. Instead, they should be described in

terms of hard work, high technical standards, and innovative technologies – categories that are recognizable and celebrated by lab members and other knowledge workers like me.

Conclusion

In this chapter I have analyzed how and when the nation discursive resource is activated by lab members. The nation discursive resource supplies lab members with a means of communicating and describing activities in terms of nation, nationality, citizenship, and/or state. And I showed that lab members activate this resource to explain why they engage in less teasing and joking than other lab members, to explain some lack in their familiarity with a technology, and to frame extraordinary experiences such as learning a skill comparatively earlier than US citizens typically do.

I also analyzed how and when lab members worked to delimit the nation discursive resource. And I showed that lab members worked to place limits on the nation discursive resource by engaging in what I called *discounting*, narrative work that prevents some things from being counted as important for understanding the narrative worker. In this case, omission of the name of an organization from a CV when a lab member presumed that it, along with experience working on "sensitive" technologies would undermine or delay opportunities. Or, discounting was employed by lab members to suggest that some interpretive schemes like media stereotypes of nationality where inadequate for understanding them. Next, I showed how lab members placed limits on the nation discursive resource by describing experiences potentially understandable in terms of national pride, civic pride, or patriotism with different terms – the terms of a language

of sentiments. And finally, I finished the chapter by showing how lab members used atrocity stories to complain about other people viewed as members of a nation or state, to call attention to how they vary from these members of nations or states, to cast themselves as hardworking and rigorous as against the lazy and untrained government workers, and thereby placing limits on the nation discursive resource.

CHAPTER 8: CONCLUSION

The STS lab studies literature has made some very important contributions by showing how lab members construct scientific knowledge, and by showing the co-construction of science and scientists. But other important questions have been neglected such as what are the conditions of possibility in which lab work is embedded? And how do lab members draw on resources from outside the lab? This study has been an effort to sketch out some answers to these questions. In terms of conditions of possibility, I have shown that lab members can rely on more than resources like machines, lab leaders, articles, and knowledge about these things to construct the realities of their lives. They also draw on a number of discursive resources, including the body, spirituality, business, and the national to do what they recognize as robotic vision engineering. Discursive resources are culturally intelligible and prototypical storylines and clusters of categories available to us to construct our experiences as meaningful (Chase 1995; Foley and Faircloth 2003; Holstein and Gubrium 2000). And these discursive resources function in different ways in the lab. They can be used to explain behavior and events, assign motives to lab members, to tell atrocity stories, to construct contexts, and to discount particular kinds of knowledge about lab members.

And to address the second question, I have analyzed when these discursive resources are activated and when they are delimited. Delimiting discursive resources is accomplished when lab members work at avoiding talking about something. In his study of the descriptive organization of senility, Gubrium (1986) offered defined the concept of "descriptive security" as the means by which people work to distinguish a category by

itself, and thereby maintain the reality described by and through the category. He adds that descriptive security can also be achieved by avoiding questioning it, and so silence can be a form of descriptive security. I argue that the descriptive security of robotics engineering is not only achieved through the descriptive work of activating discursive resources, but also through the delimitation of these resources, which helps lab members avoid talking about some things in general and avoid talking about some things for too long.

Some discursive resources are local and some are trans-local. Trans-local discursive resources are common in many different settings, including many different kinds of labs. And these trans-local discursive resources include the body and business. Local discursive resources are common to the lab in focus and to some extent other labs that are similar in some ways. These local discursive resources include the spiritual and the national.

The body discursive resource is a framework for the communication and description of activities in terms of the body in general and body parts in particular. Engineers use their bodies to plan, describe and complete knowledge about size, shape, motions, and inscriptions of robots as well as how to communicate these forms of knowledge to professors, other engineering students, and knowledge workers like me. Professional descriptions work up human bodies as machine bodies and machine bodies as human bodies, construct an affective assemblage to describe what is good for machines as also being good for humans, treat human bodies as resources for describing robotic vision technologies, and depersonalize human bodies. The descriptive circumstances for these include lectures in a robotics class for upperclassmen and

graduate students, the lab room of this class, and a robotics laboratory. The audiences, then, are composed of lab partners, engineering professors, and other engineering students. Humorous descriptions of bodies do not construct them as machine-like, but instead personalize them as bodies with a gender and a name. And these descriptions were not uniformly given across lab life. They were offered in particular descriptive circumstances: during transitionary periods before and after important events in lab life: class lectures and lab meetings. By only offering these kinds of descriptions outside of lectures and lab meetings, and then using a non-serious frame to understand what is said about bodies, the professional descriptions of bodies are protected from role distance.

The spiritual discursive resource is a framework that engineers use to plan, complete, and describe their activities in terms of the categories of, and references to, God, Catholic, Christian, Atheist, and Agnostic. I argued that engineers activate this discursive resource through transforming motives, distancing motives, and assigning speaking roles to other people in storytelling. Transforming motives transform non-group motives for behaviors potentially interpretable as spiritual into the group motives acceptable to engineers such as appreciating nature as a mechanism and in terms of categories like complexity, multitasking, and automaticity. But since mechanizing nature as a model for solving practical problems gives traction to the idea that God is like an engineer, engineers run into the dilemma that God appears more like a colleague, lab member, or engineering professor than a deity. And so engineers use distancing motives to place distance between engineers and God. And assigning speaking roles to other people in storytelling enables engineers to align themselves with the professed scientific value of skeptical questioning by posing questions through these speaking roles when

they talk about God or spiritual concerns. In doing so, engineers align themselves with the presumed interest engineers have in skeptical questioning. But the spiritual discursive resource is not felt to be equally adequate across all situations. Sometimes engineers feel it is excessive, and when they do, they work to place limits on its use. It becomes excessive when members feel that it doesn't pay enough attention to the fact that their work is engineering, or when it is felt to pay unjustified attention to the fact that the work is engineering. And so lab members work to place limits on the spirituality discursive resource through the deployment of philosophy-in-use, humor, the use of pronouns like "me" and "you", and the construction of contexts. Engineers use the term "philosophical" to describe things that they feel do not pay enough attention to the fact that they're work is engineering, and so talk about religion or spiritual objects is named philosophical to indicate that it is impractical and of marginal interest to engineers. Humor is used to invoke distinctions between words and the objects they represent, which helps frame talk in terms of the speaker rather than the world. This limits the spiritual discursive resource when listeners understand the humor to be about a person rather than some abstract object a collectivity is said to share such as "religion" or a "spiritual" life. Using pronouns like "me" and "you" to talk about God and religion works in a similar way by signaling to listeners that it is speech about a person rather than about "us" religious people or "we" believers. Finally, engineers construct contexts for hearing what they say and reading what they write. In interviews, these contexts were constructed by specifying that the speaker was not speaking as a "Catholic", but as somebody else like a "humanitarian". In the journals lab members and members of a robotics class wrote, they also constructed a context for reading their writing. They did this by treating journals as opportunities to

review for the lecture, and by depicting potentially spiritual objects as existing independent of the class and as independent of the writing about them.

The business discursive resource is a framework for the communication and description of activity that lab members use to plan, complete, and describe their activities in terms of money and competition. I showed that lab members activated the business discursive resource as a contrast structure illustrating what the lab was like, when they signal that they are talking to one or two specific individuals rather than all lab members, when they describe their activities to an audience of journalists, on the lab's website, and in the conference and journal papers they write. But like other discursive resources, lab members do not always feel that the business discursive resource is appropriate to use. And so they work to place limits on it by treating some descriptions of people understood as representing business with a dose of humor.

The nation discursive resource is a framework that members use to describe activities in terms of, and with references to, the categories of nation, nationality, and citizenship. I showed that lab members activate this resource to explain why they engage in less teasing and joking than other lab members, to explain some lack in their familiarity with a technology, and to frame extraordinary experiences such as learning a skill comparatively earlier than US citizens typically do. But lab members also worked to place limits on this resource sometimes, and so I followed when and how they do this. I argued that lab members use three different strategies to place limits on the nation discursive resource. One is by engaging in what I called *discounting*, narrative work that prevents some things from being counted as important for understanding the narrative worker. In this case, omission of the name of an organization from a CV when a lab

member presumed that it, along with experience working on "sensitive" technologies would undermine or delay opportunities. Or, discounting was employed by lab members to suggest that some interpretive schemes like media stereotypes of nationality where inadequate for understanding them. The second one involved using transforming motives to transform nongroup motives like patriotism into group motives like motives which appeal to sentiments, or emotionally informed judgments. I showed how lab members placed limits on the nation discursive resource by describing experiences potentially understandable in terms of national pride, civic pride, or patriotism with a different cluster of terms – those of sentiments. And finally, I finished the chapter by showing how lab members used atrocity stories to complain about other people viewed as members of a nation or state, to call attention to how they vary from these members of nations or states, to cast themselves as hardworking and rigorous as against the lazy and untrained government workers, and thereby effectively placing limits on the nation discursive resource.

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VITA

Matthew J. Cousineau was born on December 11th, 1984 in Hinsdale, Illinois. He attended high school at Naperville Central, graduating in 2003. Then it was off to Northern Illinois University (NIU), where he earned a Bachelor of Arts (BA) degree with University Honors in Sociology and a minor in Urban Studies. At NIU, Matt also earned a Master of Arts (MA) degree in sociology and a Certificate of Graduate Study in Geographic Information Analysis in 2010. While putting the finishing touches on his MA thesis and completing the last courses for the Certificate, he worked as an Adjunct Professor of Sociology at Elgin Community College and worked as a counselor at Linden Oaks psychiatric hospital. Upon completion of his MA and Certificate, Matt enrolled at the University of Missouri to work toward a PhD in sociology.

And in March of 2014, Matt was offered and accepted a tenure track Assistant Professor of Sociology position at Auburn University. By April of 2014, he successfully defended his dissertation research.