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Gender Writ Small: Gender Enactments and Gendered Narratives about lab organization and knowledge transmission in a Bio-medical Engineering Research Setting[1]

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Abstract

This paper presents qualitative data and offers some innovative theoretical approaches to frame the analysis of gender in STEM settings. The essay begins with a theoretical discussion of a discursive approach to gender. The paper argues for the advantages of qualitative research in terms of capturing gender as it is lived "on the ground." In light of these arguments, data using this approach are then presented and discussed. This paper draws from findings based in ethnographic observations in a bio-medical engineering lab where the majority of researchers are women. It also draws heavily from intensive interviews with lab members. Data analysis relies on a mixed methodology involving qualitative approaches and dialogues with findings from other research traditions such as experimental research in social psychology. The lab that was studied contained a range of academic levels from undergraduate to post-docs and was investigated in terms of gender issues for approximately one year. Three themes are highlighted: lab dynamics in relation to issues of critical mass, the division of labor, and knowledge transmission. The data illustrate how gender is inflected through forms of social organization that allot lab tasks as well as the cognitive labor of knowledge transmission and creation. Our results are consistent with the premise that as part of what is entailed in increasing diversity within STEM, researchers must expand our horizons further than the individualistic approach to gender presupposed in the pipeline approach.

Gender Writ Small: Gender Enactments and Gendered Narratives about lab organization and knowledge transmission in a Bio-medical Engineering Research Setting

Introduction

Using social constructionist theory from social psychology and models of analysis borrowed from distributed cognition, this article articulates an alternative framework to the study of gender and science (Hutchins, 1995; Bohan, 1997). We present the theoretical background for this approach to gender and present some results from a study of gender in bio-medical engineering research laboratories. Our framework is based in different assumptions about gender than those that guide what has been called the pipeline approach to gender equity in science. The pipeline approach to gender equity presumed that gender functions as an attribute of individuals; to foster gender fairness and eventual significant participation of women, one "pipes" in sufficient individuals with that attribute - gender in this case (Stepulevage, 2001).

The limitations of the pipeline approach have pushed the question of gender equity to perspectives that target both broader and smaller social contexts, from institutional allocations and policy to more subtle influences at the level of climate. It has been suggested that the pipeline metaphor concentrates too much on the point of entry and exit within a STEM education. There are many points of potential attrition and alternative paths to entry, which has generated the idea of a "leaky pipeline" (Alper, 1993; Xie & Shauman, 2003). Further, the metaphor of pipeline implies an analysis of the gender issues in STEM disciplines that is too individualistic. Despite modifications (to "leaky"), the pipeline metaphor still assumes that the entrance of a certain sort of individual into the pipeline of STEM education could both change science and engineering and precipitate a greater number of such individuals into positions of stature (eventually). Rather than this individualistic approach – where gender is an attribute that

an individual "has" or "is," this research focuses on descriptions and observations of interactions where gender is implied or produced within interactions. The examination of enactments of gender within the daily life of practicing scientists is what the authors mean by gender writ small. We pursue gender enactments in science through ethnographic observations and intensive interviews. Using our data, we explore gender writ small - that is, how gender plays out in the everyday practices of scientists and engineers in research laboratories. Our research and theory thus aim to address climate issues in STEM disciplines.

Understanding "[g]ender [as] the meaning that we have agreed to impute to a particular class of interactions between individuals and environmental contexts" (Bohan, 1997, p. 39) has guided research in discourse analysis, cultural studies, and social constructionist approaches in social psychology and sociology (Butler, 1990; Zimmerman & West, 1987). Gender appears and then disappears, its salience varying due to a number of factors, including the particular situation. Our focus was on <u>small scale</u> enactments of gender and on metaphors and ways of speaking that use gender codes to frame interactions and practices, either directly or indirectly.[2] We did not ascribe gender to a class of persons categorically. For these reasons, as well, we see our focus as looking at gender writ small.

As a result of this shift in our perspective on gender, we opened new theoretical avenues for our research as well as for the collection and analysis of the data. The first part of this paper describes a methodology for and a theoretical explication of gender writ small and justifies the importance of not forgetting the quotidian enactments of life in the sciences. In the second half of the paper, we present themes in our data that are relevant to current findings in gender and science research (Darke, Clewell, and Sevor, 2002). With respect to broader questions in the field, we address critical mass and knowledge transmission. Our study suggested different areas

[2] Since we italicize the exact words of our participants, we use the convention of underlining for emphasis.

in which gender issues may be fruitfully explored. First, participants spoke of gender issues in relationship to the division of labor in the lab, i.e., how the lab is organized and maintained. Second, we found interesting gender coding emerging around the issue of knowledge transmission.

I. Justifications for alternative approaches to the study of gender in Science

A. After the Pipeline

It is almost obligatory to begin any article on gender and science with figures that point out the disparities between the potential pool of future scientists and the actual numbers of women and minorities who ultimately attain levels of significant participation in science and engineering, especially positions of stature in research and academic institutions. Although the statistics show improvement for women and minorities principally at the undergraduate levels, there is a steady drop off as one ascends the scientific career ladder. The situation is worse for minorities (Fox, 1999a; Gibbons, 2002).

Women have improved their numbers in many areas, most notably the life sciences and social sciences, but their rising participation in the physical sciences, engineering, and computer science has stalled in recent years (Rosser, 2002). "Women are still underrepresented in doctoral and first professional degree programs, although they have made substantial gains in the past quarter century" (U.S. Department of Education, 2000, p. 2). These figures remain troubling to those who wish to see the fields of STEM become more hospitable to a diversity of persons, views, and visions (e.g., Rosser, 1990, 2004; Committee on Equal Opportunities in Science and Engineering, 2002). Women do not leave engineering and other fields because of poor academic performance but rather because of other factors related to what is called academic satisfaction.[3]

[3] Although the tracking of minorities in terms of their dropping out of STEM is less extensive and nuanced, studies have indicated that there are issues related to academic preparation, which in turn, are related to systematic

Adelman (1998) suggests that the reasons for women's leaving engineering (at the undergraduate level in this instance) may be related to their (lack of) commitment to science and their ambition (or not) to have a career in science. In other words, there are motivational reasons for the paths chosen by women to leave or not leave certain fields in STEM.

Such observations are important for they justify qualitative approaches to studying climate issues for women in science. The problem is not simply preparing women for their future careers in science through academic training, or even assuming that same-sexed role models strategically placed can do the trick (fixing points where leaks are found). Mentoring is, after all, a process not just the presence of a correctly sexed senior person (Valian, 2004). A prime issue is understanding aspects of science and engineering culture that either sustain the desire of women to continue in science or discourage them. Doubtlessly, we may already know many of these factors, such as chilly climate, isolation, lack of networking, alien scientific cultures (e.g. hacker culture or good ol'boy networks), critical mass, as well as family and work conflicts (Dietz, Anderson, & Katenzenmeyer, 2002; Eisenhart & Finkel, 2001).

Still, although much significant research has been undertaken and some exciting interventions have borne fruit (*e.g.*, Margolis & Fischer, 2002), there are a number of factors that are still black-boxed in existing research, factors which are difficult to disentangle in their various effects. There is a need for more granularity in the research so as to more carefully pinpoint how such factors intervene in the lives of women scientists (Ferreira, 2002; Conefrey, 2000). "The subtle barriers don't go away easily," as a woman faculty member remarked on her experiences in science (Rosser & Lane, 2002a, p**.** 340). The reasons that significant participation continues to be confined to a narrow segment of the American population in certain disciplines

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inequality in school systems, etc. But feelings of isolation and issues of academic satisfaction are also relevant. Much more probing into reasons for the loss of minority students as the progress through college and graduate education needs to be undertaken. (Clewell and Campbell, 2002; Wickware, 2000).

of STEM, while other disciplines and inter-disciplines attract more diverse populations require continued examination.

B. Taking Gender out of its Black Box: Creating new opportunities for interventions

To creatively investigate climate issues requires innovative qualitative and quantitative methodologies. One new pathway for analyzing climate issues is to treat gender as part of a climate rather than as an innate property of an individual. We refer to this process as taking gender out of its "black box." We don't assume that women will always be talking as women or that we are sure we know what it means to be a woman or man to a given individual. Calls to study gender in less reified ways have made by other scholars in the field.

> [T]here is a tendency for gender, too, to become similarly boxed in or opaque. In particular, gender is often treated as a given category and one that maps neatly onto the sex of the particular individual or group being considered. Thus there is no conceptual space within which the construction of gender as an active process (for example through science and technology curricula and practices) can be explored (Henwood & Miller, 2001, p. 238).

We see our work as contributing to understanding the conceptual space where gender is actively constructed within science and engineering. As Henwood and Miller suggest, approaching gender as an interactional, intermittent, and active process of self-construction or as a reactive process to others' assessments allows us to deconstruct unproductive static re-enactments of gender schemes and thus develop strategies for empowering women. It also allows us to see differences between women in terms of each woman's effort to construct an identity. Our approach would presume such differences.

To further develop interventions that are meaningful and empowering for participants, we need to understand how gender plays out in the context of its often inconsistent articulation rather than import preconceived ideas of gender. In this case, we can exploit such inconsistencies to open up more possibilities in terms of gender enactments (Tripp, 2000). If we do see patterns and contradictions that both define and trouble the relationship of gender to science practice, these may in fact indicate ways of bringing up gender questions within science that are relevant and compelling to women in science. It is important to research gender in the idiom through which it is expressed, which may not be the same as the lexicon of the researcher. In a study of women scientists awarded grants through the National Science Foundation's *Professional Opportunities for Women an Research and Education* (POWRE), Rosser & Lane (2002) noted that a number of women did not seem to understand a query about laboratory climates and gender.

In her most recent book, *The Science Glass Ceiling,* Rosser (2004) notes that, for certain women, there is no or little recognition of any gender issues in lab environments. Such responses from the POWRE awardees "[r]eflect the notion that gender affects neither who becomes a scientist nor the kind of science produced " (Rosser, 2004, p. 52). Rosser categorizes these responses as Stage One where the "absence of women is not noted." We, too, found that some of our participants were unaware of the impact of accumulated disadvantage on their careers, of the effects of gender schemes, and so forth (Kerr, 2001). This would fall into Rosser's Stage One. However, we also found that further probing sometimes uncovered an implicit grid of gender representations even for participants who at first did not have much to say about gender relations in the laboratory. A more granular and grounded approach to gender opens up new ways of thinking about how gender identities and gendered practices participate in

changing or maintaining a given organizational climate or sub-culture- - an important focus in current perspectives on issues in the study of gender and science and engineering (Dietz, Anderson, & Katenzenmeyer, 2002; Paiva, 2000).

C. Setting, sample, and methodology

Although participants spoke of many different laboratory experiences while talking about their current lab, our primary focus was limited to one lab. In addition, we consulted data collected from other laboratory settings that are part of our larger research project on cognition and learning (Nersessian, Kurz-Milcke, Newstetter, & Davies, 2003). We studied an university research lab that was composed predominantly of women. There were two women post-docs, four Ph.D. students, three of whom were women, and one female M.S. student. The lab also included six undergraduate researchers, (two international students), three men, and three women. Among the women in the lab, three were persons of color. The lab manager was an African-American male and the principal investigator was a well-known white male researcher. The percentage of women in this lab (60 percent) exceeded the high percentages of women in biomedical engineering overall. More generally, the percentage of women in biomedical engineering is 39 percent at the undergraduate level and 32 percent of doctorates in 2000 (Whitaker Foundation, 2001). Lab retention was excellent, which participants attributed to careful screening of candidates, a process in which lab members participated.

The research was conducted over a ten-month period, involving ten intensive interviews with lab members, interview data from a concurrent research project on cognition and learning mentioned earlier, and observations in the lab and at lab meetings. We pursued questions related to particular themes: how one handles failure, how one "becomes" part of the lab; how it feels to be in a lab with so many women; and what participants like about the field of bio-medical

engineering. In analyzing these instances, we systematize our findings by developing codes based in grounded theory methods (Strauss & Corbin 1997).

Grounded theory methods provide an alternative to traditional theory-driven research design and are best characterized as "sense making" rather than "hypothesis testing," i.e., designed to build theory rather than eliminate options. Replicability is lower than that associated with traditional quantitative methods, but consistency is a principal concern. Generalizability of the derived theoretical interpretation is assumed to increase with analysis of data from multiple sites. Our approach to coding has been inductive, enabling core coding categories to develop from the data and remain grounded in it, yet be guided broadly by the initial research questions.

We used other forms of linguistic analysis, watching for words that seemed to serve as "switch-points" that both carried gender connotations and were significant descriptors of important events in the lab. We were especially careful to query our participants about representations of events that seemed to be taken for granted and often asked our participants to unpack the meanings of their responses. Using methods based in psychoanalysis, we also watched out for slips of the tongue, the participants' humorous comments, and odd grammatical phrasing. We tracked places where inconsistent characterizations arose. Inconsistency regarding gendered characterizations of oneself or others may mark an impasse in how one integrates one's gender identity with being a scientist or indicate a transition in identity.

For example, a participant who was very attractive responded to a query about whether her appearance caused her any problems in her profession by saying no, because, "*[t]he way they meet me, they are in ways where my qualifications are out front"* (meaning they had seen her publications or vita before meeting her). This participant has not found that her looks or style to have impeded her career although she has been on the job market for a faculty position

for longer than she has wanted. Her odd phrasing (which is out front, her looks or her research) alerted the interviewer to carefully attend to other instances when feminine looks versus one's self-presentation as a scientist might conflict in the stories and interactions of this person.

Any interpretation we, as researchers, propose is tentative and is cross-checked with other readers and with the overall narrative of the participant. At times, we double-checked with a participant, depending on our rapport. The influence of psychoanalysis and the interviewer's training in this field meant a certain awareness of impasses and conflicts in participant's responses. Often the effects of gender are not consciously reflected upon. Instead gender is lived implicitly or reported through a select use of metaphors that are employed to describe laboratory relations. Gender can emerge contingently within science, becoming associated with particular scientific practices (informal networks, a way of talking, or attention to detail, seeing one's work as "babysitting the cells"). These rhetorical invocations of gender may help women make science better match with other aspects of their identity (say gender in the family) or they may indicate obstacles to one's integration within a specific scientific discipline and to one's identification as a future scientist.

We understand that our approach of in-depth study through intensive interview and ethnographic observation misses some important features that can be ascertained through meta-analysis, experimental studies, and broader analysis of aggregate data. However, to understand the more subtle barriers that can affect women requires a more fine-grained approach that can pick up the nuances and attempt to understand the role that they play. We see our work as a complement to larger scale research. In this study, we are working in parallel with some of the directions pointed out by Dietz *et al*. (2002) who have called for more theory-grounded research and suggest that ethnographic research be engaged to frame and accompany broader, more

quantitative or outcome oriented research, where the former provides "a rich and sophisticated analysis that can capture change in an organizational climate" (Dietz *et al*. 2002, p. 404; see also Conefrey, 1997).

Approaching gender at this level of granularity does not mean that we can speak only of singular cases or that we are left only with what our participants say. Such research can be informed by attention to social psychological variables that affect gender, achievement, and motivation. Research on gender schemes and interpersonal perception suggests that judgments placed on women related to their gender often operate non-consciously; women activate gender schemes to the detriment of women as often as men (Valian, 1998). Further, questions in our study were derived in part from research done in science and gender where a number of findings seem to be well-founded and good platforms from which to examine and integrate particular data (Clewell and Campbell, 2002).

In summary, we employed a mixed methodology that draws from a number of traditions including ethnographic observations, grounded-theory methodologies, and psychoanalytic strategies. We analyzed our findings within the context of other findings that are based in other research traditions, such as experimental social psychology and survey research.

II. Theoretical perspectives in looking at gender writ small

There are two important aspects to our particular approach to gender enactments. Both derive from theoretical frameworks developed in the sociology/psychology of gender (Connell 2002; Gergen 2001; Whitehead and Barratt, 2001). First we treat gender as an on-going form of identity formation, as a matter of self-construction. On our view, one's gender identity proceeds along side one's identity formation as a scientist. Secondly, we do not rely solely on sociological notions of gender or assume that there is only one dimension to gender (e.g. power). These two

aspects are interrelated. As a person creates and assumes her identity as a scientist, she must negotiate gender representations and norms that govern what it means to be a scientist. These norms are inflected through local culture and the subculture of labs, departments, and classrooms. Identity formation, as a scientist or in terms of gender, is a continual process that entails both personal transitions in interactions with others and with broader (sociological or disciplinary) norms (Canary & Emmers-Sommer, 1997).

A. Gender as Self-Construction

Our research has made some progress at seeing how gender is not necessarily a property of an individual that he or she carries around constantly, but a factor that emerges inconsistently, not always consciously, within the context of certain types of interactions, and within and across participant narratives. Gender emerges as a way to code one's reactions to events and as a component of self-construction where participants draw on gendered meanings to make sense of or become involved in laboratory practices.

We assume that each individual negotiates what it means to him or her to be a woman or a man and a scientist. In our data, gender sometimes emerged as salient in terms of references to practices in the lab (girls/women are more organized, girls talk, relate a lot). At other times, we inferred gender effects by following what words or ideas were strung together by the participant. Regarding the latter type of analysis, one participant tied *not being straight* in the way she pursued her studies (*straight biologists, straight out of school*) and being *in-between* with her racial identity though lacing together the same set of metaphors to symbolize her experiences academically and socially. Although our awareness of certain patterns reflects categories that are found in other research, we are being very careful not to assume that everything women or men say represents their gender and thus either confirms gender difference or gender sameness.

However, we do assume that science may be tilted to masculine ways of effecting an integration of a person's various identities, without erasing the particularity of each person's effort to ground his or her subjective identity as a scientist.

B. Gender is Both Social and Personal

Our second theoretical tenet refers to a gap between the stories of the experiences of women scientists (anecdotes of exclusion, disenchantment or overt discrimination) and the necessarily more sociological categories (*e.g.* race, gender, ethnicity) that organize analysis of aggregate data. Two participants queried our research group (we paraphrase): *How do you tell the difference between gender and personality?* Their lived experience of themselves and others was felt as a matter of personality differences rather than gender differences. Our research tries to bridge the more sociologically inflected research in gender with the narratives of female and male scientists. While we treat the narratives as a reflection of the personal journeys of participants, we also understand them as drawing on representations and understandings that are culturally organized (Scott, 1996**;** Connell, 2002). We listen carefully for those moments when the social category of gender (or gendered meanings) emerges to negotiate a personal difficulty, is aligned with issues of motivation, or participates in some significant way in the lab culture.

III: The Study

The research we discuss here is based on a successful laboratory in a Biomedical Engineering Department at a major research university. The lab members have backgrounds either in engineering or bio-medical engineering. At present, the sole "pure" biologist in the group is the lab manager who has a Masters degree in biology. The lab includes undergraduate, Masters, and doctoral students, and post-docs. As we detailed earlier, the majority of scientists in this lab are women, a fact that the P.I. is often asked about. He takes, "[o]*nly the best*."

Although understudied in terms of their social organization, labs have often been noted by scientists as essential to their formation as scientists or their disillusion with science (Conefrey, 1997; Rosser, 1999; Ferreira, 2002; Seymour, Hunter, Laursen, & Deantoni. 2004). Equally important, labs differ from other settings in STEM in ways that are significant for gender. They are more hands-on, and can include cooperative learning, dimensions that may well be important in increasing diversity in science (Clewell &Campbell, 2002). There are often more mixed lines of authority among lab members. The ways in which peers, different educational levels, and levels of lab experience intermix to create learning provide an interesting and unique environment for transmitting knowledge. The organizational culture is significantly different from a classroom organization or even instructional lab sections of science courses, where the one who knows is often more clearly demarcated. Further, students usually do not have to negotiate the use of desks or notebooks with other students, and instructional labs try to avoid surprise problems and long periods of frustration and failure.

This last point is particularly salient in our research. Most of the labs we have studied are sufficiently cutting edge that members encounter numerous kinds of failure almost daily. Yet overall they succeed in making progress including getting degrees. There are some set procedures but in many cases, members invent procedures and construct research artifacts as they go along. Experimental technologies and knowledge are in a constant state of evolution. Given all this, it is understandable that "*[i]t's ninety percent failure*," as one participant told us. With failure and long periods of "intellectual purgatory" the question of motivation becomes even more significant. The lab from which we have gathered our current data on gender has an excellent record of sustaining minorities and women at all educational levels.

IV. Findings

A. Summary

From our data, we have identified three major themes. First, our data suggest that critical mass does not only lower gender salience or provide opportunities for mentoring. The effects of critical mass can be quite complex. Critical mass can provide the context wherein gender identities are changed in ways that allow people to reframe relationships with other lab members. Second, gender is transported into the labs and sustained through division of labor. Third, varied forms of knowledge-making and transmission intersect with gendered meanings. We develop the theme of knowledge transmission to consider how one positions oneself *vis a vis* knowledge creation. We look at modalities of "attending" in knowledge transmission and styles of communication as a way to position oneself toward knowledge-- what do you attend to in knowledge transmission and creation? This third finding is the most complex of the three.

B. Critical Mass and the Realignment of Gender Identity

Within the context of our study, the question of critical mass directly emerged through queries that explore what it means to work in a lab where there are so many women. One participant, a woman, discusses critical mass specifically, after hearing a talk by the researchers on women in science. A1, a doctoral level student, begins by saying:

> *Yeah with the gender in science and engineering thing. I really liked the idea of critical mass …. the idea of a critical mass of women (voice inflects up). You mentioned that and I think that that is totally true.*

The participant then begins to discuss the issue that critical mass helped her negotiate in the lab. As the reader will see, the allocation of lab tasks is a gender hot spot for her, and a topic to which we will return in the next section.

I feel like a lot of men that I know that are married or have sisters or interact with women a lot accept the fact that or like the fact that they just kinda do their thing but the women tend to re-arrange things around them and they schedule this that, do you know what I mean …. So I think that because they are, maybe used to that, or like that, it's like a complement of the two sexes, the way I see it, that spills into the scientific lab, or something like that….For example, I think that [D4] (one of the males in the lab other than the PI) does really really well in our lab of lots of women because he's married, he has two sisters and it works for him and I know … [his wife], super well. They're a great couple but they but the way that their relationship works is very much like, you know, he does stuff and (his wife) is the planner and the arranger.. and that kind of thing and so in our lab, the women in our lab are very similar to, like, his wife in the sense of arranging and of reminding him to do stuff … do you see what I mean does that make sense?? …. The male/female relationship stuff I think it kind of spills over outside of the personal arena and into the professional arena. Just the relationship between the two genders in general. I'm kinda fumbling, it's just kinda an idea.

In A1's narrative, gender is brought in through the medium of lab labor, and housework, and marital status. A certain style of attending to others is marked as feminine and that mode of attending to others appears in a particular domain of application, lab tasks. It is at this intersection of gendered meanings that critical mass, the fact of the presence of other women, becomes important (as an aside not all lab members see what A1 sees as gendered). In A1's account, earlier gender identifications that *spill* in from the outside are transformed through identifications and norms that can be created because of a critical mass.

> *Right, so, maybe say it's disorganized, it's, you know, it's kind of a mess and… but maybe this woman comes in and she's a big organizer. Well, it's hard for her, as "the one person"… to change the current system…. When there's nine other people …who aren't like that. But, if there's ten women … um, ten people in the lab and three of them are women… then they will band… like, and they approach things similarly … they will band together and um, decide how to approach the rest of the group and they'll do it, like, as a team. Right?... Do you see what I mean? …. So that's what I'm saying… It's just… and so… and then it's not all on one person, it's not one person trying to change the lab. It's more of a… I'm not really sure, I'm kind of fumbling this a little bit, but, uh, does that make.....*

A1 who admits she may be fumbling a bit (her metaphors are often tactile) still indicates that critical mass allowed a perspective on lab organization to be sanctioned as more than the preferences of *one* person. A1's reflections on critical mass emerge out of an instance where a certain number of women work as a *team* to change lab norms. The change allowed her to negotiate a gender impasse in that she had imagined a particular (and more generally) male and female relationship as being complementary, like a couple. As an effect of critical mass, norm changes in the lab were re-inscribed so as not to be so *personal or like a couple.*

At one point in this lab, where women hold a clear majority, a male who had an especially critical and physical lab job, was upbraided for failing to supply enough CO_2 cylinders to supply the incubator. The lab members settled the issue by developing new norms, a log to track the installation, use, and replacement of CO_2 cylinders. The following passages track the change from the side of the male researcher whose behavior came under the orbit of these new

norms. Like A1, gender identity is realigned for the male researcher. However for the male researcher, both gender and the personal dimension become more salient.

> *Like I took offense at the phrase we need a new system because this isn't working , let's say the CO_2 tanks, the system was me. So I took offense at that. It was working fine. These other extraneous things like people leaving doors open or whatever are the stimulants that cause the system to fail but the system was also not transparent, right? (D4)*

The push to communicate differently is addressed more fully in the section on knowledge transmission. But one should note that just as A1 clearly was aware that it was other women who helped change norms, D4 eventually expresses a keen awareness that women are foisting the norm changes on the lab. At one point, he speaks of the need to "placate" the others who are ultimately gendered as possessing a feminine (the detail thing) urge.

> *Cause I have been doing this job for three years … its only been the last couple months that something happened and somehow that removes me from authority as somebody that would know, you know, that kind of thing and so it was all and I decided I am going to keep a log sheet. I didn't think I needed to but I'll do this now* [develop a log] *so that everybody can look and see and something that placates the detail urge (KM: Is this a gender thing.) Oh I don't know if it's a gender thing. I think it has more to do with the detail thing, which may be a gender thing.*

For the *team* of whom A1 spoke, the new norms are not personal; the team gets her out of a gender identity impasse. For the male, a new norm is very personal ("*I am the system"*) and through the allusion to the detail, his response is gendered as a reaction to particular others, "*something that placates the detail urge."* The women see norm changes as fixing a problem.

D4 refers to the same process (more than once in his narrative) as *placating* the other(s) where the gendered difference appears in an attention to details that he calls an urge. The gender enactment over lab procedure is writ small, but it contains some of the most difficult elements in the gender mix: power, knowledge, and even a hint of sexuality Referring to what kind of man could work in a lab with so many women, a male participant (G7) remarks (English is his second language), "*I think you have to be a little bit of easy going first and , um, how do you say that, I don't think it takes a dominant guy to work in the lab like that."*

C. Gender and the Division of Labor: "The male/female relationship stuff I think it kind of spills over"

As the passages cited from A1 indicate, some people can code the allocation of lab responsibilities in gendered terms. Many labs have hierarchical distributions of tasks depending on academic status. The labs we have studied are less hierarchical in organization, which may bring out certain taken for granted gender codes in the distribution of lab labor or differently gendered modalities of approaching lab work. The narratives of D4, A1, C3, F6, and E5 suggest that lab labor may carry implicit gender meanings for participants.

Lab tasks are a social component of lab life, not related immediately to a constituent value of science; they represent the buzz of activities that surround science and allow the *real* work to happen. But in fact, such duties and the social organizations and fantasies about gender they may evoke are not irrelevant to one's becoming part of the lab or one's relationship to doing science or engineering. Take, for example, the seemingly mundane task of ordering materials for one's experiments. C3, a woman who is a post-doc, discusses ordering lab materials along very explicitly gendered lines.

For example, I would order some sub reagent, and it would come in and no one would tell me it was in. I didn't know when it was in until I just discovered it on my own or when asking for it or when I went, " I wonder if that's in?" and went and looked. And in the women lab….We have communication in the women lab (laughs). So, in the women lab (laughs)…. When something comes in and you go, "Oh, who ordered this?" and they don't know… or if they know who ordered it, then they come tell you. And if they don't know who ordered it, then they like, write a little note, so that the whole lab knows, right… So, we have this board…. So, everyone knows when it comes in and that way you know when your stuff comes in. I mean, I literally worked in a lab [before] that was so small that whoever handled the ordering, and it was one person, knew exactly who ordered it and knew when it came in, but did they tell me? No. Didn't tell me. (KM:: Was it hostility? ....) This was the style. This was just the style. No, no. There's no hostility. It was the style. (laughs) and I can tell you… I can tell you another story. (KM: This resonates with me ... It drives me nuts) C3 whispers: Oh they drive me nuts.

The interviewer says "it" [drives me nuts]. The participant picks up on this priming but says "*they" [drive me nuts*] clearly making it a matter of men. <u>The point is not whether this is true of men or not but that it has been gendered as such in a narrative.</u>.

C3 speaks about the *style.* What we have seen is that a heavily gendered domain, the (domestic) division of labor *spills* into the lab through the organization of lab labor, arranging and scheduling, and so forth. This domain is further coded as gendered with respect to styles of communication. When C3 describes in what she calls the *woman lab* where "[*w*]*hen something comes in and you go, "Oh, who ordered this?" and they don't know… or if they know who ordered it, then they come tell you. And if they don't know who ordered it, then they like, write a*

little note, so that the whole lab knows, right." In the passage from C3, the word know appears four times. Knowledge transmission is implied. In this example (about ordering materials) attentiveness to others indicates a particular attitude towards knowledge transmission (Traweek, 1988). The issue of gender is not simply about the division of labor or organization of lab tasks; beyond lab tasks, gender is implicated in how one participates in a system of knowledge transmission. Through this second aspect of gendered communication and *style* of attentiveness we can examine one's relationship to knowledge and thus how it is transmitted.

D. Attitudes toward Knowledge Transmission and Creation

The final thematic finding was inferred from narratives that discuss issues of knowledge transmission and creation. The section moves from a comparison of styles of communication to data that suggest differences (some of which can be gendered) in how one understands the pursuit of knowledge or is drawn to it. This section shifts the focus to how a given researcher positions himself or herself in knowledge transmission and creation. We ascertain differences in mentoring, in how one manages what is personal versus what constitutes the impersonal nature of science, how one is positioned toward knowledge production (is it knowledge transmission or creation), and the locus of one's attention in one's engagement with knowledge.

Biomedical engineering involves detailed work, a small slip can spoil weeks of arduous preparation. A good number of participants noted that women had a different relationship to details, at least in this lab (words, like *attention to detail, meticulous, more organized, etc)*. But attentiveness is also implied in this gender attribution, a certain type of awareness of and way of attending to things and to others. C3 called it a *style*. E5, a post doc in the lab and who prefers male dominated labs, notes this about a lab where she used to work:

> *I was the only female grad student and what I really liked about that environment was that … we actually had a very small space, we all actually sat next to each other and literally this close and that fosters a lot of communication when we were talking about ideas…. [The men] would not necessarily help you but they would tell you that you are doing it wrong (laughter) and then you know at least that gives you the knowledge to work on and they were not mean people, I mean you could ask them for help. They kind of gave you the one word answers, is this right, no…you're not going to expand on that? No actually you work it out…that was an environment where it was mostly men and, although it was not personally that friendly a lab, it was very productive.*

This is an interesting narrative for although the participant speaks of *a lot of communication,* her examples might suggest that communication (knowledge transmission) was rather begrudgingly granted. Her story illustrates how a communicative style that C3 just described in the quotidian domain of lab labor may also be the norm in other domains, related to knowledge transmission. But knowledge transmission is not just a matter of how one communicates to others but also how one positions oneself in relationship to making knowledge. How one relates to knowledge crosses the border between social scaffolding of the lab and the actual production of knowledge within science.

For E5, the basis of knowledge and what she loves are data. Data are *fixed,* objective, and timeless. One's pursuits are guaranteed by this reliable system of knowledge.

> [T]*he data itself is fixed. It's as valid 100 years from now as it is now. It's just your interpretation of it that changes as a function of time so i guess that's what I like. I like the objectiveness of it. The timelessness of it.*

In contrast to this vision of knowledge where one's reference point is fixed and objective, there is another positioning in relationship to knowledge where the production of knowledge is not all that clear and self-transparent. Analogously, the knowledge system itself is treated as if it were less closed and complete. B2, a woman, .referring to her bio-medical classes that were problem based learning tells the interviewer:

> *Normally, if a professor teaches you, you just kind of stick to what he teaches you. <u>You don't go out and find extra, you don't have a passion for it....</u> (Emphasis added)*

B2's *extra* is something that is outside the knowledge system delineated by the profession. In bio-medical engineering, there is something attractive about not knowing, a fact true for all scientists, but perhaps one that may be inflected through gender identities in different ways. *Why* are women attracted to new fields? Why are women, as an aggregate, better at open-ended questions?

Discussed above in the abstract, different positions towards knowledge and thus within knowledge transmission are lived out in the concrete activities of the laboratory such as mentoring and styles of collaboration, where they intersect with representations of gender. A skeptical view of having less structured relationship to knowledge and transmission comes from the woman researcher, E5 (see above) who genders this variability in the knowledge base. She notes that this lab has not standardized procedures sufficiently. She talks about informality and friendliness, which she codes as feminine. She then ends these remarks on the problem of not establishing more formalized procedures by using the example of cell culturing, *"A perfect example is that none of us make constructs the same way which is kinda the bread and butter of this lab."*

D4, a male researcher, talks about the *girls* as having a particular approach to knowledge production. It starts at the level of protocols[4]. Although D4 sees himself as much more alike than different from the *girls*, he does note a different relationship to procedure: Women are more careful with details- a very strong and repetitive theme in D4's interview. And details carry a number of gendered meanings for him.

> *D4: Uh, you know, I know myself, I pay attention to my experiments and I have very organized experiments, but as far as a detail kinda person, I'm not, you know, um, I mean, I guess I, I don't know how to explain it as well, but uh, if, if there's a protocol that works…. I won't start again from scratch, to end up with the same conclusion, just so that I know, right.....If it works, um, I'll use it, and go with it ..... And it's okay, you know, when it doesn't work, then I do stuff .... [I] [d]on't care if it's optimal*

The signifier "details" is gendered in D4's narratives as being more specific to women. As D4 explains how he is not a detail person and then goes on to clarify what he means, he discusses following protocols without being *optimal.* The system works and one executes knowledge. In the next passage, D4 sets out the contrast class and he genders this activity by his casual references to the girls:

> *D4: But these girls are all still trying to figure out what it is they're going to do, figuring out, you know, how they're going to measure a certain thing, whereas I've kind of, I established my methods this is what I'm gonna look for, this is what I'm gonna do*

D4 may not feel all this endless *figuring out* is a good way to do knowledge production or the *girls* may not include him (an interpretation suggested by another participant). Whatever the reason, D4 gendered this difference.

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[4] Both men and women in the laboratory referred to the women as the *girls*.

Gender also appeared in reflections on the relationship of the personal and impersonal in science. E5, who wanted more standardization in the protocols, refers to (some) women's style of lab organization. She tells us that in one lab where she had worked previously, the women staff developed informal networks of exchanging items (*e.g.* snacks) to establish relationships that would expedite genetic assay reports. She disparages this way of organization in knowledge transmission; she wants her science to be enough (to get her reports). This latter position is gendered as both more masculine by this participant and more properly scientific. Certainly, the operation of informal networks is important in networking and in getting in the knowledge loop. But, for anyone, there are distinctions between what is scientific in knowledge transmission and what is illegitimate non-science.

In parallel reflections, A1 also speaks about standards of science in her interviews. A1 notes with respect to lab meetings that there is an objective style to knowledge transmission in lab presentations:

> *There is actually something interesting in when it comes to science. It's a skill that scientists have to learn and ah some people do better with it than others and that's talking about the science, talking about the experiments, but its not talking about the person-does that make sense?? . ... So if I am talking about and it can drift into a more personal criticism but usually its not especially in a lab meeting context –only in a superheated conference discussion you have with foes of opposing, you know, whatever... it can drift into personal attacks. [B]ut what we are talking about is the science and the experiments. We're ... talking about, you know, do you think the experiments are designed well, not do you think I am good at designing experiments.*

Like E5, A1 makes distinctions between what is science and what is not, although in "*superheated conference discussion*" such boundaries might not be respected. How much does this personal component come into science? What A1 has clearly identified is a style of communication that is related to knowledge transmission, but does it bear any relationship to gender?

Differences in knowledge transmission, which are partially gendered and definitely not always recognized as an official way to "do" science, appear in the following description of the women's relationship to knowledge. At first, C3 described her desire as the need for what the literature would call "psycho-social support," compassion and responsiveness to issues ulterior to science. In fact, she characterizes the males' lab talk in this way:

> *We would have conversations and they would always be about science or maybe things I just didn't relate to …*

The interviewer was quite surprised when C3 conveyed what was so nice about what happened when another woman joined the lab:

> *That's right. I was lonely…. I just kind of felt like… and then we did, at one point, another woman entered the lab ….. And it was great. She entered the lab, and we like bonded and we saw… And the thing is we could talk about research. We talked about research a lot.*

In trying to explore this difference between *"science"* (the men) and *"research"* (the women), C3 and the interviewer began to flesh out these possibilities:

> *C3: Whatever it was, it was so conscious though, a lot of it was. I just knew that I was a little bit bored, and they were… And I like to talk science, but I got bored easily.(KM Is it that the focus is too narrow?) The focus is very narrow*

After a bit more probing, C3 continues,

C3: (long pause) Yeah. Let me see if I can figure out what the differences were. (long pause). I need to write a list of the qualities… when I talked to the women in the lab… I think it's just… maybe it's the dynamics? It might even be rhythm? It might be something that's just more comfortable. Do you know what I mean? Rhythm and like where you pause and… and they pick up and … how easily they understand you or not understand you.

A comparison of what a "woman" likes about mentoring and a "man" likes about mentoring furthers our understanding of this distinction between personal and impersonal in its relation to gender and science.[5] A1 says,

A1 You are very physically close together and you're, there's, um, this vulnerability about the new person, because they're like, "This is totally new to me", you know, "I have no idea what I am supposed to do here and I need you to teach me", but there's not that power set up of like someone who knows what they're doing and someone who doesn't know what they're doing? …. [Y]ou can comfort the person by being like, " Oh yeah, I did that and listen to this crazy story where I did this". And then, so, then it's like, "Hey, we both went through this kind of vulnerable stage where we didn't know what was going on, and you're able to relate through that, through those experiences, right? So, now you've got, physically next to each other, relating about how you both, how this person is learning it, but I had to learn it too… You are building that relationship…., and after you've spent that much time with that person, you know, focusing on holding the flask like

[5] We are using scare quotes because the intent of our research is not to presume that a man speaking is speaking for a certain set of gendered meanings, necessarily. There are contexts where gender emerges in science, where in those contexts, one is cross-gendered identified or where gender is not salient.

this and you've kind of built, I'm not sure, what it is, but you've built something there, to where that person trusts you?

Another view of mentoring, a value to which D4 (a man) is deeply committed, is given below.

(KM: What do you like about mentoring?) Cause you get to see somebody learn .. that witnessing [of] learning is kinda neat experience and getting somebody to the point where they start out knowing nothing and they get to the point where they know more than you on a particular thing is a great thing, you know, that would be the ideal as opposed to somebody that doesn't know as much and still doesn't even in this particular area , that would be an awful thing but that relationship will foster, you know, its like making another friend (KM: Ah ha, it's like building a relationship?) Yeah, I think there are lots of sides to it, that are really appealing and teaching . I like teaching ah, because, not only for me, being able to communicate material just solidifies my understanding of it but also that learning thing again, its neat to grade tests and see the people who didn't know any of the stuff when they started , understand it.

In comparing the views on mentoring, different ways to position oneself in relationship to knowledge transmission are implied. The more "objective" relationship to knowledge transmission or rather the enjoyment of a particular relationship to knowledge (*they get to the point where they know more than you on a particular thing is a great thing*) may reveal a symbolic constellation where gender subtly shows itself within the functioning of science. In D4's scenario; one compares or competes in a friendly way against a standard of knowledge. By contrast, A1 notes "*there's not that power set up of like someone who knows what they're doing and someone who doesn't know what they're doing?* (A1's downplay of differentials in knowledge). Although she clearly wants to keep science from becoming too personal, A1

identifies with the one who does not know and discusses a *personal* relationship of trust. C3 talks about discussing research in a way that, as a woman, is *more comfortable*. The ways that the personal versus impersonal enters into science and intersects with gender are myriad.

In the following, E5 contrasts traditional scientific values with how women sometimes operate within labs and she talks about women being more personal. In discussing women's taking science more personally, E5 notes that women are competitive in certain ways (dress is the example that participants most frequently gave us) and have to curb a tendency to personalize science. The personal component makes women competitive. E5's gender attribution contrasts with other research (Sonnert and Holton, 1995; Fox, 1999b). E5's topic is competing for an award, a promotion or some other honor.

> *I've seen with women that sometimes its personal right so and one women gets it and other doesn't, they ask, why did she get it? When really that's not the question, you control only what you do and did to get the job, what the other person did was really irrelevant.. ah, and maybe that's the difference, women are always comparing themselves among each other and men are always looking at the absolute values of what they are.*

When E5 gender codes absolute value, it is assumed that what determines the absolute value is something that is true and non-relative. It is in terms of science that E5 assumes one can prove his or her absolute value by staying within the system of science. C5, the other woman post-doc, discusses being personal from a much different perspective. Here the men's non-personal approach is not valued but found to be an obstacle to a good laboratory climate.

> *C3: And so for another example for you [of how men act differently in a lab] , there was a piece of equipment, right, that I was starting to work on, and there was, there was one*

piece of equipment that we were having to negotiate time schedules to share. So, what would happen was, we build a whole new apparatus, right? New everything… All of the pieces that go together. So, we built this whole new one. So, now we have two copies of the same thing, So, one was for me to work on…. So, I started working on it. So, I started experiments. I go in one day, it's all taken apart. (laughs) I'm like, "What happened?! Why is it all apart?!" …. And I asked and they go, "Oh well, we needed this little thing here and so we like, took it." And I'm like, " OH! But that's mine to work on!" [KM: Was it about your being a woman?] No, no, no. I don't think it was about me being a woman. I think it was about…this is how they are. Like, I think if they had done that to another man, like for example, if I did that to D4 's stuff, D4 wouldn't go, "Who's the male in our girl lab?" … He would go, " Hm." Like this, because he does it to us all the time. And, and he does it because he doesn't even think. And he goes… he would just not care. He would go, "Oh you did? Oh, okay, huh." Like he would just that and if I did that to another female in our lab? I mean, I never would. It's just overstepping boundaries, right? I would… I would email them and I would say, "I'm so sorry there was nothing else I could have done" or I would have, of course, at first, try to go to them … and say like, "I really need to do this, you know can we work this out?" Because it's a boundary thing, right? If someone is working on that piece of equipment, even though it belongs to the whole lab, right? … Clearly there's one person that's like working on that right now, and so, we would respect that, and then communicate about it.

As C3 has gendered it, the "men" are part of a knowledge/practice system where they are comfortable when they use things that are, within the system, interchangeable. Science is impersonal through and through. C3 says men in her current lab would not be bothered about

this sort of behavior either.[6] For both men and women, the ideal of science as not personal (see A1 above) is still vibrant. Nonetheless, some women*, e.g.* C3, do not seem to fit into this ideal impersonal system quite as easily as other women (E5). Further, this constellation of meanings, from personal to impersonal is gendered by both participants and may have appeared in our data through nuances of the two descriptions of mentoring.

V: Discussion of Findings

A. Gender as Enacted in Lab Activities

Our paper has tried to untangle the processes of enacting gender as it enters into (or not) significant activities in a Bio-Medical Engineering lab. Often participants' comparisons with other labs told us as much as reflections on the current lab. Given that the lab we were studying was majority women, one issue that has interested us is how "critical mass"- the cumulative effect of a certain percentage of women in a science setting (between 15-25% or above) played out in a laboratory setting. From other studies, it appears that critical mass creates an environment where women scientists report greater satisfaction and is a factor in the retention for women, at least among faculty in STEM departments. Critical mass counteracts the so-called "stereotype threat" and reduces the effects of gender schemes being activated non-consciously (Valian, 1998 ; Alper, 1993; Quinn & Spencer, 2001). Critical Mass, however, does not automatically translate into positive effects for women (Etzkowitz, Kemelgor, Neuschatz, Uzzi, & Alonzo 1994; Fox, 2000).

Our qualitative findings on critical mass "on the ground" both support and challenge some of the usual assumptions about its effects within STEM settings. A1's reflections on critical mass parallel what has been said about critical mass elsewhere: the "other" sex status is

[6] There are viable alternate explanations to the dismantling of C3's apparatus. C3 may not experience this (or allow herself to), but there is discouraging evidence that men value women's scientific achievement less than men's comparable achievements (Wenneras & Wold, 1997).

lowered, the same sex identification empowers by transforming the subjective meaning of being a woman. However, insofar as critical mass set the conditions for a new way to integrate gender, it does not necessarily simply reduce gender salience. "Homegrown" gender identities, from the family or romantic contexts, are realigned and changed with the support of critical mass. For both genders, critical mass may transform how one experiences gender rather than simply reducing its significance.

Our data suggest that researchers look more closely at the division of labor in laboratory settings and how that division of labor is appropriated and perceived by either gender. A lab has one foot in the household as the history of science reveals (see Schiebinger, 1999) but engineering labs are heirs to a somewhat different heritage, the less hierarchical but nonetheless boys' environment, a mechanic's shop. This mixed heritage is entered into differently by the two genders. Further, if there is anything in gender research that clearly marks gender as difference, from childhood to adulthood, it is the division of labor in the household (Hotchschild, 1989; Canary & Emmers-Sommers, 1997). If lab labor carries gender connotations for men and women (and it did in this lab) then it is one entry point to make the lab more welcoming for both sexes.

Gender representations also emerged in describing interactions that entail what we have called knowledge transmission and creation. Three of our themes on knowledge transmission may contribute to a better understanding of the relation of gender to one's position toward knowledge. First, a relationship to knowledge is implied within mentoring.. There may be an emphasis on knowledge creation or more on standardized transmission. Second, there are interesting gender issues surrounding the division between what is personal and the impersonal nature that supposedly characterizes science. Third, there may be differences in how we see

knowledge, as fixed or more in flux. While one participant emphasizes timeless data and absolute values, another seems to prefer that there be something extra, and another spoke of a certain (feminine) approach that is less narrow. The more contingent and open position toward knowledge can be further illustrated in an anecdotal report from a woman studying bio-medical engineering. She enjoys the field because there is "the ability, or at least the opportunity, to be very creative. In other avenues of engineering, there's more of a rigidity to it. In biomedical engineering, it's really brand new. There are no cut and dry answers" (Whitaker, 2001).

Our results may shed light on another finding. Scholars researching women scientists in other contexts note that "[w]omen appear to work more intensively before making their work public" (Etzkowitz, Kemelgor, & Uzzi 2000, p. 242). Just as one male lab member did not optimize or figure it all out, a way of working he coded as feminine, intensive preparation could mean a different approach to knowledge as well suggesting issues about women, science and self confidence. Differences in approaches to knowledge may intersect with gender identity and with how one comes to see oneself as a scientist (on problem solving and gender, see Valian, 1998).

One's position in relationship to the knowledge system of a lab may involve different ways of finding an affective tie to knowledge and locating an identity in relationship to science. It is thus a place where "personal/professional" transitions occur. Such transitions are important in career choices of future scientists (Seymour et al., 2004). Styles of communication and thus modes of knowledge transmission implicate both the personal and the professional (Conefrey, 1997). The matter of styles of knowledge –creation and transmission - has intrigued gender and science research and feminist philosophy (Longino, 1990; Fox- Keller, 1986; Haraway, 2001) for decades.

VI. Conclusion

Our intention in this essay has been to establish the potential fruitfulness of the "gender writ small" approach. As such, there has not been an opportunity for an extended discussion of all the implications and complications of our mixed method approach. We present the data as illustrative of the interpretative points we wish to make. However, we want to underscore that such interpretations are based on numerous ethnographic observations and interviews using grounded coding methods (Strauss & Corbin, 1997) and psychoanalytic interpretative strategies (Henriques, Hollway, Urwin, Venn, & Walkerdine, 1984). Our work is aimed at a level of granularity that may allow questions we derive from this research to serve as a basis for broader survey work that may as well yet address new populations. If sufficient generality can be established, this research suggests some compelling points for interventions and research in relationship to: 1) how one handles a movement toward a critical mass (of women or minorities), 2) the social effects of the division of labor in the lab, and 3) the examination of different modalities of knowledge transmission. Each of these points directly addresses factors that can influence workplace climates within STEM disciplines and laboratories and thus speak to how each of us diversely enters into science and engineering.

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