A Good Place to Do Science: An Exploratory Case Study of an Academic Science

Department

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Executive Summary

Purpose
We studied an academic science work environment that has been conducive to the advancement of female and male scientists to identify factors that have facilitated cooperation, high quality science, and inclusion.

Methods
We conducted this study using several qualitative methods including document & archival research, direct observation, and 29 interviews of departmental members (faculty, staff, post-docs, and doctoral students).

Findings
The basis of the cooperative, inclusive productive aspects of this department's culture appears to be a set of values and beliefs about scientists and the goals of science that are reflected in the types of interactions that occur within the department. Most scientists in the Science Department valued doing high quality science and valued doing science in an interactive way. Three widely held beliefs included:

1. Good science is the pursuit of meaningful, significant advancements of knowledge.
2. Scientists achieve good science through interactions that provide and generate resources.
3. Anyone can do high quality science if they can learn quickly, are well trained, can communicate their ideas, are creative and willing to work hard.

Constructive interactions support processes that foster cooperation and produce high quality science and inclusion. We list them here in increasing order of complexity, trust level required, and work impact:
- Collegial Interactions – extending respectful, civil and congenial behaviors towards others
- Tacit Learning Interactions – information sharing and modeling behaviors that convey work norms, processes, practices, and other undocumented knowledge about work.
- Relational Interactions – taking personal interest in others, expressing concern and caring for others emotionally and in support of their work
- Generative Interactions – Interactions, through which important resources are provided, received and or generated between individuals and for the group.

Participative departmental activities initiated or explicitly supported by the chair, facilitated constructive interactions:
- Team teaching with participation across faculty ranks.
- A variety of department social events, some of which occur after hours and others, which are family friendly.

- Participative faculty meetings in which information important to all faculty members is shared and the opportunity for decision-making input is provided.
- Participative faculty recruiting through which all faculty members have input into the selection of new faculty. Broad support for the new faculty member is established through this activity.
- Regular applicable research presentations and seminars that stimulate ideas and provide feedback and modeling of approaches to research and effective presentation of ideas.

Department wide learning and inclusion processes stimulated and supported wide influence in decision-making, engagement, learning about one another, and disseminating, comparing and creating a shared understanding of the external environmental factors surrounding the department. These processes also play an important role in embedding norms, behaviors, values, and beliefs into the culture of the department. These processes included:
- Transparent decision-making
- Engagement of faculty across ranks
- Dissemination of information important to work
- Creation and or sharing of resources important to work
- An open faculty selection process

Cooperative leadership practices of the chairs facilitated the development of the culture of the department. Most of these practices were also evident among faculty.
- Supporting the creation and advancement of good science, regardless of who is developing it.
- Seeking input from all affected in decision-making
- Promoting meaningful opportunities for interaction
- Treating everyone fairly and equitability
- Using the role of chair in service of the scientific community within the department

Conclusions

This study identifies conditions and factors that facilitate the development of a cooperative inclusive and productive work culture. The foundation of such a culture is values and beliefs that support high quality science, inclusive, productive interactions and outcome focused criteria for whom can do science. These values and beliefs foster constructive interactions and participation in a range of department activities. Several of these activities provide the context for constructive interactions. Leadership practices influence the creation of some department level activities and or provide sponsorship of others. The chair may initiate these practices, but support and ongoing leadership can come from the faculty. Leadership practices are also important facilitators of department learning and inclusion processes. With the context provided by activities and behaviors derived from constructive interactions, department learning, and inclusion processes support norms, practices and processes supportive of a cooperative, inclusive, productive department culture. Over time, these processes embed values and beliefs held by a majority of department members as shared values and beliefs of the department, which sustain the overall culture creating process.

A Model of a Cooperative, Inclusive, Productive Academic Culture
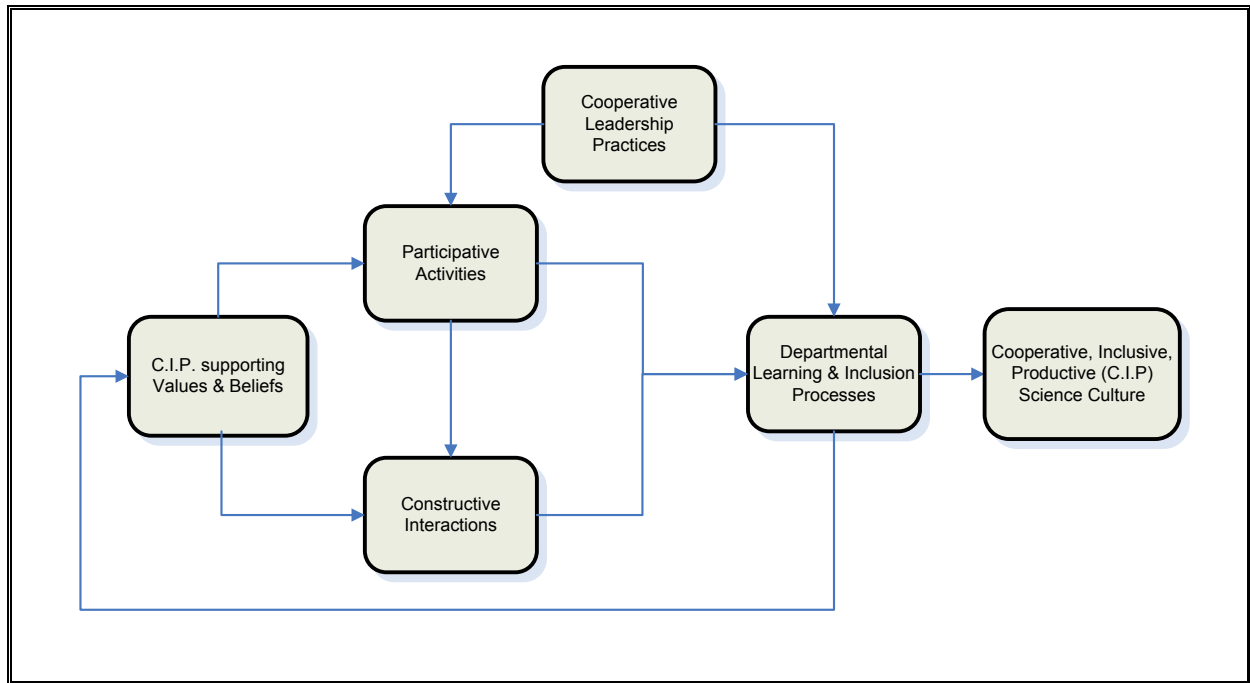
PURPOSE OF THE STUDY

This case study of a science department at a Tier 1 research institution is a component of the NSF ADVANCE program with the objective of institutional transformation that will effect tangible change for women in science and engineering. The proposed case study description from the NSF ACES (Academic Careers in Engineering and Science) grant proposal document is as follows:

"[Conduct] a case study examination of the [Science Department][1] as an example of a department with a history of strong participation and advancement of women faculty. The goal will be to identify the departmental conditions that foster full participation of women at all academic ranks. The Science Department is nationally ranked in the 7th percentile. It has 19 faculty, 5 of whom are women, 2 at the full professor level. The female department chair was recently elected to the National Academy of Sciences. Although the department has no defined policies in this area, it provides an excellent case study site for examining the working environment conducive to the advancement of women faculty and students."

Our research questions were:

- How does a work environment, conducive to the advancement of women at all levels, work?
- How do people interact with each other in such an environment?
- What do people do to create inclusion, productivity, and high quality science?
- What cultural processes and practices operate in this academic science environment?

METHODS

We conducted this study using several qualitative methods after obtaining IRB approval.

Document & Archival Research
We collected basic information about the department such as the department structure, activities, and formal policies and processes from the university's archive, the schools' website, and documents provided to me by department members. We also obtained published copies of faculty members' bios and published department rank data.

Direct Observation
Observation allows the researcher to collect data on relevant behaviors or environmental conditions (Patton, 2002; Yin, 2003). We observed several department-wide presentations, two candidate job talks, a student's dissertation defense, and post-defense celebration gathering. We also observed a faculty meeting at which faculty members discussed a candidate for a tenured faculty position. We visited all the primary faculty labs at different times of the day and week in

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[1] We will refer to the department studied as the "Science Department" in this report.

order to understand the work setting and routines. See direct observation guide in Appendix 1

Interviews
We conducted semi-structured, one-on-one interviews (Knight, 2002), of about 1 hour in length, with all of the primary faculty and a willing sample of active secondary faculty, doctorial students, post-docs and staff. The focus of these interviews was participants' personal experience within the work environment, their perceptions of the environment and the impact of this environment on their work and careers in science. See the sample interview guide in Appendix 1.

Data Collection and Analysis
Following Yin (2003), we bounded the sampling frame of this case by department membership or direct affiliation. We conducted interviews with all 16 primary faculty members, three of whom were women. We interviewed four secondary faculty members based on willing participants from among the seven who had an active role in the department. "Active" secondary faculty members were those faculty members who were training students from the department, were involved in teaching, supported recruiting and attended department presentations. However, secondary faculty members were not directly involved in department decision-making. The secondary faculty participants consisted of two women at the associate rank and two men, one at the associate rank and the other at assistant rank. We audio recorded and transcribed all but four of the interviews. Four participants did not want to be audio recorded, so we took written notes doing their interviews.

Of the administrative staff and laboratory staff within the department, we interviewed three staff members. They provided their observations about how the department operated and observations of faculty behavior and interactions. We also interviewed six students and post-docs.

The interviewer took notes after each interview regarding ideas, emerging concepts and open questions. These notes guided framing of the open-ended questions in subsequent interviews. These notes also guided the initial coding of a subset of transcribed interviews into topic areas, ideas and examples or "analytic categories" (Knight, 2002). Next, we analyzed the remaining interviews to elaborate concepts and confirm or test emerging concepts or relationships. We used the direct observation data and archival data to provide examples of concepts and identify relationships. Finally, we provided all quotes used as examples of concepts to participants for review and comment. This practice increased the accuracy of the participants' comments and ideas and provided confirmation of the link between examples and concepts.

BACKGROUND – CASE STUDY SETTING

The focus of this case study was a basic science research department at a Tier 1 research university in the United States. The Science Department was about 15 years old at the time of the study. The department formed in the late 1980's during a time when an unprecedented number of women were entering the science programs and the science workforce. The women's movement had made its mark on U.S. culture. Thus, for the first time in U.S. history, women

were becoming visible in fields that had been dominated by men. Amid these societal changes, the Science Department developed in response to the emergence of a fast growing area of scientific inquiry.

There have been two chairs of the Science Department over the course of its history, both female. The Science Department achieved top program and NIH funding rankings among departments in its field during the tenure of the first chair. It maintained its high rankings as it continued to grow in size under the second chair. (Annual Report, 2000)

The department was ranked above average in terms of number of women faculty and number of female students (Department Presentation, 2004). Two women faculty members joined the department at tenure ranks. One woman has advanced from assistant (junior) to associate rank. Of eight faculty members who joined the department as junior faculty, including one woman, only one male did not advance to tenure. Women comprise about 56% of the students in the graduate program, which awards masters or PhD degrees. The department attracts top students as indicated by higher than average student GRE scores for the field. (Department Presentation, 2004)

FINDINGS

Values and Beliefs which Support Cooperation and Inclusion

Members of the Science Department professed and acted consistently with several values and beliefs that appear to support cooperative and inclusive behaviors.

The two core values mentioned consistently are high quality science and interaction. Department members often stated that doing good science or high quality science was the main goal of their work.

> "I cared more about just doing good science and I figured if I was able to do good science I'd probably get tenure, so the main goal was to do good science, and I figured everything else would flow from that." (male associate professor)

Departmental members also valued a work environment rich in high quality peers who were willing to contribute to the pool of available resources to do science. For most department members, a scientist is not a "lone wolf", "in his or her own world competing with the outside world to get a paper published or get more money" (female associate professor). Interaction is important to creating the resource rich environment that enables member to produce high quality science.

> "You know, I think the environment is really important throughout one's entire career, especially these days where it takes many different methodologies to complete a research project. For example, there are certain methodologies that I don't know how to do, but my research would benefit from it. If I'm in an environment where that methodology is

not available, I'm out of luck. But if I have a strong environment that's relevant to my research, I may be able to go to go down the hall and ask someone to help me interpret data or help me to use a method that I don't know how to use, to help advance my research." (male associate professor)

"I think he or she has to be an interactive person to make the group better. You know they can't just sit in their labs and be great scientists and never talk to other people. It is good scientists that participate in group activities that have a broader impact on the department and university, because they transmit their ideas to students, post-docs, and other faculty members in the department." (female associate professor)

In the Science Department, women were included in social networks that support the work of scientists. Every female professor recounted multiple stories of networking with men or men mentioned cases of networking with women in their stories. This, indicated that a range of scientific resources, from knowledge and ideas to research and cross-lab collaboration were available to women and men. The founding members of the department valued cooperation and high quality science.

Thus, most scientists in the Science Department valued doing high quality science and valued doing science in an interactive way.

In addition to shared values, the interviews with members of the Science Department point to three widely held beliefs.

4. Good science is the pursuit of meaningful, significant advancements of knowledge.
5. Scientists achieve good science through interactions that provide and generate resources.
6. Anyone can do high quality science if they can learn quickly, are well trained, can present their ideas, are creative and willing to work hard.

Constructive Interactions

We identified four types of interactions that appeared to support the development and maintenance of a cooperative, collegial work environment. Regardless of gender, tenure, rank, or nationality, participants reported a variety of supportive, useful, and/or instructional interactions with peers, post-docs, and students. These interactions led to positive feelings about faculty peers and/or advanced people's work in some way. We used the term "constructive interactions" to identify the interactions related to these positive experiences. Constructive interactions are interactions (both emotional and task related) that facilitate doing high quality science in a cooperative work environment.

Constructive interactions involve exchanges of resources starting with what Isabelle Bouty termed "common resources". Common resources include information on published papers, general scientific/technical information, or "non committing services" such as the giving of

names or addresses of other contacts. They require little effort to provide and are a very small part of what a person can offer another. Exchange of common resources may mark the beginning of interactions leading to the exchange of "strategic resources". Strategic resources consist of tools, techniques, samples, specimens or personal services that directly assist a scientist in advancing his or her work. Both common and strategic resources are instrumental in nature. They facilitate or directly support work outcomes (Bouty, 2 00).

However, other interactions in the department occurred around another key resource, emotional support. Emotional support consists of "counseling, friendship, and role modeling (Kram, 1988), that helps participants develop self-esteem and professional identity (Thomas, 1993 p. 170)" (Gersick, Bartunek, & Dutton, 2000, p. 1028). These interactions are "characterized by minimal hierarchy, ease and freedom to be one's offstage self, and mutuality" (Gersick et al., 2000, p. 1037) These interactions make work more enjoyable and the environment more congenial. These interactions also build strong ties between colleagues (Gersick et al., 2000).

Faculty members exchanged both instrumental and emotional resources, through constructive interactions. We will describe the four types of constructive interactions in the following sections.

Collegial Interactions
Collegial interactions are congenial, social civilities that occur between scientific peers in formal or informal settings. These interactions indirectly relate to work outcomes. In the Science Department, collegial interactions included polite exchanges of greetings and courtesies, providing general information or "common resources" and or getting-to-know-you type conversations that could lead to instrumental and emotional exchanges. These interactions took place during day-to-day encounters in passing, and at social venues such as before academic presentations or faculty meetings. They also occurred at scheduled social events such as the department's beer hour or the department picnic. Faculty mentioned their initial experience of the collegial interactions during their early visits to the department.

> "There was no one that had some sort of negative agenda going on, and people were friendly. People were collegial." (male associate professor)

Generally, collegial interactions are introductory interactions that form the basis for more complex and productive interactions. They also maintain connections between departmental members, who may not otherwise have a need to interact. Both men and women in the department reported these social interactions. We also observed such interactions at department meetings and events. A female student observed:

> "I kind of got the feeling that people here at least spoke to each other as opposed to being locked up in their labs all day and not getting along or having time to socialize."

Tacit Learning Interactions

Tacit learning interactions occur around formal work roles and activities associated with faculty obligations. These reported interactions include formal mentoring of junior faculty to the extent that it occurs, serving on student committees, and activities that are a part of the graduate program such as teaching, advising, and weekly scientific presentations. Tacit learning interactions provide important opportunities for faculty to observe and learn from each other. Faculty in the Science Department modeled and reinforced cooperative norms and behavior through these interactions. This was particularly important for junior faculty since there was little formal ongoing mentoring that occurs in the department. The participation of faculty in tacit learning interactions across ranks also distributes the department's teaching workload, which is important to junior scientists trying to establish their labs.

Participants also reported that the way people went about these interactions made the required tasks more pleasant. One male professor noted that even as a small group of faculty wrestled with a difficult workload obligation, they maintained open and honest communication about the situation, concern about the welfare of all involved, and awareness of the potential impact on the department as a whole.

Relational Interactions

Relational interactions are interactions that help form, maintain, or strengthen professional and or personal relationships. These interactions consist of taking interest in others, providing care and providing emotional support in the context of professional or personal friendship or colleagueship.

> "He [A male full professor] genuinely sounded interested in his research, which is usually the case, but he was also interested in what I had to say. And, he asked me how I felt about the idea of coming to work in the lab. I thought he seemed very interested in me and how I was, not just telling me what the lab is about, and finding out about my resume. He was just very upbeat, and overall just gave me the sense that it was a happy lab. You can tell, if you're paying attention, if somebody's really got a happy lab going on." (female staff researcher)

> "But this environment is so much more like family than it is like work-mates who you don't talk to or care about or see much outside of the work space." (female post-doc)

There are several faculty members, both male and female, who came into the Science Department with prior knowledge of or established relationships with faculty in the department. However, other faculty members, for whom relational interactions began in the department, initiated relational interactions around shared, similar, or related research interests. Such relational interactions appeared to be an outgrowth of collegial and tacit learning interactions.

We gathered reports and observations of several events of emotional support. We observed at a meeting as faculty members offered condolences to a colleague about a research setback. The other was a story around support as a group of faculty grappled with a difficult administrative situation.

> "It's been interesting to me that many of the faculty have come up to me and said, "I'm really sorry this is a situation and if we can help, let us know". That's community."
> (male full professor)

A male faculty member, who at the time was junior faculty member, reported how the encouragement of a more senior professor in the department sustained him through rejection of his first grant. A female faculty member reported how the interest of more senior faculty in her ideas and their willingness to share their ideas made the department a stimulating, enjoyable environment for her.

Several faculty members perceived that, as a whole, people were interested in each other's success in doing good science. Several faculty provided examples of celebrations that highlighted the separate accomplishments of a male and a female peer.

Men reported personal informal relational interactions that occurred after hours over beer. These informal personal talks are reportedly open to all faculty members. However, only men reported attending these gatherings. Women did not report attending these meetings nor did they report feelings of exclusion from any informal gatherings.

The majority of reported relational interactions, for both men and women, consisted of informal, sometimes lengthy conversations about science. Most female faculty and two male faculty members reported relational interactions, involving discussions of work-life balance, with students and or post-docs, in the context of mentoring relationships.

Social, role, and relational interactions support more complex, riskier, and high yielding interactions that we will discuss in the next section.

Generative Interactions
Generative interactions are the most overtly interdependent and complex of all interactions. These interactions fill the pool of resources available within the group. Generative interactions may start with a one-way provision of resources in response to a request from a peer. However, as people respond to receiving a resource by providing a different resource to the giver, responding generously to others, or joining together to secure resources for the group, more resources become available to the department. The more resources are shared and passed along, the more resource rich the environment, thus the term generative.

Generative interactions appeared to occur in the Science Department as part of ongoing relationships within groups. They require trust that a peer will not use these resources to directly compete with or "scoop" each other. A male associate professor reported that this kind of competition was "not a factor" within the Science Department.

While most reported generative interactions were directly related to work outcomes, two faculty members, one male and one female, retold the "ladder story" that exemplified the relational and productive nature of generative interactions:

> "So when I came here, when I interviewed here – a professor told me a story of the department's ladder. It turns out, that three or four of the faculty got together and bought an extension ladder for cleaning their gutters. And every fall they'd drive it around to their different homes and help each other do their gutters." (male associate professor)

The message that he took away from this story was that we have our separate labs, but in this department, we gather and share resources that support the success of everyone's lab. He reported this was a very different orientation to department life than he had experienced in graduate school.

Faculty members provided many other examples of generative interactions. One reported example was between a female faculty member, who was an assistant professor at the time, and a senior male faculty member. A mutual question about a particular organism led an exchange of a specimen and knowledge, which supported the male professor's research and lead to a funded stream of research for the female professor and subsequent employment of a graduate student from the male professor's lab. In another example, a female full professor requested and received technical and material assistance from a male associate professor. She then provided him with useful data from her use of the resources he provided her. In a third example, three junior faculty members cooperatively secured a shared equipment grant necessary to replace a vital but outdated piece of equipment which provided a resource to the entire department. There were also several examples of cross-lab research exchanges that stimulated ideas across research areas and provided a forum for student and post-doc development.

Faculty members talked about how important this access to resources was to their scientific work, as exemplified by this statement:

> "Here in the Department, everybody is working on completely different projects and topics. I think where we try to help each other is with the techniques. So if I see somebody is doing, let's say [name of a technique] and I can't do this. I go to him, and I try to learn it there. There are a lot of techniques in the Department, which are available, (and) that you could use and gather. That's what a Department is for." (male assistant professor)

Other types of generative interactions involved steering funding opportunities to other labs, and helping peers, even those in other departments, to obtain funding. One female professor referred to these activities as "looking out for each other". Being "looked out for" appears to promote a kind of reciprocity in the receiver that encourages her or him to pass along resources to others who are seen as part of the Science Department community. Since these interactions generate new capacities and capacities for work and people do not limit sharing of these resources to a single individual or group, the resources available to all department members grow.

Some scientists had also come to believe that going it alone was a bad idea competitively. They actively supported interactions that maintained the autonomy of labs while leveraging different resources available across labs to create new resources. Some faculty members viewed these interdependent interactions as central to survival and success in the increasingly competitive environment of science.

"The thing that makes the department different from being 16 independent entities is that there's interaction and there can be guidance. There can be support between these self-contained laboratories. To some degree, that's forced by the system, because you have to have other faculty involved with training your students. Usually you have other faculty involved in teaching courses… and there are more and more cases. I think the better the department is, the more cases there are of faculty working together on things that benefit the department but not necessarily an individual faculty member exclusively." (male associate professor)

"Also, right now, the way the NIH is funding things, I think it becomes more important to have these cross interactions. They're [NIH] really pushing these interactions. It's going to be hard for any lab to survive for a long period of time all by itself, without interacting with other labs, because no lab can do every technique or has expertise in all areas of a particular field. It just doesn't work anymore…. They're going to have to find their interactions among their colleagues. (female full professor)

Many faculty members recognize that these generative interactions are important to providing the knowledge and resources needed to compete with larger labs, while still maintaining their own laboratories and pursuing their unique ideas.

The congenial environment of this department depends on the first three types of interactions we have presented here. However, generative interactions specifically help advance a scientist's work and career. These generative interactions increase the knowledge, resources, and capabilities of scientists across labs, and even across departments. While it is possible to develop these interactions outside of the university, like many scientists do, when they occur in a department or within an institution, the efficiency of interactions is improved (walking down the hall vs. phone calls, emails, and papers sent across country), and the capabilities of that department are improved as a whole.

Over the years, both chairs of the Science Department, with the support of faculty, introduced several department level activities appear that appear to promote constructive interactions. We will discuss these activities in the following section.

Participative Departmental Activities

Several types of department activities were conducted in the Science Department. Departmental activities provided the context for constructive interactions. These activities also supported ways of doing work and running the department that promoted inclusion of the entire faculty. All activities required the support, involvement, and leadership from the faculty. Some activities were also open to and supported by students, post-docs, and staff. We will discuss these activities in more detail in this section.

<u>Team Teaching across Faculty Ranks</u>
Team teaching of courses within the graduate program has been part of department practice since the days of the first chair. A senior faculty member provided leadership of this activity. Various faculty members, across ranks, participated in teaching parts of the graduate program.

> "So I give some of the lectures in the course [graduate level science course], but I also organize everything like the exams and the handouts and grading, etc. Quite a few people in the Department cooperate. About six different people give lectures that have to be coordinated. It's a very positive experience. People are very willing to do it and they meet deadlines that I set for them and do their best. And the students seem to like the course." (male full professor)

Advantages of this approach mentioned by faculty included:

- A manageable teaching load for all faculty
- A lower load for junior faculty, thus giving them time to devote to lab start up
- Opportunities for junior faculty to learn from more senior faculty
- Opportunities to interact with faculty that one might not normally interact with

A junior faculty member discussed the advantages of team teaching as follows:

> "Doing the teaching, I found to be quite a lot of fun, because it was a team-taught course. So I actually interacted with people that I wouldn't normally have interacted with. Getting an insight into what they do every day was interesting. I hadn't had that perspective before…It was just good to actually talk to them in a setting that was more of a work environment, rather than necessarily say a social environment because sometimes you discuss things that are more work related if it's a teaching environment. Where if it tends to be a social environment, then you don't always find out as much about the work they're doing at that time." (male assistant professor)

Since the department does not provide ongoing formal mentoring of junior faculty, these built-in interactions like team-teaching provide an important means of informal socialization and development of junior faculty.

<u>Department Level Social Events</u>
As the department has grown, the opportunities for spontaneous, informal social exchanges have diminished. The current chair initiated department wide activities to afford faculty, students and post-docs opportunities to interact outside of their labs. Faculty members have supported these initiatives by participating in and rotating the leadership of activities. These activities include a weekly beer hour, which is sort of a "science happy hour". Beer hour rotates between labs, the faculty, and students. Rotating beer hour between laboratories gives each lab visibility and enables different labs to put their own twist on the event. For example, one laboratory used a chili theme thus focusing the event more on tasty food. Thus, all of the laboratories are involved. The chair also introduced a department picnic and retreat. The picnic in particular provides a more family friendly context for interactions. These events provide opportunities for a range of constructive interactions between faculty members, students, post-docs, and staff.

Participative Faculty Meetings

The current chair used faculty meetings to keep faculty informed and engaged in decisions that could affect their work. The participative style of the chair, the interpersonal skills of the faculty, and mutual respect demonstrated by all participants kept these meetings constructive and on task. We noted that participants took the time to elicit and consider multiple views and information in decision-making. A faculty member later commented on a meeting we observed as follows:

> "But you have to have the respect for each other. When you get that, then you listen to what other people say in the meeting...You may not agree with them because you realize they're looking at something in a different way than you would look at it, but you can't just say, "Well, that doesn't count." Or "That's not important." (female full professor)

Participative Faculty Recruiting

Group recruiting of new faculty members was an activity initiated by the current chair. All faculty members participated in this process as interviewers, hosts, evaluators of presentations, and decision makers (or advisors if they were secondary faculty or had had minimal contact with the candidate due to schedule conflicts). This process not only gave faculty the opportunity to provide feedback on the candidate, but also encouraged faculty to think as a group about how this person fit into the department, what the candidate could contribute, what the candidate's developmental needs were, and whether department members were able and willing to help that person develop as a scientist.

We observed a seminar, "chalk talk", and faculty meeting surrounding one candidate for a junior faculty position in the department. We noted that a significant portion of the discussion about a candidate was about both fit with the department, in terms of the person's research direction, and his or her ability to interact with others. Faculty looked at the strengths and weakness of the candidate's science. Strengths were areas that the candidate could leverage into funded research and capabilities the candidate could provide to departmental peers. Faculty assessed weakness in terms of likelihood that people in the department were willing and able to help the candidate develop as a faculty member and if the candidate might be receptive to that help. A faculty member referred to the same meeting as follows:

> "You could listen to the conversation and you could see people were thinking about how this person would contribute. This was particularly true in the meeting that you were sitting in on. But also, "We have to mentor them". So, are they [the candidate] in a position where they can be well mentored? Or are they so far back that the faculty will be spending a lot of time, too much time, doing the mentoring? You want to see that, if you put in the mentoring, it's really going to pay off. So I think everybody sees how the whole thing affects him or her." (female full professor)

The result of this process was a candidate people felt good about, which provides the new person with a cache of social credit needed to weather any initial setbacks that may be part of the new faculty experience.

"And that's why I think the recruiting as a group is important because you want to bring in people that everybody feels good about." (female full professor)

Feeling good about a person promoted interest in that person's success and encouraged acts of inclusion.

"But I think the strength of the department is that it's got a large group of faculty that has been involved in hiring the people. [These faculty] are now invested in many people in the department because they played key roles in their recruitment. And so we're trying to work on ways, through the infrastructure of the department, to expand the circle. To have people more interconnected with other labs, so we're trying to find ways to have the labs that aren't involved in this central cluster of faculty be more involved in having them on students committees, having them on exams. Try and reduce the ability of people to be really isolated." (male associate professor)

Regular Meaningful Seminars and Presentations
Many faculty members mentioned the importance of department seminars and presentations in stimulating ideas, helping them to fashion their own projects and making contact with peers with mutual interests. Two students also indicated that the interactive, interesting, and well-attended research seminars attracted them to the department. The faculty emphasized the importance of these seminars for the development of young scientists by making the sessions mandatory for graduate students. Faculty, both primary and secondary, attended the sessions we observed. The room was abuzz with conversation among faculty before the presentation. Faculty members were responsive to the presenters. Some faculty nodded their heads in response to the speaker. Others asked questions that helped the presenter clarify points or consider new angles or ideas about the research. Afterward, some faculty lingered, talking with peers and students. Thus, seminars and presentations were an important means for constructive interactions.

Departmental Learning and Inclusion Processes

Department wide learning and inclusion processes stimulated and supported wide influence in decision-making, engagement, learning about one another, and disseminating, comparing and creating a shared understanding of the external environmental factors surrounding the department. These processes also play an important role in embedding norms, behaviors, values, and beliefs into the culture of the department.

Transparent Decision Making Processes
All faculty members had the opportunity to be a part of important decision-making processes. The faculty meetings and, in particular, participation of the entire faculty in recruiting, were the means to transparency. These activities removed the mystery around important questions, such as who was involved in the selection of a new faculty member or how a newcomer fit into the department. Also important was that a single individual or sub-group (e.g., senior professors, professors of certain status or standing in the field, or by age or gender sub-group) did not monopolize decision-making power. Thus, transparency was an important tool for creating inclusion.

"So in general, for the recruiting, I think that everybody knew their input counted. In the end, we did go the way that the group decided for all the positions." (female full professor)

"So there aren't any politics, and nobody's being forced to do things. People are genuinely interested in teaching or are certainly interested in the job search. And so it's sort of a team effort, which makes it rewarding. I think that there is not very much of a hierarchy in the Department, between the junior faculty and the senior faculty. And, to some extent, the students feel like they're part of the process. So people feel empowered. People's opinions are asked and they receive feedback." (male full professor)

Engagement of Faculty across Ranks
Faculty engagement in a variety of activities from team-teaching to the department picnic demonstrated their desire and ability to interact. This reduced the chances for isolation, and increased the chances of finding opportunities to generate and share new resources. Furthermore, by cross rank sharing in the activities of recruiting and teaching, the academic workload of the department was more evenly distributed. This non-hierarchical distribution of the service and teaching responsibilities appeared to have a status-leveling effect within the department. Joint recruiting also distributed decision-making power and responsibility throughout the department.

Dissemination of Information Important to Work.
Faculty meetings, team teaching and high quality research seminars and presentations provide department members with the knowledge and information they need to advance their work. These activities support the department level process of dissemination of relevant information, which is strategic resource.

> If you had questions, you could go talk to one another very freely. You could ask people for advice, people that were more senior to me. I found it be very harmonious and productive in a cooperative environment." (male associate professor)

Creation and or Sharing of Resources
In the Science Department, people reported access to role models for approaches to the work, peers they could generate ideas with, and access to important new techniques and methods being available for the asking. Faculty described their peers as "friendly", non-competitive and the department as having "no slackers".

The cooperative environment of this department was not a gender-specific goal. Most faculty members regarded a cooperative environment as a valuable and highly effective way of doing science.

> "You know, I think the environment is really important throughout one's entire career, especially these days where it takes different expertise, methodologies to complete a

research project. For example, there are certain methodologies that I don't know how to do, but my research would benefit from it. If I'm in an environment where that methodology is not available, I'm out of luck. But if I have a strong environment that's relevant to my research, I may be able to go to go down the hall and ask someone to help me interpret data or help me to use a method that I don't know how to use, to help advance my research." (male associate professor)

Overall, participant's characterized relations in the department as "cooperative", "supportive", and "smooth".

"So I would say the one thing that's very clear in this Department, as opposed to some places where I've been, is that people get along with each other and that makes everything a lot easier." (male full professor)

The Open Faculty Selection Process
The faculty selection process did not always involve significant faculty participation. The first chair exercised wide leeway in recruiting new faculty. Many faculty members, both primary and secondary, recall being invited to join the department by the first chair. Several participants recall that the chair's main criteria, aside from high quality science, was "no prima donnas" or jerks (several faculty both male and female). Several faculty members reported that they continue to use this criterion in selection of new faculty. In discussing this criterion, some faculty acknowledged that it is not fool proof. While six males and one female did advance to tenure, one male did not advance due to reported "style" differences (anonymous informants). The second chair opened up the selection process from the recruiting dinners and meetings to the decision-making discussion about the candidate. A strategic directive to diversify the research areas and techniques within the department (Department Annual Report, 2002) guided the open process. Everyone has the opportunity for input. Both male and female faculty, recruiters, and recruits, who discussed the open process, expressed satisfaction with the outcomes. While still not foolproof, and subject to a final decision by the chair, the process does serve to provide a means of influencing the direction of the department, securing peers who support, and or complement, the work and norms of the department.

Cooperative Leadership Practices

Leadership also played a key role in the development and maintenance of the department's culture. The current and past chairs employed very different leadership styles, but both shared the goal of a high quality, cooperative science department. First, both chairs supported a workplace environment of people energized by the work itself – the advancement of science. They valued good science, regardless of the gender, nationality, or age of the scientist. Next, faculty perceived both chairs to be fair, equitable, and supportive of the advancement of science regardless of whose lab produced it. Several faculty members, both male and female, noted the fairness and forthrightness of the current chair. No one reported either chair as having favorites or supporting cliques. Both chairs sought the thoughts and opinions of the faculty before making decisions. When the department was small, the first chair did so by talking to faculty one-on-one. The second chair employed more group-level activities. Both provided the faculty with a

sense that a wide range of opinions mattered, not just the desires of the chair or a privileged subgroup. Both chairs created opportunities for faculty members to engage meaningfully across ranks, through the various activities that we have described in this report. Neither chair treated the department as an extension of her self or her own work by monopolizing resources and recognition for their own ends. They did not use their status to demand unwarranted resources, authorship, or access. Instead, they created and shared resources to support others' labs, particularly those of junior faculty, both among primary and secondary faculty. Participants cited many instances of the chairs securing funding for new faculty, including one story of the current chair allowing a junior faculty member primary authorship of work that the chair's lab had supported. Thus, both chairs viewed their role in terms of doing a service to the department and advancement of a scientific community, not as a reward to leverage.

CONCLUSIONS

(Etzkowitz et al., 2000) conducted a study to determine the characteristics of graduate departments that showed the most and least improvement in recruitment and retention of women and conferring of the Ph.D. degree. The study employed 1974-1990 statistical data from the National Research Council. They found that the vast majority of science and engineering departments reflected "negative attitudes towards women in science". These departments they termed: "instrumental". They also found a few departments with a: "collegial and cooperative atmosphere that provides the safety to take the risks necessary for innovative work and the collaborations necessary for networking" (Etzkowitz et al., 2000, p. 181). They termed these departments "relational". A characteristic of relational departments was their attractiveness to "a number of tenured women faculty who had struggled for recognition and status in prestigious graduate schools and post doctoral programs that were highly competitive and hierarchal" (Etzkowitz et al., 2000). Other researchers have also suggested that cooperative or collaborative departments are better environments for the development and advancement of women scientists (Etzkowitz et al., 2000; Rosser, 1999; Sonnert & Holton, 1995). The findings of the present study support the findings of prior research. In addition, we identified specific interactions, activities, processes, and practices that facilitate the development of a cooperative science culture within a department. Such an environment can be appealing and advantageous to both female and male scientists.

The Figure below represents our conceptual modeling of the relationship between the major constructs that emerged from the data.

Figure 1 **A Model of a Cooperative, Inclusive, Productive Academic Culture**
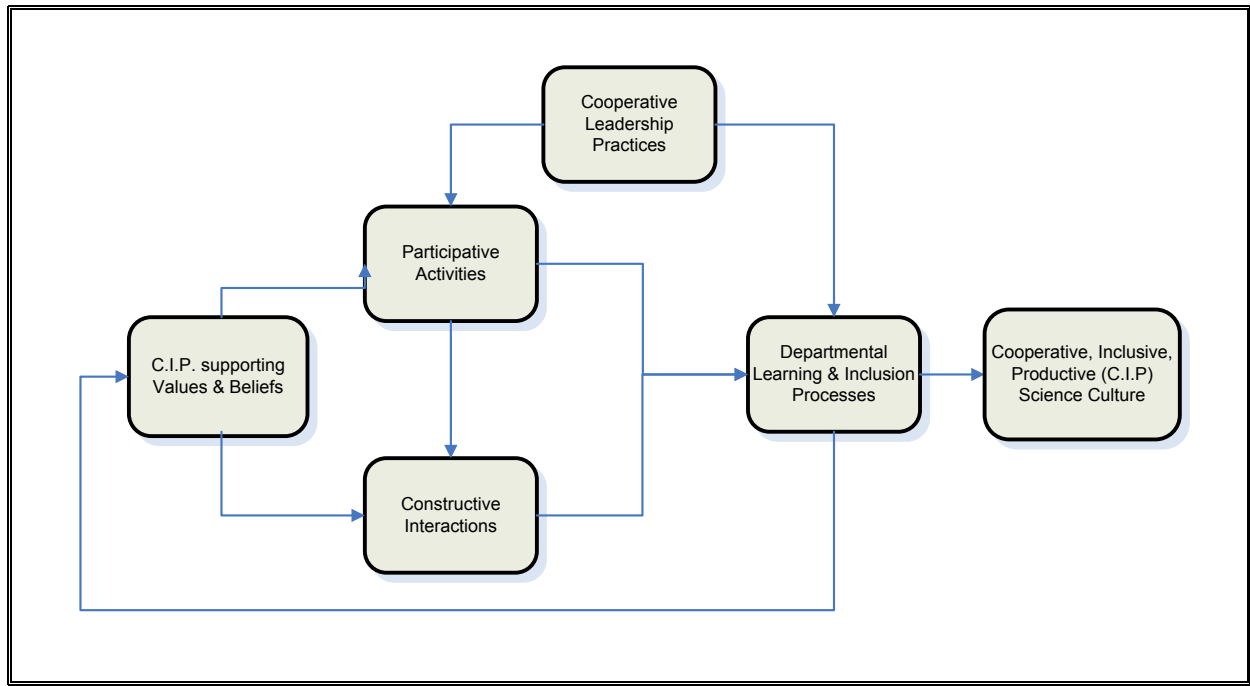
The foundation of a cooperative, inclusive productive academic culture is values and beliefs that support high quality science, interaction between scientists and outcome focused criteria relating to who can do science. These values and beliefs foster constructive interactions and participation in a range of department activities.

The most readily observable factor in the development of the culture was constructive interactions between faculty, staff, and students. This day-to-day contact helped department members build social connections and trust that supported engagement in more complex giving and exchanges of strategic resources. Constructive interactions ranged from collegial departmental interactions to generative interactions that gave rise to synergistic connections. We found evidence of constructive interactions across dimensions of diversity like academic rank, sex, age, and nationality. This indicates wide spread inclusion of scientists in these interactions, which are important to work and career advancement (Bouty, 2000; Gersick et al., 2000; Zuckerman, Cole, & Bruer, 1991).

It is through constructive interactions that departmental members contributed and received valued resources to and from colleagues in the work environment. For most faculty, giving, receiving and, for an active subgroup, generating these resources through interactions were viewed as essential to their work, their identity and their feelings of engagement in science.

The number and frequency of departmental activities was also readily observable. Several of these activities provide the context for constructive interactions. Some of these events were

social in nature, which helped to establish and maintain relationships. Other activities directly supported the work and transmission of tacit knowledge to new members.

The constructive interactions as they occurred in the context of departmental activities, created the ground for departmental learning and inclusion processes. These processes promoted networks of relationships and access to influence in decision-making. Pelled, Ledford, and Mohrman defined inclusion as " the degree to which an employee is accepted and treated as an insider by others in a work system" (Pelled, Ledford, & Mohrman, 1999, p. 1014). They then identified three indicators of workplace inclusion: decision-making influence, access to sensitive information, and job security (Pelled et al., 1999, p. 1015). The departmental processes we identified from this case appeared to provide members with influence and access to information that supported their work and or advancement to tenure. We viewed the department's success rate at advancing junior faculty to associate faculty rank, seven out of eight, including one woman, as indicative of high job security. The transparency of decision-making processes, participative decision and information dissemination processes and the resulting stake of faculty in the success of others, supported inclusion into existing social networks in the department as well. In other research studies, women have reported feeling excluded from informal relational interactions. They perceive that men share important information and make important decisions during such interactions. Thus, women perceived their influence in decision-making and access to information to be diminished (Etzkowitz et al., 2000). In the Science Department, there are open channels of communication through inclusive processes like transparent decision-making. Thus, members have access to alternative means of information and influence. This may explain why women in the Science Department did not indicate feelings of exclusion or lack of influence due to gender. Last, departmental learning and inclusion processes also serve to create and embed norms, practices, and processes supportive of a cooperative, inclusive, productive department culture.

Finally, the leadership practices of the two chairs appear to play a key role in promoting and supporting department wide activities, and processes into the culture as norms, rituals, and shared values. The first chair promoted the idea of a "strong department" by recruiting high quality scientists interested in working in a cooperative, collegial environment. The second chair added activities like faculty meetings and wider scale social gatherings that enhanced workplace inclusion in a growing department. With a core of scientists who valued a cooperative environment in place, the team recruiting activity, initiated by the second chair, became the means to continue to bring in scientists with similar goals and values who were willing to contribute to the resources of the work environment.

One male faculty member noted that science chairs, in some institutions, have the reputation of treating the department as an extension of their own labs and using their power to advance their own work or reputations. In contrast, both chairs used the role of chair in service to the department and the surrounding scientific community within the institution. Both chairs were active in establishment and or advancement of junior faculty. Both supported activities that helped the work of all scientists. Both championed high quality science. While the establishment of a cooperative culture certainly required support of the faculty, leadership has a special role in establishing what is important, modeling, allocating resources and bringing in new members in ways that establish the department culture (Schein, 1992).   Faculty also exercised

cooperative leadership practices, both in their own labs and in assuming leadership of department wide activities. Thus, distribution of leadership appears to be important to sustaining activities and processes important to the work environment of a department.

Academic departments often produce high quality science in competitive, isolating, and male-dominated work environments. However, the academic science department studied for this report demonstrated that scientists could achieve high quality science in a cooperative, inclusive, and interactive environment that facilitates the advancement of all scientists, regardless of gender. In the words of a male associate professor, the cooperative science culture made the Science Department simply "a good place to do science".

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APPENDIX 1
Observation Guide

Questions to guide observations of researcher during direct observation activities

Physical Space & Equipment

- What is the overall physical space of the department like and where are its members located?
- What are the workspaces like (Labs, offices, meeting areas?)
- What are the differences and similarities in workspaces? (Labs and offices)

The Work in the Department

- What is the work of this department and its members?
- Where do people typically spend their day?
- What kinds of work and ways of working appear to be rewarded or acknowledged in the department?
- What is the purpose of this department? What seems to be important based on what people send their time doing?

Work Norms

- When do people work?
- What are norms about group and one on one time?
- What dynamics occur around equipment? (Access, how much to use it, who uses it?)

Interpersonal Interactions

- Are people working with each other or individually?
- What kind of work requires interaction?
- What interactions are occurring here? (tasks, relational, informational)
- How and when do people interact with and or respond to each other? Who participates? Who doesn't? How do people respond to non-participants?
- What are the styles of interaction?
- What kind of access to faculty do students and post-docs appear to have?

Groups

- What kinds of group meetings take place?
- Where do they take place?
- What are these meetings like?
- What is the purpose (information, idea generation, decision making)
- What kind of decisions made, and information conveyed.

- What is the structure (formal or informal agenda) and process (how is the meeting conducted?)?
- How are agreements reached or disagreements handled?
- What are the interactions in such meetings (norms about speaking, order of speaking, who speaks and who does not)?

Leadership

- How do people display and respond to leadership? (Chair, program heads, committee heads, student leaders (if any))
- Are women "followers" or "leaders" in this environment?

Climate

- What do classes, research presentations and other broader group gatherings feel like?
- What is the overall tone or emotional feel of the department under various circumstances?
- Do people look comfortable?
- Are there indications that people support each other?
- Does the environment feel non-threatening?
- What do you observe about competitiveness in this environment?
- What do you observe about hierarchy?

Integration and Socialization

- How are new members brought into the department? What are the criteria? How are they selected? How are they introduced and socialized?
- What is expected of a scientist in this department? What do people appear to expect of each other?
- What are the observable rituals or some habitual behaviors in this department?

Sample Interview Guide

(Review Informed Consent, answer any remaining questions, sign forms to formalize agreement to participate)

This interview consists of three questions about your experiences in the department and three open-ended questions about work-life and science. I will ask questions for clarification and detail and I will monitor the time. So here is the first question.

(1) What brought you to this department? (Secondary faculty: How did you become affiliated with this department?)
    Prompts:
    What appealed to you about this department before you joined?
    How has your actual experience matched those observations or impressions?
    For faculty here since department founding: How is the department the same now as it was when you joined? How is it different?

(2) Thinking back over the last 6 months to a year you have been in this department (or working with the department), can you tell me about a time that you felt positively engaged, happy or perhaps pleased with an activity that is part of your work.
    Prompt:
    This can be in research, teaching, service or department related administration.
    Use adjective "satisfied" if participant does not relate to engaged, excited or interested

(3) Please tell me about a time that members of this department helped you develop as a scientist.
    Probe:
    What role did the chair play?

    Clarification questions for questions 1-3 are:
    What were the circumstances?
    What was your role?
    Who was involved? Not asking for names, just roles
    What happened?
    What was the outcome?
    Aftermath, if any?

    Closing probes:
    In what ways do you feel you are valued or recognized?
    For your work in this department?
    As a person in this department?

(4) When have you had to make the choice between your career and other personal demands or important aspects of your life?
    Prompts:
    What can you tell me about the situation?

How was it resolved? (// phrasing: What was the outcome?)
What did you learn about your priorities through this experience?
What did you learn about the department through this experience?

Probes:
What kind or forms of support are readily available?
What kind or form of support were you offered from department members?
What kind or form of support did you request?

Note: An added question follows:

(5) What has been different about having women, married students or students of color in the department/lab vs. your experience in other departments/ labs (as a student or post-doc)?

Follow-up question:
Do you have a sense of how differences like gender, cultural or social background, or age have contributed to either the Science Department or the Institution?
      Probe if needed:
      What about gender or cultural background?

(6) To sum up: What is a "good scientist"?
      Prompts:
      Who is this person? (What characteristics?)
      What are concrete things this person does to be good? Successful?
      What kinds of skills and abilities does this person have?
      What kinds of contributions does this person make?
      What kinds of resources or support does this person need?
      What is it like for you and others to be around (work with) this person?

      Probe for detail on factors related to personal characteristics, lab management, mentoring, funding, and or training.