

Advancing Women Faculty at the New Jersey Institute of Technology through Collaborative Research Networks: an Analysis of Preliminary Results and Methodology

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Abstract

By stimulating and supporting interdisciplinary research synergies, NJIT ADVANCE endeavors to expand women's social and professional networks, improve information flow, and stimulate social capital formation. In this paper, we report the initial results of our efforts—and, discuss the distinctive assessment strategy we have designed to measure faculty advancement: mapping networks in research oriented social space over time. We present an overview of our data-collection methodologies and a preliminary analysis of the data we have obtained thus far.

*"If one could get far enough away from it, human life would become pure pattern."*¹

Introduction: The Problem of Small Numbers

Thirty-five years ago when I first came to teach at the New Jersey Institute of Technology, the most popular show on television was "M*A*S*H*." All the doctors were male. Off-screen, too. Less than 10% of US physicians were female, and only 4% of US lawyers. Ally McBeal and Shirley Schmidt were nowhere in sight. The signs of change were already there, however; and over the next three decades, women made dramatic progress in virtually every field. Today, nearly a third of all lawyers and doctors are women (WEPAN 2006). So are more than half of the nation's corporate managers. Women now own and run over nine million US companies (Catalyst 2004). There is one startling exception to this trend, however: engineering.

During the 1980's and 1990's there was a small but steady increase in the percentage of women in the US engineering workforce; however, the ascent peaked in 1998 at 11.2% (n = 240,000). During the last decade, both the percentage and actual number of female engineers have drifted downward. Today, only 10.1% of practicing engineers are women (WEPAN 2006). Female undergraduate engineering enrollments have followed the same parabolic course, rising modestly from 15.7% in 1984 to 19.8% in 1999, and then declining (WEPAN 2006). In recent years, the percentage of US women earning doctoral degrees in engineering has increased; however, this is largely an artifact of the steady decline in the numbers of male engineering doctoral students (WEPAN 2006). Although there have been slight increases in the proportion of female junior faculty in several engineering disciplines, some of this apparent growth is really a function of male attrition as well. The absolute number of women engineering academics at all ranks remains dauntingly small. In 2004, there were only 2260 tenured or tenure track female

engineering faculty members in the entire country—a group that could fit comfortably in the Grand Ballroom of the Hyatt Regency St. Louis (WEPAN 2006).² Women are especially scarce in the higher ranks, where departmental decisions are made (Perna 2005, Nelson 2007).

The Impact of Isolation

Women faculty generally bring enormous resources of knowledge, energy, and passion to their careers in science and technology; but because their numbers are small, they often find themselves disconnected from each other and from the mainland of academic life (Steffen-Fluhr 2006). Women researchers have plenty of human capital—the ‘what-you-know’ component of career success; but because they are isolated, it is much harder for them to accumulate social capital, the ‘who-you-know’ connections through which information flows and upon which advancement often depends (Etzkowitz et al. 2000). This process begins in graduate school where women researchers are often left alone to “pursue the myth of scientific individualism even as men...operate within networks of collaborative learning that advance most ideas competitively” (Etzkowitz et al. 2000). Isolation limits women’s opportunities to reality-check their expectations. It limits access to tacit knowledge (Rankin 2007). It blocks the flow of news about hot research areas and funding opportunities; access to unpublished research; invitations to join grant initiatives; support for intellectual exploration and risk-taking; guidance that demystifies opaque P&T processes; and, not least, brokered connection to the high status people—in short, it cuts women off from all of the assets that flow to male peers through their social networks (Creamer 1998; Etzkowitz et al. 2000). These losses are often small and subtle, but they accumulate with devastating effect. As a result, women in science and technology are more likely to dropout, seeking the greater flexibility and collegiality available to them in other careers (Preston 2001; Trower and Chait 2002; August and Waltman 2004).

NJIT ADVANCE Strategies

The NSF-funded ADVANCE Program at the New Jersey Institute of Technology (NJIT) uses a variety of strategies to address the problem of faculty isolation. Our objective is to link women researchers to each other, to male peers, and to female counterparts in industry and government. By stimulating and supporting interdisciplinary, cross-sector research synergies in this manner, we believe we can help enlarge women faculty’s professional networks, improve information flow, stimulate social capital formation, and, over time, increase agency and expand options—including the option to serve in an official leadership position.

During the last 18 months, NJIT ADVANCE has developed three mutually-reinforcing streams of activity:

Stimulating and Supporting Women-Led Research Teams

An ADVANCE-funded Geospatial Technologies research group, consisting of women faculty from four different disciplines, has begun an innovative three-year collaborative research project designed to assess coastal water quality. In the spring of 2007, six new interdisciplinary collaborative proposals were developed and submitted in response to an NJIT ADVANCE Seed-Money Competition. Eight of NJIT’s 14 STEM departments were represented in the proposals, which were judged by a nine-member advisory panel composed of senior research faculty from

across the university community. The winning proposal—a richly interdisciplinary project in which a young woman physicist has teamed with a young male chemist to do research on the frontiers of biology—will be showcased in the spring of 2008 as part of the NJIT ADVANCE Collaborative Workshop series. NJIT ADVANCE also awarded travel grants to nine faculty researchers in 2007 and will make additional awards in 2008.

Network Building

In order to stimulate collaboration, NJIT ADVANCE has sponsored interdisciplinary colloquia that bring leading women science and technology researchers from across the country to the NJIT campus for lectures and small group discussions. These events give faculty from various departments a chance to meet each other and discover shared research interests.³ In the fall of 2007, ADVANCE added a new “Opportunities for Interdisciplinary Research Seminar Series” built around cross-cutting research themes. At these seminars faculty from several different departments jump-start the discussion by presenting brief overviews of their current research in the theme area. Then attending faculty are encouraged to interact with each other in a game-like format we call “intellectual speed dating.” Theme areas for 2007-2008 include Information Management Systems; Emerging Environmental Contaminants; and Bio Applications. ADVANCE also stimulates cross-sector synergies through its Open Partnership initiative, linking women researchers in academia with women researchers in New Jersey industry and state government. The Open Partnership conference in April 2007 brought together participants representing nearly 50 different domestic businesses and universities.

Designing Communication to Support Women-Centered Research Networks

In addition to creating new face-to-face networking opportunities for women faculty, NJIT ADVANCE has also begun developing a cross-sector virtual research network (*V-Net*) as part of its Open Partnership initiative. In subsequent years, ADVANCE will help to develop *V-Net* into a fully functional knowledge-sharing system, including searchable databases containing information on grant applications, patents, and publications.

Understanding Social Network Analysis

NJIT ADVANCE derives both its organizational change strategy and its assessment methodology from a reading of social network analysis theory (SNA), particularly the well-known work of Mark Granovetter on “the strength of weak ties.” In the later sections of this paper, I will discuss the NJIT data collection and assessment methods in some detail. First, however, I want to spend a minute defining several key terms—including the word “network” itself. Thanks to Facebook, “networking” is part of our national idiom, but it is a much more problematic concept than we generally realize.

The slippery nature of “network” terminology is inadvertently illustrated in the essay “Weak Ties, Hot Networks, and Tacit Knowledge” written by ADVANCE investigators at the University of Colorado for the 2007 anthology *Transforming Science and Engineering* (Stewart). The essay begins by creating a binary distinction between “weak ties” and “hot networks,” arguing that both are important to the advancement of women in STEM fields. The writers define “weak ties” as “interactions between individuals and groups that otherwise would not interact—

individuals and groups that are different enough in background, training, and taken-for-granted assumptions that contact between them is like to generate clashes between, and questioning of, paradigms, along with much exchange of information...(Rankin 2007, 31). In contrast, they define “hot networks” as “highly energized, remarkably productive teams that lead to unusually satisfying intense interactions (sometimes for an extended period)” (31). “We hypothesize,” they conclude, “that weak links, which bring unlike minds together, and hot networks, which keep people intensely interacting, tend to be associated with the kind of changes and paradigm, shifts that are relevant to large-scale change initiatives....[Interventions that encourage] the development of new links...can help to create an environment in which bridging networks, which are more likely to challenge the status quo, develop” (35-36).

Essentially, this essay uses “weak ties” as a synonym for “diversity” or “group heterogeneity”—and attributes an inherent capacity for out-of-the-box thinking to such groups. The connection between diversity and creativity is an important one and is supported by a growing body of research (e.g., Page 2007); however, this is not exactly what social network analysts mean by “the strength of weak ties.” The term “hot networks” is equally confusing. In SNA parlance, what is being described here is actually a “cold network,” characterized by “high transitivity” (Katzmair 2005). (“Transitivity” refers to whether connections between two people imply connections to a third person.) This confusion of terms is more than a semantic issue. The authors of the “Weak Ties, Hot Networks” essay are translating social network terminology in ways that anthropomorphize it, attributing binary personality characteristics (progressive/conservative) to the metaphors they are creating. What gets lost in the process is the context-dependency of social network analysis, a discipline whose conceptual strength is empirical, not socio-political. Whether or not a “bridge” leads to cultural revolution depends a lot on who is standing on the span directing traffic!

Social network analysis is a distinct, mathematics-based research field with its own international organization (the INSNA—International Network for Social Network Analysis) and professional journals. “Social network analysis is focused on uncovering the patterning of people's interaction,” writes Lin Freeman. “...Network analysts believe that how an individual lives depends in large part on how that individual is tied into the larger web of social connections.... From the outset, the network approach to the study of behavior has involved two commitments: (1) it is guided by formal theory organized in mathematical terms, and (2) it is grounded in the systematic analysis of empirical data (Freeman 2007).”

In short, social network analysis is descriptive, not prescriptive. It can be a powerful instrument in our institutional transformation toolkit; but only if we recognize the complexity of the discipline and make working alliances with experts in the field. Efforts to domesticate SNA for personal use in career advancement are highly problematic—as is demonstrated in an otherwise helpful 2004 ADVANCE website essay on the importance of avoiding isolation: “How do you know if you are doing a good job of networking? We suspect that you will know intuitively how well you are doing but if not then....Social Network Analysis (SNA) is a promising new area of organizational sociology...that basically measures the number and strength of network ties as well as the distance between them....How can you do this crudely for yourself? One easy way to do it is to make a list of key activities in your life and then under

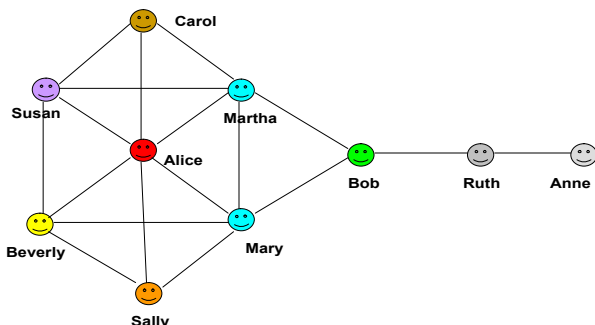
these headings list who you who would contact for help or advice if you needed assistance” (Rankin 2004, 7).

There are several problems with this well-intentioned advice. First, simply enumerating your own direct contacts (“alters” in SNA parlance) will not allow you to map the structure of the network(s) in which you are embedded or to understand your position in these structures. You also need to know the contacts of your contacts (the friends of your friends, the colleagues of your colleagues) and the “content,” “direction,” and “strength” of each of the multiple relations (or “strands”) that characterize each of these multiple ties. This is not the kind of data you can gather in your spare time (in the unlikely event that you have any spare time). Fully mapping even a single “ego-network” is a daunting task even for experts. Garton et al. (1997) report that it took more than a year for one “heroic researcher to identify all the interactions in the networks of only two persons” (11). Secondly, understanding the structure of your ego-network will not, in and of itself, allow you to understand the organizational structures in which you work (your department, your college, your university.) Ego-network analysis provides only a “Ptolemaic” view of the organizational universe. To get a more Copernican view, you will have to perform a “whole-network” analysis. As Garton et. al. (1997) explain, “This approach considers both the occurrence and non-occurrence of relations among all members of a [bounded] population. A whole network describes the ties that all members of a population maintain with all others in that group. Ideally, this approach requires responses from all members on their relations with all others in the same environment” (7). Obviously, this requirement places constraints on the size of the population that can be examined. Again, this is not the sort of research one can do as a hobby—or as a casual add-on to a WEPAN or ADVANCE-style programmatic intervention.

Because mapping social and professional networks is so complicated and time-consuming, individuals and organizations who attempt to track the effectiveness of personal “networking” strategies often end up simply counting heads. Indeed, this is exactly what the authors of the 2004 networking essay (above) advise: “Generally speaking, the more people you know the more chances you will have to benefit from your network. Perhaps the most important thing that that networks can provide is awareness that others feel the same way that you do” (Rankin 2004, 7). There are two problems with this recommendation—both of which lead us back to the paradoxical phrase, “strength of weak ties.” First, although “too much ain’t enough” when it comes to chocolate cake, when it comes to networks, more contacts is not necessarily more better. It depends on who they are, where they are, and where you are, in the *structure*. As SNA wags are fond of saying, “Location, location, location!” Moreover, encouraging strong ties between people who “feel the same way” may actually diminish opportunities for individuals to acquire social capital and diminish programmatic leverage for institutional transformation.

This counterintuitive observation—a linchpin of SNA theory—creates a conundrum for those of us in WEPAN and ADVANCE. Because isolation (and its corollary, “invisibility”) are painful and discouraging, and because pain and discouragement have such negative affects on our ability to move forward, we have spent a great deal of time and energy over the years fostering strong ties among STEM women—creating cohorts, support groups, mentoring and role-modeling programs. We have also encouraged women to develop “leadership skills.” All of these efforts are necessary, and often personally satisfying, but they do not necessarily lead to significant change because it is “the position within the network [that] determines the opportunity for

changing the position” (Katzmair 2007). The well-known “kite network” created by David Krackhardt of Carnegie Mellon (1990) illustrates the issue elegantly:



Kite Network

At first glance, Alice seems to have the strongest position. Apparently an effective “networker” in the generic sense, she has the most direct ties (i.e., the highest “degree centrality,” in SNA terminology). There is a structural weakness in her position, however. She only connects to people who are already connected to each other. The members of her local network may be diverse; but structurally, they constitute a clique. In contrast, Bob, although he has far fewer direct ties than Alice, is in a more powerful location, filling what Ronald Burt calls a “structural hole.” He connects actors that would otherwise be disconnected, controlling the flow of information between Alice’s clique and Ruth and Anne on the periphery. (He has the highest “highest betweenness centrality.”) Mary and Martha are also in a good location although they, too, have fewer direct ties than Alice, because have the shortest paths to everybody else in the network (the highest “closeness centrality.”) This “closeness” enhances their ability to track information flow across the entire network (Krebs 2007). In this fragmentary sociogram, Anne is a virtual “isolate.” In real life, however, she might be connected to other, external networks and thus also be a “bridge” across which resources can flow.

Thus, as Garton et. al. (1997) remind us, “Both strong and weak ties play roles in resource exchange networks. Pairs who maintain strong ties are more likely to share what resources they have.... However, what they have to share can be limited by the resources entering the networks to which they belong....Weakly-tied persons, while less likely to share resources, provide access to more diverse types of resources because each person operates in different social networks and has access to different resources. The cross-cutting ‘strength of weak ties’ also integrates local clusters into larger social systems” (5).

Collecting Data and Analyzing Data at NJIT

As the discussion above suggests, the rise of SNA marks a fundamental shift from the individual as the unit of analysis toward a greater concern with patterns, structures, and social systems (Garton 1997, 4). Similarly, the creation of the NSF ADVANCE Program as successor to the NSF POWRE Program represents a shift in focus from individual empowerment to

organizational transformation. In evaluating the new institutional transformation strategies developed over the last six years by ADVANCE universities, and by national associations such as WEPAN, there now needs to be a commensurate conceptual shift in assessment methodology—from the demographic approach traditionally used by academic institutional research offices to the structural approach used in SNA. The former (embodied in the “NSF 12”) counts individuals by category; the later analyzes relational patterns, allowing us to map subtle changes in organizational culture over time.

With this goal in mind, NJIT ADVANCE has begun to explore non-traditional methods of collecting and analyzing institutional data, documenting the difficulties we have encountered and the work-arounds we have developed in response to those difficulties. There are three major aspects to this work: 1) **An interactive Faculty Publications Database**; 2) **A Campus Climate Study**; and 3) **a Social Network Mapping Project**. Our initial data-collection strategies were developed by NJIT ADVANCE investigator Roxanne Hiltz, an internationally recognized researcher in computer-mediated communication. A sociologist by training, Hiltz was able to solicit assistance for NJIT ADVANCE from two prominent SNA researchers, Caroline Haythornthwaite of the University of Illinois at Urbana-Champaign and Barry Wellman of the University of Toronto. Following their advice, we have used a combination of data collection methods, including both self-reporting and the downloading of objective electronic data from well-established sources.

Initially, we planned to extract baseline research collaboration data from faculty CVs using a resume “ripper” software package. We immediately ran into difficulties, however, in part because the software was expensive but also because many faculty members regard their CVs as proprietary intellectual property. We worked with the STEM deans and chairs to get around this problem, at one point offering a small incentive to the first chair who submitted a complete set of updated faculty CVs. (Industrial Engineering, the smallest department, won!) In one large department, a prominent male researcher personally collected CVs for us from his colleagues—one nice result of our efforts to form alliances within informal department leadership networks. However, large holes persisted in our data sets; and, although the provost, Priscilla Nelson, serves as a Co-PI on our ADVANCE grant, there was little she could do to help. NJIT faculty are represented by an AAUP-affiliated union, and requirements for reporting of individual faculty “productivity” data (publications, grants, etc.) are part of the collective bargaining agreement. All tenured/tenure track faculty are required to submit an “annual summary” each fall. Some departments enforce this requirement, excluding faculty from consideration for merit money if they do not comply; but enforcement is inconsistent across the university, especially for tenured faculty. The annual summary response rate is usually below 30%, and faculty rarely submit hardcopies of their CVs to the chairs or deans unless they are undergoing P&T review. The online software package used for the annual summary is outdated, cranky, and requires key-stroking in data, a process that many faculty regard as a cosmic waste of time. The software is equally cranky at the output end, producing separate printouts for each faculty member rather than uploading inputs to a common multi-year database. Given these constraints, NJIT ADVANCE decided to use CVs only as a reliability check on data gathered through other means, principally: 1) a social network survey and 2) a faculty publications database.

Social Networks Survey

Barry Wellman generously shared his procedures for gathering data with the ADVANCE team. Unfortunately, these measures involved a paper-based instrument that required an hour or more with each subject. Given that there were nearly 300 potential subjects (the tenured/tenure track faculty cohort) and only three overburdened ADVANCE researchers (two faculty PIs and one graduate assistant)—and given the historical reluctance of NJIT research faculty to spend time answering questions—we eventually decided not to use Wellman’s protocols. Nevertheless, the Wellman questions formed the basis for a shorter survey instrument that we designed to be completed either during a face-to-face interview or online. After obtaining approval from the NJIT Institutional Review Board (IRB), a lengthy process in itself, we pre-tested the survey in interviews with a small faculty sample; elicited feedback from them; revised the instrument; got it re-approved by the IRB; then pre-tested it again.

The survey consisted of four sections. **1)** In the **Background Information** section we collected data on subjects’ age, gender, department, rank, and research interests; **2)** We asked respondents to fill in a form with the names of their current **NJIT Research Colleagues** and to check off the specific nature of their interactions (e.g., discussing research ideas or activities, working on a formal research proposal or project, coauthoring a paper or book, etc.); **3)** We asked respondents to give us the names of their **Research Colleagues Outside of NJIT**. **4)** Finally, we asked respondents for the names of their **NJIT Friends**.

The “friends” category turned out to be extremely problematic. Faculty in our pre-test sample differed in gender, ethnicity, and age; in consequence, they also differed in their ideas about what constitutes “a friend.” Some subjects found our question confusing; others became suspicious. (“Why do you want to know who my friends are?”) After a number of iterations, we eventually settled on a working definition of “friend”; however, it later became apparent that reluctance to name friends increased faculty reluctance to complete the networks survey as a whole.

We made another decision that apparently reduced the subsequent faculty response rate as well. We added a Campus Climate Survey to the end of the Social Networks Survey. Feedback from the pre-tests of our initial instrument made it clear that “sense of community” had to be measured separately at the department level and at the campus level. Hence, we revised the survey, creating two similar but separate instruments. We then converted the entire six-part questionnaire (the network survey + the climate study) to a web-based format, put it up on SurveyMonkey, and began to publicize the project, offering incentives for participation.

Unfortunately, the addition of the climate study made the survey as a whole much too long.⁴ It also fueled paranoia. Many faculty who were quite willing to name research colleagues and reluctantly willing to name “friends,” balked entirely at characterizing their departmental climate. Both log data from Survey Monkey and anecdotal comments indicated that a number of faculty who began the survey opted out before completing it. Fifty percent of tenured/tenure track female faculty completed the climate study sections, but only 15% of male faculty did so. We have additional data from the pre-test sample; nevertheless, response levels to the climate survey were too small, and too skewed, to allow us to draw any fine grained conclusions—although the fact that both male and female mean scores were below the midpoint on both measures suggests that there is substantial room for improvement in campus climate!

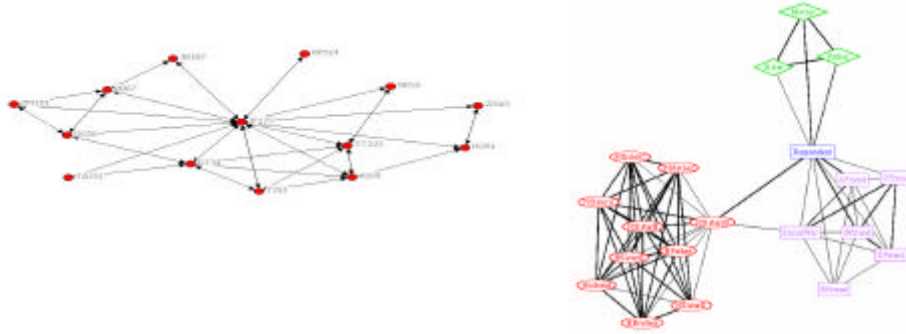
Despite the problems created by our inclusion of the climate survey, we were able to obtain useful network data, at least for female faculty. Nearly 80% of the women completed the social network survey, and we have additional data from the pre-test sample. However, less than 20% of male faculty completed the survey. Thus we do not yet have sufficient data to map collaboration patterns within the university. We are working around this problem by narrowing and deepening our focus. We are preparing to conduct whole-network analyses of two STEM departments. We propose to obtain data for these analyses from six sources: 1) by mining our existing Social Networks Survey database; 2) by administering the network survey to non-responding faculty in interviews; 3) by collecting CVs from the department chairs; 4) by querying our new faculty publications database (see below); 5) by asking faculty in the sample departments to update their publications DB profiles; and by 6) querying a new database of faculty grants, developed by a student IT team in collaboration with the NJIT Research Office.

Faculty Publications Database

Anticipating that self-reported data on faculty networks might be both difficult to obtain and potentially unreliable, from the very beginning NJIT ADVANCE sought means of collecting data empirically, and electronically. In the fall of 2006, we began to collaborate with a team of from NJIT's Van Houten library to build an interactive faculty publications database, believing that such a database, when fully populated, would allow us to map patterns in collaborative research, by gender and by department. The initial database structure, designed using MS Visio, included tables for storing data on authors (NJIT authors and external collaborators) and citations for each type of publication (articles, books, book chapters, conference papers/proceedings, and patents). The structure was revised, and an undergraduate MySQL programmer, working under the guidance of ADVANCE RA Maria Plummer, developed a process for automated uploads from electronic public databases to which the library subscribes, as permitted by licensing agreements. A statistics interface allows ADVANCE researchers to analyze collaborative patterns of NJIT faculty, by department and by gender. A prototype was successfully demonstrated in April 2007; a Beta version will be ready for faculty testing this spring.

Analyzing Social Network Data

As we continue to collect additional data, we are analyzing the data we already have. Like everything else about social network analysis, this is a complicated and time-consuming process. We are using UCINET, the most popular of several software programs designed specifically for SNA. This requires an intermediate procedure, in which raw data from surveys or other sources are entered in a text file using one of the formats suitable for importation into UCINET. Each "relation" ("strand") in a whole-network analysis requires a separate matrix. UCINET can then be used to analyze crucial measures such as *degree centrality*, *betweenness centrality*, *closeness centrality*, etc. Simple graphs can be subsequently imported into a visualization software package such as KrackPlot which generates multidimensional network maps, giving us a right-brained way of teasing out underlying patterns.



NJIT Faculty Ego- Network (left) KrackPlot- Whole- Network Map⁵

Mapping whole networks over time in this manner can support our work in WEPAN and ADVANCE by helping us better understand the dynamic structure of the organizations we seek to transform—structures that are often very different from the official organizational flow charts—and the changing place of women faculty in those structures. Social network analysis should not, and *cannot*, entirely replace more traditional, demographic-based measures of change (or lack of change)—e.g. the NSF 12 indicators.⁶ Nor should it replace *qualitative* research which is much more likely to capture subtle inequities such as the amount of invisible pro-bono work that women faculty tend to do, adding a Third Shift to their other two. However, with the important caveats that I have raised in this essay—including the need for reinvigorated cross-disciplinary partnership among engineers, educators, and sociologists—SNA can be a powerful tool for organizational change. At its best, it allows us to step out of our square on the matrix and see the big picture in which our individual lives are embedded.

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¹ Roger Brown, quoted in Freeman (2007).

² 651 female full professors, 701 associate professors and 908 assistant professors. (WEPAN 2006).

³ . Speakers in this series have included Margaret Leinen, Chief Science Officer and VP, Climos and former Assistant Director for Geosciences at NSF; Deborah Estrin, Jon Postel Chair in Computer Networks at UCLA and Founding Director of the Center for Embedded Networked Sensing; Susan Richardson, Research Chemist at the US Environmental Protection Agency; William A. Wulf, then-President, National Academy of Engineering; and Diana Rhoten, Director of Knowledge Institutions, Social Science Research Council, and NSF Program Director, Office of Cyberinfrastructure (Virtual Organizations and Learning & Workforce Development).

⁴ There was also a technical problem caused by the incompatibility between SurveyMonkey and Internet Explorer 7.0 that made it impossible to respond to the questions on social climate. Some subjects informed the investigators of this problem and chose to complete the social climate section using other methods. Others simply abandon the idea of trying to complete the questionnaire.

⁵ Source of the KrackPlot map: Nagurney 2004.

⁶ “NSF 12” Indicators:

1. Number of men and women tenured and tenure-track faculty by department, rank and gender
2. Number of non-tenured men and women faculty (e.g., Instructional, Research, Clinical, Postdoctoral)
3. Number of faculty who submit tenure packets, and number awarded tenure, by gender and department
4. Number of faculty who apply for promotion, and number promoted, by gender, department, and promotion transition (assistant to associate; associate to full)
5. Number of tenured associate professors by department and gender with years-in-rank (in 6, 3-year categories)
6. Number of faculty who leave their departments, excluding those who died or retired, by rank, gender, and department
7. Number of faculty hired by rank, gender, and department
8. Cohort analyses of tenure and promotion, including to full professor
9. Number of men and women scientists and engineers in leadership positions
10. Study of salaries of men and women faculty (with additional controls such as department, rank, years in rank)
11. Study of space allocation of STEM faculty by gender (with additional controls such as department, etc.)
12. Study of start-up packages of newly hired faculty by gender (with additional controls such as field/department, rank, etc.)