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“Facilitating Interdisciplinary Scholars”

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Abstract

Interdisciplinary scholars by definition, do not “fit” within institutional structures based on disciplinary departments. They face difficulties at every step along the way: negotiating interdepartmental resource and workload expectations when first hired, being productive in traditional venues, achieving recognition for their accomplishments, co-teaching, and administering grants. This culminates in a lack of clarity about promotion and tenure criteria. Often interdisciplinary scholars are placed in the unfair position of having to create their own process and structure, at the same time that they are attempting to navigate it.

Institutional structures and cultures are adapting to address these challenges. Some are establishing review criteria encompassing a broader range of scholarly activities, others have established new Vice Provosts for Interdisciplinary Activities, or Directors of Interdisciplinary Initiatives to provide guidance and oversight. Additional needs include a broader awareness of the multiple issues faced by interdisciplinary students and scholars, deliberate fostering of interdisciplinary personnel, and an awareness that interdisciplinary programs and faculty require greater investments to make them work than do long-standing disciplinary departments which have an established system of professional and educational support structures.

Introduction

“Through the control over faculty appointment, promotion, and tenure decisions, departments shape the intellectual capital of the campus in tune with the cultures, norms and intellectual orientations of the disciplines. Universities also derive recognition and prestige through the collective achievement of their departments as probed by discipline-based mechanisms (e.g., the National Research Council’s assessment of doctoral programs).” (Sá 2008)

As innovation increasingly occurs at the boundaries of disciplines, scholarship is now breaking out of the lines that make the “discipline within a department” structure troublesome for the interdisciplinary scholar. Traditionally, power, money, hiring and promotion are allocated by departments, posing barriers to interdisciplinarity at every turn: in the universities’ organizational design, lack of motivation within the institutional power structure, and lack of institutional incentives. These lead to difficulties in managing the complexity of interdisciplinary relations – the transaction costs -- both within and outside of the institution. Even students feel the strain when they undertake interdisciplinary programs of study and find themselves being taught and advised by faculty on loan from departments, unstable course offerings leading to difficulty in completing requirements, and a lack of facilities, community, and information on potential career trajectories. This chapter reviews the dynamics of interdisciplinary scholars functioning within a

disciplinary tradition and provides guidance for better support mechanisms to facilitate interdisciplinary scholarship.

Personal Approaches to Interdisciplinarity

In many cases, a variety of issues are conflated with the pursuit of interdisciplinary scholarship and teaching (Table 1). This adds a level of complexity to the life of interdisciplinary scholars as they work within the traditional disciplinary framework. Many interdisciplinary endeavors are in new fields, requiring establishment of new scholarly communities, with new resource needs (e.g., the need for shared space or additional travel) and new relationship demands (e.g., the need to learn a shared language). Interdisciplinary research and education is often collaborative, using informal, *ad hoc* teams (Evaluation Associates, 1999; Lattuca, 2001). Informal arrangements result in questions about credit for leadership, and challenges in negotiating group interactions. Assessment of an individual’s contribution (crucial for promotion and tenure) is also problematic in that interdisciplinary scholars tend not to specialize (Porter *et al.*, 2007). And researchers who don’t specialize pay a productivity penalty (Leahey et al., 2008), as coming up to speed in new fields and setting up new collaborations slow down publication rates. An additional complication is that members of groups underrepresented in the academic elite (women and perhaps minorities) appear to be disproportionately drawn to interdisciplinary research and education (Evaluation Associates, 1999; Beraud, 2003; Rhoten and Pfirman 2007a,b).

Table 1 Characteristics often associated – and conflated -- with disciplinary and interdisciplinary research and education.

Disciplinary	↔	Interdisciplinary	
Departmental	↔	Interdepartmental	
Mainstream	↔	Non-mainstream	(WISELI, 2003)
Specialized	↔	Diverse	(Leahey, 2006)
Discovery	↔	Integration, Application	(Boyer, 1990)
Specialization	↔	Integration	(Porter <i>et al.</i> , 2007)
Laser	↔	Searchlight	(Gardner, 2007)
Disciplinary	↔	Synthesis	
Basic	↔	Applied	
Hierarchical	↔	Collaborative, Democratic	
Formal		Informal	(Lattuca, 2001)
Established	↔	New (“Fringe”)	(Spanner, 2001; Choucri <i>et al.</i> , 2006)
Established Order	↔	Dissolution and Amalgamation	(Weingart and Stehr, 2000)
Majority	↔	Minority	(Rhoten and Pfirman, 2007 a,b)

However, not all interdisciplinary research is collaborative, nor is it all applied – as Rhoten and Pfirman (2007a,b) point out, there are many ways to be interdisciplinary (Figure 1). One can approach interdisciplinarity at a variety of scales, ranging from intrapersonal – where an individual decides to tackle research from multiple perspectives; to interpersonal – working with others; to inter-field – working with non-academic stakeholders, for example business and policy makers. Interdisciplinary teaching ranges through the same categories, each with their own set of administrative issues: the need for course release to develop the intrapersonal expertise, co-teaching credit for the interpersonal approach, departmental buy in for the inter-field class, and adjunct support for practitioners when external stakeholders are involved. (cite Teaching chapter).

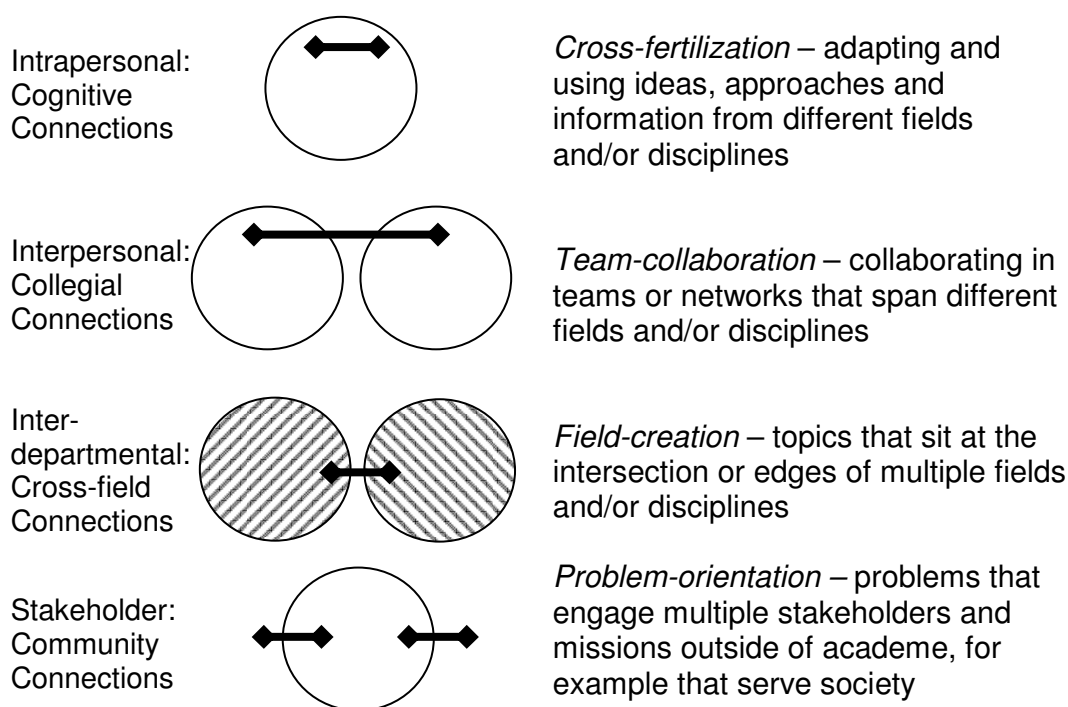


Figure 1 Interdisciplinary ways of conducting research and of teaching, from Pfirman, Martin *et al.*, 2007, based on Rhoten and Pfirman (2007a,b).

What this means in practice, for the establishment and fostering of interdisciplinary scholars, is that they are dealing with many issues at the same time: not only the gathering of their own, individual expertise and gaining recognition for their creative contributions, but also the need to justify both their field and their approach (Langfeldt, 2006), even within small interdisciplinary research teams.

“Each of us has had the experience of feeling as though we do not ‘really’ belong to the research team, or that, upon returning to our scholarly ‘homes’ after a research meeting,

we do not really belong there either. Working at the boundaries of communities of practice, team members can feel uprooted, alien, frustrated. ... When data from one's discipline is under scrutiny in an analysis session, the insider may perceive a need to defend her turf, provoking a sense of resentment and conflict with the rest of the team ...” (Lingard *et al.*, 2007).

Spanner (2001) found that most interdisciplinary scholars believed that they operated in a more complex environment than disciplinary scholars, and many thought that they needed to know more information – with significant problems locating useful information scattered across diverse fields (see Palmer chapter, HOI):

“When one considers the unique problems and barriers ID scholars face, particularly in tandem with their expressed discomfort levels in non-affiliate fields and dissatisfaction with available resources, the lot of the average ID scholar might be more stressful and pressure ridden than those conducting traditional single-discipline research.” (Spanner, 2001).

Co-teaching an interdisciplinary course raises similar issues in the classroom as faculty feel compelled to justify their teaching methods and content selection (Jang, 2006). These continued self-examinations and appeals for acceptance can lead to a sense of personal vulnerability, tension, insecurity and demoralization. Many believe they must continually declare, and be modest about, their limited knowledge of other fields in which they are working, else they risk being considered as “dilettantes who knew too little and claimed too much” (Lattuca, 2001). As scholars move away from a disciplinary base into interdisciplinary endeavors, they often report that they no longer fit in as well as they once did: while their peers establish identity and status within the discipline, interdisciplinary scholars have to “live without the comfort of expertise” (Lattuca, 2001). It is therefore not surprising that the University of Wisconsin’s Women in Science and Engineering Leadership Institute (WISELI) found the critical determining factor in the quality of workplace interactions (including: informal departmental interactions, colleagues' valuation of research, isolation and "fit," and departmental decision-making), was whether or not individuals thought their colleagues considered their research to be “mainstream”.

Despite these challenges to personal identity, many scholars are determined to follow their interdisciplinary research and teaching agendas, even when they are not in supportive environments. In the analysis of United Kingdom researchers by Evaluation Associates (1999), 30% of highly interdisciplinary scholars were based at institutions where they rated the “overall environment in your institution for interdisciplinary research worse than that for single disciplinary research.” For others it is a choice between interdisciplinarity or something else completely: as Kinzig commented in Haag (2006) “I think we have an increasing number of students who aren't that interested in being disciplinary. I think if I had had to focus narrowly

within a particular discipline, I would not have finished graduate school. I just would have gotten bored.”

Junior interdisciplinary scholars are especially affected by issues of academic community, evaluation, and administrative responsibility. When they first embark on interdisciplinary research and education, they are buoyed by excitement and see mainly the positive aspects of venturing into new territory (Table 2). By breaking new ground, they are able to set themselves apart from others, have a lot of autonomy in their research agenda, and can work with colleagues from a variety of disciplines and communities. But then, as they continue their research, often moving toward tenure consideration, the negatives become more and more problematic (Choucri *et al.*, 2006), and many of the conflated issues (Table 1) raise difficult challenges. It is harder to publish interdisciplinary research in traditional journals well known by the disciplines. Collaborative projects take a long time to get up and running due their high transaction costs. Additionally, if scholars have affiliations with more than one department, they may be getting conflicting advice (or none at all) on how best to demonstrate their research contributions.

Table 2 Aspects of conducting interdisciplinary research and education are disproportionately skewed towards positive in the early stages, followed by negative at later stages (adapted from Pfirman, Martin, *et al.*, 2007).

Interdisciplinary Research		
	Often Early Attraction ...	But Later Difficulties ...
New area	Can break new ground Less competition Less urgency	Less recognition by established scholars Fewer sustained funding opportunities Fewer journals Fewer peer reviewers Career trajectory not known Long start up time
Social/Applied Connections	Appeals to social conscience Connect with public good	Less prestigious research area Considered less rigorous
Complex questions	Holistic approach required	Considered less rigorous
Collaborative	Build on strengths of others Use people skills	Time to cultivate and maintain Critical literature in other field Dependent on collaborator Idea origin not clear
Between Depts/Centers	Freedom because outside of established hierarchy	Less administrative support

Inter-institutional	Broadens network for letter writers	Requires travel Less visibility on home campus
Interdisciplinary Education and Community		
	Often Early Attraction ...	But Later Difficulties ...
Teaching	Exciting subject Student interest Co-teaching Field experiences Service learning No textbook, resources	Fewer textbook, resources Less infrastructure and fewer rewards to sustain “extra” activities (field, service) Co-teaching Heavier student advising load
Campus Life	Campus programming Community connections Bridge between disciplines: search committees, presentations Become known on campus	More service and outreach expectations
Scholarly Participation	Field more open, can initiate programs	Fewer high level, prestigious committees Fewer honors than in disciplinary fields
Promotion and Tenure		Criteria often disadvantage interdisciplinary scholars

Similar issues arise from the perspectives of education, community participation and service (Table 2). Given these challenges, junior scholars are often wary – or warned off -- of embarking on interdisciplinarity, while senior scholars tend to be more open and willing. Mentors, champions, and role models are often helpful in easing the personal anxieties of junior scholars at the same time that they provide professional guidance and support.

Institutional Support for Interdisciplinary Scholars

Institutions have recognized that departmental structures create barriers for scholars working between departments and are adjusting to the needs of interdisciplinary scholars (Table 3). While most institutions have now made at least modest efforts to include interdisciplinary educational programs through establishment of minor courses of study, many others have established interdisciplinary centers and programs, created interdisciplinary departments, and hired senior interdisciplinary scholars: some have gone as far as breaking down the disciplinary departmental structure altogether (Feller 2002; Collins 2002;). The Consortium on Fostering Interdisciplinary Inquiry (2008) includes ten large research universities who partner to build

upon their interdisciplinary policy and process experiences, aiding each other to improve institutional structures affecting interdisciplinary activities.

The greatest stress seems to occur at intermediate levels of investment as institutions and individuals attempt to adjust to the needs of interdisciplinary scholars. Because their needs are novel, the scholars often fall between the cracks of administrative responsibility (Figure 2). As Monroe, *et al.* (2008) commented (with regard to women in academia) the “... lack of established procedures reflect an institution in flux, not one that is biased so much as unfamiliar with the needs ... and struggling hard to catch up to a new institutional reality and culture.”

Table 3 Spectrum of institutional interdisciplinary commitment, investment, and therefore also responsibility (adapted from Pfirman, Martin, *et al.* 2007).

Commitment and Investment	Modest	Intermediate	Significant
Students, Curriculum	Minor, General education elective	Concentration, Special major	Major, General education requirement
Administration	Committee	Center, Program	Interdisciplinary department, Dissolution of departments
Faculty	Affiliated hire in disciplinary department, Adjunct hire	Off-ladder, Joint hire	Tenure-track interdisciplinary appointment
Research Scientists	Soft-money support for single or short- term project	Multi-year support	Institution-committed career interdisciplinary research scientist line

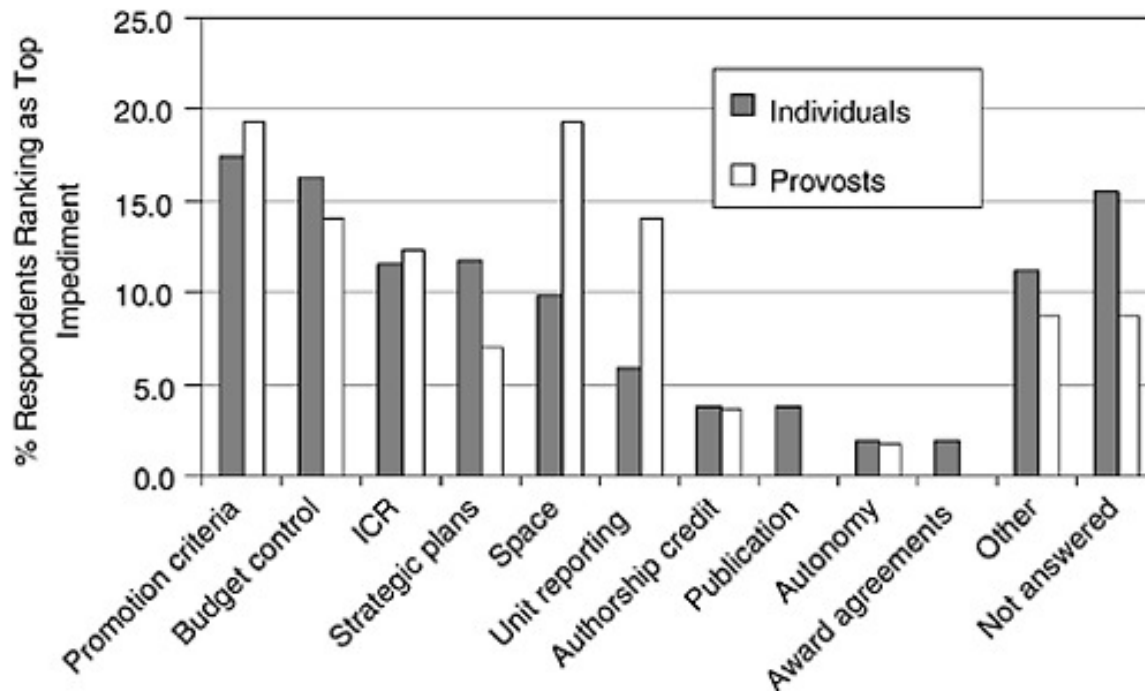


Figure 2 Impediments to interdisciplinary research identified by individuals and provosts in response to a request to rank the top five impediments to interdisciplinary research at their institutions (Committee on Facilitating Interdisciplinary Research, 2004). Note the high ranking of promotional criteria as well as structural/administrative concerns: budget, indirect costs, space, and unit reporting. **NEED COPYRIGHT PERMISSION**

Being intentional about supporting interdisciplinary scholars requires thinking through the potential challenges in advance. The individual should not be put in the position of having to create their own process at the same time they are attempting to navigate it. Creating an awareness of differences between interdisciplinary and disciplinary experiences – as we discuss below – can be helpful, from structuring a new hire, to understanding issues related to productivity, teaching, recognition, and evaluation. Awareness, however, is not enough. Funding and administrative support must also be provided. It is critical that institutions make commitments at the level of provost, vice president for research, or dean to the implementation -- not just to the initiation -- of interdisciplinarity (Feller 2002).

Structuring an Interdisciplinary Hire

The process of creating a new interdisciplinary position and the negotiation of the hire often determines the administrative framework of a position, and it is this frame that needs special attention for an interdisciplinary scholars. Decisions about new interdisciplinary positions require more extensive cross-institutional preparation than for traditional disciplinary hires. At the start of position creation, roles and expectations must be clarified and agreed upon, by all the departments and academic administrators involved, ideally including representatives of

promotion and tenure committees, and those responsible for allocating facilities and resources (Figure 2, Pfirman, Martin *et al.*, 2007).

While joint appointments (department-department, or department-center) appear to make sense for interdisciplinary scholars, such appointments often lead to mismatches in their professional life. One is the expectation for service, an expectation that is often double for the joint appointment, serving the needs of two entities (or being penalized for appearing not to serve – for example when teaching is bought out by a research center). Joint appointments may be held to the tenure standards of both departments, which may be at odds (e.g., publications in journals vs. books, sole- vs. multiple- authorship). Because responsibility for joint hires is divided, the junior scholar may not get the guidance that they would within a disciplinary department or even through a professional association (Table 2). The annual meeting of a discipline’s professional association is the place to give presentations, test ideas, and meet the leaders in the field. Interdisciplinary scholars either contribute at the fringe of disciplinary meetings, or risk limited mainstream visibility when they participate in smaller workshops closer to their field of endeavor.

When interdisciplinary faculty are joint hires, it becomes imperative that each department manages their expectations, so that the time and activity demands on the joint appointment are reasonable and not doubled. Having a departmental split of 60:40 or 70:30 may be preferable over a 50:50 split to provide immediate clarity about departmental service (Pfirman, Martin *et al.*, 2007). For junior faculty, an even better arrangement might be an “affiliated hire” where they are clearly based in one department, but have specific research and teaching contributions to another department, program or center (Table 2).

For all interdisciplinary hires, but especially for those that are joint between departments, the scope of the position should be articulated in a memorandum of understanding (MOU) that spells out scholarship expectations, promotion criteria, teaching responsibilities, departmental and community service, budget, indirect costs, graduate student/technician support, and space (Table 2 and Figure 2). These expectations can then be shared with potential candidates, and later adjusted as part of the negotiation package for the new hire.

Interdisciplinary teaching expectations need particular attention. Co-teaching classes with scholars from other departments can result in difficult negotiations with the administration and each department about course load, credit, responsibility, content, and classroom management methods. Also, many interdisciplinary educational goals would be best served by student-centered pedagogy -- taking students out into the field, interacting with stakeholders, getting involved in civic engagement, or conducting student-led research (e.g., van Hecke *et al.*, 2003). While these types of programs are often cited by students as transformative educational experiences, they are generally considered by the administration to be optional for faculty where

the academic program has traditionally been delivered through in-class lectures and structured laboratories. Faculty who choose to incorporate these aspects in their teaching therefore do so at the expense of time they could spend on research, and may even risk having their teaching considered “soft” or “not rigorous” in comparison with colleagues who use more traditional approaches.

An institutional structure that can work well for interdisciplinary hires is a cluster hire (usually two to about eight new positions, Sá 2008) to support a general theme or initiative, such as environmental sustainability. University of California campuses have been using cluster hires to quickly build interdisciplinary research teams. The administration, relevant departments and centers, work to create the cluster, setting the stage for broad acceptance of the theme. Departments can compete to be the home department of the new hires, thereby creating greater departmental acceptance of the interdisciplinary scholar.

Productivity and the Interdisciplinary Scholar

One of the most critical aspects to the success of any scholar is that they are productive: the number of publications is the factor first reviewed for faculty hires and candidates for tenure (Steinpreis *et al.*, 1999). Interdisciplinary scholars face hurdles in being productive beyond those of other researchers for a variety of reasons, the field may be new, the scholarly community not yet established; collaborative research requires high overhead/transaction costs in terms of communication, administration (Tables 1 and 2; Collins, 2002; Shanken, 2005; Sá 2008), and additional training requirements. Moreover, each discipline has its own convention for writing grants and publications, and disciplinary-based reviewers often raise issues and request revisions inappropriate for the scope of the interdisciplinary project, or difficult to reconcile because they are at odds.

An interdisciplinary scholar could deal with this situation by building expertise in their particular interdisciplinary area – effectively specializing in that area – and then branching into related research topics and publishing in related journals. Leahey *et al.* (2008) showed that in sociology and linguistics, researchers who specialized (had a more limited set of key words associated with their publications) were twice as productive as researchers who pursued a research agenda that changed fields substantially over the course of their career trajectory.

Although junior researchers in any field are often admonished to not “spread themselves too thin” this advice might be especially important for interdisciplinary scholars. Research by Porter *et al.* (2007) indicates that scholars who are highly integrative, tend not to specialize (Table 1). It may be that people with a “synthesizing mind” (Gardner, 2007) use integration as part of their methodology, just as a lab scientist may enjoy addressing lab research problems through experiments in their lab throughout their career. Spanner (2001) also found that interdisciplinary

researchers – especially those at the junior level – reported that they often deviated from their research agenda as they received input from another field.

Börner has tracked intersections among the disciplines by mapping knowledge domains – in the process creating a communication tool (e.g., Shiffrin and Börner, 2004). Interdisciplinary scholars can use this approach to work through related communities in linked networks, expanding their connections, (e.g., Ginsparg et al, 2004;) and therefore their spreading their professional recognition. Mapped knowledge domains not only connect scholarly communities but can act as another measure of interdisciplinary productivity ((Börner, 2006; Palmer, HOI).

Recognition of the Interdisciplinary Scholar

Along with productivity, assessment of research performance relies on reputation, especially recognition for creativity and achievement (Avital and Collopy, 2001). Recognition arises from scholars reading and discussing each other's work, often within disciplinary boundaries. As noted by Csikszentmihalyi (1996), individuals who act as gatekeepers for a field have the responsibility to decide whether a new idea or product should be included in the domain. It is much easier for gatekeepers to recognize innovation when the advance is a direct extension of their own work or that of known colleagues. This issue is compounded by publication in new, interdisciplinary journals with nascent reputations (Campbell, 2005). Without a process and a community for achieving recognition for creativity, the interdisciplinary scholar is faced with significant hurdles in promotion and tenure as well as in funding .

One way to create an interdisciplinary culture on campus, as well as to raise the profile of specific interdisciplinary scholars, is for interdisciplinary scholars to invite leading researchers to give presentations locally. This allows the local scholar to be the host: they get to know the external speaker better, they have the opportunity to talk about their own research, and issues of common interest become something known and talked about on campus. Such interactions are useful for any junior scholar, but are particularly important for those who are interdisciplinary or are in emerging fields (Tables 1 and 2). Lee and Bozeman (2005) showed that scholars typically spend about 50% of their time working with members of their own department, 15% working alone, 10% with others in the same institution, and 25% with outside collaborators. This means that, within a discipline-based department, there is a tremendous amount of shared knowledge. Interdisciplinary scholars often work with a broader community outside of the department, with collaborators who may be unknown to their departmental colleagues; it is helpful in gaining trust if departmental members get a chance to meet prominent interdisciplinary experts first hand.

While our focus thus far has been mainly on junior interdisciplinary scholars, senior scholars also experience recognition challenges (Pfirman, Martin *et al.*, 2007). Most disciplinary societies have something along the lines of a “lifetime achievement award” that identifies major

accomplishments and gives credit for accumulated success. In emerging interdisciplinary areas, the scholarly community structures, and therefore the opportunities for recognition, are not well formed (Tables 1 and 2). Also, if the interdisciplinary scholar has not specialized, their contributions may be spread over a number of different communities and therefore may not rise to the level of an award in any one of them. Less likely to be the targets of recruitment from other institutions, interdisciplinary scholars may not get the offers that stars do within the disciplines. It is essential that institutions recognize these fundamental differences, and that they support their interdisciplinary scholars – perhaps through establishment of institutional awards and medals that recognize their overall impact.

Interdisciplinary Evaluation and Promotion

Conventional, disciplinary-based procedures and standards to assess the work of interdisciplinary scholars ignore the real asymmetries between disciplinary and interdisciplinary research and teaching. In the 2004 study by the Committee on Facilitating Interdisciplinary Research, concern about “promotion criteria” was the most frequent issue raised by both individuals and provosts in response to a request to rank the top five impediments to interdisciplinary research at their institutions (Figure 2). Mismatched metrics include: the number of publications (as noted above, interdisciplinary, multi-authored work often has a slower production rate), focus on single or first-authored papers (interdisciplinary publication often involves multiple authors), prioritizing well known, disciplinary journals (not always an outlet for interdisciplinary scholarship), and citation indexes (interdisciplinary research is often new and must build its own constituency, Table 2).

While tacit knowledge including unwritten guidelines for tenure within a department are passed along through informal collegial interactions and following the outcomes of individual cases, the interdisciplinary scholar commonly is the test case that establishes the criteria through their own performance. But it is not their responsibility to do so – institutions that hire interdisciplinary scholars should create appropriate procedures and metrics, and then be clear about expectations. A compelling way to address this situation is to change how scholarship is evaluated. Boix Mansilla (2006) noted that interdisciplinary work can be viewed through the lens of “consistency with multiple disciplinary antecedents, balance of disciplinary perspectives in relation to research goals, and effectiveness in advancing knowledge through disciplinary interventions.” Lattuca (2001) recommends judging all scholarship simply “on the basis of its contribution to the advancement of knowledge.” Another option is to shift from using only ‘discovery’ as the critical component, to use of Boyer’s (1990) expanded set of criteria: ‘discovery’, ‘integration’ ‘application’ and ‘teaching’ (e.g., Porter *et al.*, 2006). Individuals can be asked to provide information on their contributions in each of these areas in their annual performance reports and then the same categories can be used in tenure review. The University of Southern California, Duke University, University of Michigan Medical School, along with some small liberal arts

colleges and some large US land grant universities do this now, because of their historic mission. However, a word of caution, one study of applied health researchers found that even when interdisciplinarity is at the core of an institution's mission, the chairs of promotion committees, and, to a lesser extent the deans, tend to accord significantly more value to traditional scholarly outputs, ranking the importance of non-traditional research output at or below the level of teaching (Phaneuf *et al.*, 2007).

Reviews of interdisciplinary scholars and proposals can also be facilitated by providing institutional clarity in terms of overall staffing/budget priorities and helping evaluators understand their mission. Letter writers, reviewers and evaluation committees, can be alerted that the scholar or request for proposals is interdisciplinary, and then providing them with the original position or program description. Other options are to collect input from more areas of expertise, permit proposers to provide input on reviewer selection, and allow for proposer response to initial reviews (Langfeldt, 2006).

In the case of a tenure review, the make up of the review committee itself can be critical: it is frequently helpful to include an external expert in the field of the candidate on a tenure review. A problem that can arise, particularly with new areas of interdisciplinary endeavor, is that the outside expert may not be a senior scholar, and therefore may not carry the same professional capital that the external member typically wields in this situation. In order that the review does not depend on this one scholar, individuals can also provide an annotated *curriculum vitae*, detailing their specific contributions to co-authored publications and grants, co-taught classes, informal advising, and standing of journals/publications venues which may not be known to members of the committee (Pfirman, Martin *et al.*, 2007).

Funding for Interdisciplinary Research and Education

Traditionally funding sources, whether internal or external to the university, have been channeled through disciplines. Therefore, support for interdisciplinary research is less stable than that for disciplinary research. When interdisciplinary calls for proposals are issued, they often have incredible proposal pressure, resulting in low funding rates: for example 4% for NSF-EPA Water and Watersheds (NSF AC-BIO, 1996). Then, the funding area is often either discontinued, or moved to another administrative structure. The National Science Foundation, after a period of attention toward an interdisciplinary area, frequently migrates support back into the disciplinary directorates, with the goal of changing the culture in the directorates, as well as allowing for new areas of focused attention at the cross-directorate level. However, because the established, disciplinary communities are strongly manifested in the directorates, the emerging interdisciplinary areas may not fare well, especially under conditions of budgetary stress! As a result, interdisciplinary scholars lack continuity in programs and program managers to go to for

support. When responsibility for the program shifts, interdisciplinary researchers must establish new contacts, spending considerable effort on rebuilding professional capital.

Funding agencies and institutions can help support interdisciplinary scholars by first recognizing that as they initiate interdisciplinary activities, the individual will move “out on the limb” with their infrastructure lagging behind their needs (Collins, 2002). They can be provided with release time, co-funding, matching funds and other support for crafting and implementing complex or major research proposals, as well as new interdisciplinary or co-taught classes. Investing and promoting a small number of high profile projects likely to have success can help institutions develop models that will then reduce resistance for tackling more risky endeavors.

The second major need in terms of funding is to explicitly support all four approaches to interdisciplinarity: intrapersonal, interpersonal/collaborative, interfield/departmental, and working with external stakeholders. The scholar wishing to develop intrapersonal expertise will need seed funding, sabbatical time, course release as well as perhaps travel support to learn from other institutions, along the lines of the Andrew W. Mellon Foundation “New Directions” grants.

Scholars who are pursuing collaborative, interfield, and stakeholder approaches can be facilitated by funding agencies allowing more than one principal investigator (PI) to be listed on the grant, permitting PIs to be rotated or even added as the grant evolves, and crediting non-academic products.

Support is also required to develop opportunities for collegial contact, both professional and social: time and space is needed for collaboration to occur. Co-funding of research centers is one way many institutions are supporting interdisciplinarity. But funding for informal interactions is also helpful. As noted above, most interdisciplinary research is conducted in *ad hoc*, rather than formal, research teams (Evaluation Associates, 1999). Similarly, 91% of the interdisciplinary scholars in the 2001 Spanner study rated collegial contact as being very important for their work. Trust, in addition to serendipitous connections, can be built through shared experiences such as social occasions and field trips, as well as through the more usual academic paths such as seminar series and workshops. Managing teams is difficult, but managing *ad hoc* interdisciplinary teams is even more challenging, due to issues conflated with interdisciplinarity (Table 1). Explicitly training interdisciplinary scholars in team management could lessen stress and increase effectiveness.

Interdepartmental and inter-institutional initiatives also face major hurdles in negotiating terms of budgets, indirect cost recovery, and space. In fact, the Committee on Facilitating Interdisciplinary Research found that, after promotion criteria, these are the most critical issues faced by interdisciplinary scholars (Figure 2). Having a point person within the institution’s

administrative structure whose job it is to sort out these issues greatly reduces the transaction costs of initiating new projects.

Concluding Remarks

Clearly, institutions serious about interdisciplinarity need to invest in support for individuals conducting interdisciplinary scholarship and teaching. Discretionary resources, incentives and administrative support such as seed funding, incubation grants, co-funding and matching grants, cross-disciplinary workshops and seminars, leaves, travel, joint appointments can go a long way toward helping people overcome personal and professional challenges. Funding agencies and donors can also help improve the working environment for interdisciplinary scholars by supporting research on reform of faculty reward systems and investing in research on ways to evaluate and facilitate interdisciplinarity.

Institutions interested in fostering interdisciplinarity should review their administrative processes to determine whether there are impediments to fair and objective review and support of scholars working across disciplines. Administrative structures must be flexible to address the needs of interdisciplinary scholars as one size does not fit all. Attention to the particulars of the interdisciplinary scholar's position is crucial, starting from the point of position creation to those of a senior faculty member. The lifecycle analysis by the Council of Environmental Deans and Directors (Pfirman, Martin *et al.*, 2007) provides guidance for overcoming typical questions and challenges at each stage of career development.

High-level administrative leadership – through a committee or an individual with strong support from the provost-level – should oversee the implementation of interdisciplinary activities and fostering of interdisciplinary scholars. Leadership actions include: crafting MOUs for interdisciplinary hires, hosting an interdisciplinary speaker series, running interdisciplinary faculty research and pedagogy events, providing training on managing and evaluating interdisciplinary scholarship, and recognizing junior and senior scholars who have contributed significantly to interdisciplinary scholarship or teaching. An interdisciplinary faculty pedagogy forum, joint with schools or departments of education, can be designed to foster sharing of best practices, as well as an increased awareness of new educational approaches and challenges faced within different disciplines. It can also open up education as an area of common ground, building ties between disciplinary and interdisciplinary academic professionals.

Interdisciplinary faculty can thrive when institutions make the investments necessary to create the support structures commensurate with those provided – and taken for granted – by departments and professional societies for those within the established disciplines.

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