Innovative Faculty Evaluation Criteria for Incentivizing High-Impact Interdisciplinary Collaboration

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Abstract - This paper presents five innovative practices in the evaluation of engineering faculty that work collaboratively across disciplines: i) use of a four category meta-matrix for calibrating evaluation standards across diverse research outcomes and practices, ii) replacing the traditional author hierarchy with group authoring practices for collective research products, iii) evaluating and rewarding the size, strength and diversity of a faculty member’s network of collaborators, iv) establishing guidelines for balancing interdisciplinary and disciplinary components of the evaluation across collaborating departments and v) using interdisciplinary evaluation committees at all levels of evaluation. These practices are key components of the interdisciplinary evaluation criteria of the School of Arts, Media and Engineering at Arizona State University. This paper presents the development and implementation process of these criteria as well as preliminary results from their use for faculty evaluations over the past five years. It discusses how these practices incentivize substantial interdisciplinary collaborations and related high impact results.

Index Terms - Interdisciplinary collaboration, faculty evaluation, promotion and tenure

CONTEXT AND PRIOR WORK

Many of the current and future challenges for engineering, and many of the key challenges of the 21st century overall, will require interdisciplinary approaches. All of the fourteen Grand Challenges of Engineering listed in the 2008 NAE report [1] require interdisciplinary collaboration. Some of them (i.e. advanced personalized learning) require research teams that span engineering, sciences, humanities and the arts and extensive field work in the real world context of the challenge. The type of interdisciplinary needed is not one of surface collaboration nor of tangential inclusion of knowledge from other disciplines. These are “complex problems that must be attacked simultaneously with deep knowledge from different perspectives” [2] and require effective communication across disciplines for the development of system level designs [3,4].

We have growing quantitative evidence of the benefits of interdisciplinary team research. A number of studies in the past few years have used computational modeling and analysis of collective efforts to show that diverse teams outperform individuals when dealing with complex problems [5]. A recent paper based on surveys of high impact publications shows that teams produce exceptionally high-impact research and more frequently cited research than individuals and that the advantage of groups vs individuals has been increasing over time. This holds true in sciences, engineering, social sciences, arts and humanities with science and engineering showing the strongest trend towards high impact team research [6]. Another paper uses surveys of publications and computational modeling to show that diverse teams outperform homogeneous teams. It shows that diverse perspectives produce more innovative solutions than homogenized pools of knowledge [7]. The Engineering Criteria 2000 developed by ABET [8] acknowledge these emerging trends. They combine traditional engineering attributes (i.e. science and math) with innovative attributes such as ability to function in multidisciplinary teams. These new attributes are consistent with continuous calls from industry leaders for engineers who are trained across disciplines [9]. Recent surveys show that industry representatives place communication and teamwork at the top of their lists of desirable skills for new engineering graduates [10].

Integrating engineering with other types of knowledge to address real world problems is also attractive to younger generations and may help address the problem of recruiting more students into engineering and science careers. In the 1990s, the enrollment of US citizens and permanent residents in graduate science and engineering programs declined substantially [11]. According to a recent survey of youth and adults conducted by Harris Interactive on behalf of ASQ, “an overwhelming 85 percent of youth say they are not interested in a future engineering career”. Thirty percent of the survey respondents say that “they prefer a more exciting career than engineering” [12]. Although young students may not be attracted to traditional engineering and science education, they do “show increasing enthusiasm about problems of global importance that have practical consequences, such as disease prevention, economic development, social inequality, and global climate change—all of which can best be addressed through (interdisciplinary research)” [2].

In response to the growing need for interdisciplinary activities, the National Academy of Sciences, National
Interdisciplinary Faculty states that “of the sixty-five advertisements posted to the CRA Job Announcement page recent Best Practices memo by the Computing Research organized around a specific problem (i.e. Biodesign). A traditional academic department (i.e. CS) and a center problem (i.e. informatics and biology) or between a represent the key types of knowledge needed for resolving a these appointments are across two departments that challenge themes. We see an increasing number of faculty appointments with interdisciplinary mandates. Many of these appointments are across two departments that represent the key types of knowledge needed for resolving a problem (i.e. informatics and biology) or between a traditional academic department (i.e. CS) and a center organized around a specific problem (i.e. Biodesign). A recent Best Practices memo by the Computing Research Association (CRA) on Promotion and Tenure of Interdisciplinary Faculty states that “of the sixty-five advertisements posted to the CRA Job Announcement page between December 1, 2007 and January 2, 2008, twenty-four were either for a specific interdisciplinary area (e.g., bioinformatics, music informatics, robotics), or specifically mentioned that interdisciplinary skills were required or preferred. An additional five advertisements noted that the hiring department had strong interdisciplinary connections”. The memo discusses the challenges faced by interdisciplinary faculty especially in regards to the promotion and tenure process. The single greatest difficulty it identifies is that “evaluating faculty tend to judge other faculty according to the norms and criteria of their own discipline. Even when faculty members conducting the evaluation adopt an open-minded stance, it may be challenging for them to calibrate the metrics for impact and academic success within another discipline, even a closely related one”. The memo proposes addressing some of these problems though interdisciplinary personnel committees. Similarly the FIDR report states that “in attempting to balance the strengthening of disciplines and the pursuit of interdisciplinary research, education, and training, many institutions are impeded by traditions and policies that govern hiring, promotion, tenure, and resource allocation”.

The report recommends that these traditional practices “should be revised to take into account more fully the values inherent in IDR activities”. New policies should aim for the appropriate “balance between criteria characteristic of IDR, such as contributions to creation of an emerging field, whether they lead to practical answers to societal questions, number and mix of participants, and traditional disciplinary criteria, such as research excellence”. Both above reports and other publications on interdisciplinary engineering research and education identify two additional challenges: a) evaluating the interdisciplinary collaboration record of a faculty member (a faculty member’s ability to collaborate in diverse networks and be a good citizen of such collective efforts) and b) assigning credit for collaborative products. A 2005 report by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE) and a related publication by Pfirman et al. show that all knowledge areas, not just engineering, are facing similar challenges with interdisciplinary faculty appointments. These two publications also emphasize the many pitfalls faced by junior faculty members holding joint appointments across two units.

Although many units across the nation are dealing with the challenges of evaluating interdisciplinary faculty, information on innovative practices in interdisciplinary faculty evaluation remains mostly anecdotal. The problems are well identified but suggested solutions remain vague. A number of more recent publications and reports are however taking the next step and providing concrete guidance. This paper aims to contribute to the growing need for a formal, concrete discussion on interdisciplinary faculty evaluation practices. The following sections will present the interdisciplinary promotion and tenure criteria and procedures of the School of Arts, Media and Engineering (AME) at Arizona State University and our experience with their development and implementation over the past five years. We start with a summary of the structure of AME and its interdisciplinary faculty appointments. This is followed by a presentation of the criteria focusing on how they address the key challenges identified in prior work: i) creating appropriate evaluation bodies across multiple units, ii) calibrating evaluation matrices across a diverse set of outcomes and practices, iii) assigning credit for collaborative efforts, iv) evaluating and rewarding interdisciplinary connectivity, and v) balancing interdisciplinary and disciplinary components of the evaluation. The paper closes with a brief presentation of the tools developed for the implementation of the evaluations and a summary of results from the use of the criteria and procedures over the past five years.

THE AME SCHOOL AND ITS INTERDISCIPLINARY FACULTY

The School of Arts, Media and Engineering (AME) was established as a graduate program in the Fall of 2003. It is a joint effort of the Herberger College of the Arts and the
Fulton School of Engineering. It focuses on interdisciplinary research and education in digital media with special emphasis on experiential media – systems that integrate computation in the physical human experience. AME offers digital media concentrations in the graduate degrees of ten units: Computer Science, Electrical Engineering, Bioengineering, Psychology, Education, Design, Music, Visual Art, Dance and Theater and Film. AME also offers a PhD in Media Arts and Sciences co-organized by the two supervising Colleges. AME has eleven faculty members. They teach a full array of digital media courses attended by students of all the concentrations. They also lead the interdisciplinary research teams of AME. Faculty and students from all the participating disciplines join AME faculty, staff and students to form research teams that develop digital media systems with applications in health, K-12 education, communication, creativity and complexity for sustainability. AME was elevated to School status in May of 2009 and will start offering undergraduate curricula, in collaboration with its partner units, in August 2009.

The majority of AME faculty are junior faculty members that have their tenure home with AME and a joint appointment with one of the collaborating units. Having joint appointments allows the faculty members to recruit and supervise students in the different concentrations and connect overall AME research and education activities with the activities of the participating Departments. Building the program through junior faculty members allows incoming faculty to develop an interdisciplinary profile focused on the central problem area of AME - digital and experiential media. It is preferable to hiring established faculty with an existing disciplinary profile. The inter/transdisciplinary core of AME faculty members can then work in tandem with faculty from collaborating Departments to build a wide interdisciplinary network of digital media faculty across ASU. However, this choice also made it necessary for AME to develop evaluation criteria and procedures that are in-keeping with the interdisciplinary profiles of AME faculty and that carefully address possible pitfalls of joint appointments for junior faculty.

THE AME INTERDISCIPLINARY FACULTY EVALUATION CRITERIA AND PROCEDURES

The AME faculty evaluation criteria and procedures had to incentivize and reward interdisciplinary approaches to research and education in digital media and at the same time be acceptable to the different collaborating units of AME that supported the other half of many of the joint appointments. A working group of senior faculty from participating Departments (Spanias, Panchanathan, He, Smith, McBeath, Savenye) collaborated with the chair of AME (Rikakis - the author) and AME junior faculty (Sundaram, Ingalls, Qian, Birchfield, Thornburg, Kelliher, Campana, Olsen, Coleman) to develop the AME criteria and procedures. The criteria were reviewed and edited by all participating Departments, the Deans of Engineering and Arts and approved by the office of the Provost.

I. Creating interdisciplinary evaluation bodies across multiple units

The AME personnel committee is made up of senior faculty members from collaborating Departments that are actively engaged in AME research. Junior AME faculty who achieve tenure will be included in the committee’s rotating membership. The college level evaluation committee for AME faculty is an ad-hoc interdisciplinary committee with representation from the arts, engineering and the sciences. The Deans of Arts and Engineering produced a joint recommendation for the promotion and tenure of AME faculty. For faculty members with joint appointments, the interdisciplinary AME personnel committee requests input from the personnel committee of the joint Department and integrates that input in their evaluation. The same process occurs at the chair level with the AME chair requesting input from the chair of the collaborating Department. That way, the AME faculty member holding a joint appointment receives one coherent evaluation voice, both at the personnel committee and chair level, with the disciplinary input integrated in a broader interdisciplinary perspective.

II. Calibrating evaluation matrices across a diverse set of outcomes and practices

Because the AME program bridges engineering, sciences and the arts, the set of outcomes produced by its faculty members are very broad. They range from high impact journal publications, to software and hardware systems, field-work in schools and communities, and performances. To facilitate the work of personnel committees it was important to produce a meta-matrix that could help calibrate the different types of research outcomes in a quantifiable manner. A hierarchy of four outcome categories was created: major, standard, minor and supportive. All participating disciplines were asked to provide some form of quantitative criteria for ranking the faculty research and creative activity outcomes of their discipline into these categories. We give below examples of the criteria developed for placing publications, performances, software/hardware systems as well as non-traditional research outcomes into these categories.

Categorizing publications: There are three criteria for defining a publication as major: 1) Highly competitive peer review with low acceptance rate (25% for conferences, 35% for journals); 2) Long paper; 3) In a high impact journal or highly cited conference. A publication that meets all above criteria can be defined as major. For each criterion not met the category is lowered one step (i.e a publication that meets two of the three above criteria can be defined as standard). If none of the three criteria is met, then the publication has to be defined as supportive.

Categorizing a performance/installation/showing: There are four criteria for defining a performance/presentation/showing as major: 1) Has gone through peer review with low acceptance rate; 2) Work presented is substantial (either in duration, complexity or size); 3) Presentation location is nationally/internationally known and highly cited in the discipline; 4) Long performance; 5) Highly cited performance.
literature or press; 4) There were more than 500 people in attendance (cumulative). A presentation that meets all four of the above criteria can be defined as major. For each criterion not met the category is lowered one step (i.e. a presentation that meets at least three of the above criteria can be defined as standard).

Evaluating software/hardware packages: Complete software or hardware systems released by a major industry outlet or complete freeware packages with a continuous user base of over 10,000 users are considered major research products. Significant components of software/hardware packages released by a major industry outlet or complete freeware packages with a continuous user base of over 5,000 users are considered standard research products. All other are considered minor or supportive.

Outcome categories are also used for classifying non-standard research outcomes. Media systems that are embedded in real life contexts and have the potential for significant societal impact may be considered non-standard academic research outcomes under certain circumstances. For example, one AME interdisciplinary group is creating mixed reality rehabilitation systems for stroke survivors and is working on a regular basis with stroke survivors and medical doctors in clinical settings on developing and testing the system. Another group is developing systems for embodied mediated learning in K-12 education. It installs the systems in local schools and works on a daily basis with teachers and students to deliver standard curriculum in a mediated, active learning manner. Such complex, embedded projects might require a long gestation period before producing results that can be published in major journals [16, 17]. During that gestation period the faculty member must get some credit for their efforts in embedded research. Thus, the AME criteria allow for an embedded media system or methodology to be treated as a research outcome in its own right and be categorized as a standard or minor research product based on two indicative embeddedness criteria: a) the level of product adoption by the relevant communities (i.e. how many teachers in K-12 schools use the system to deliver curriculum to a significant number of students) and/or b) level of documented improvement in daily life of relevant subject groups (i.e. a considerable number of stroke survivors are using the system to enhance their daily rehabilitation routine).

The four-category meta-matrix described above facilitates the comparative evaluation of AME faculty members by evaluators from multiple disciplines. Evaluators not familiar with a particular type of outcome (i.e. an engineering faculty member might not be familiar with the impact of a permanent installation at the Exploratorium in San Francisco) can develop an appreciation of the significance of that outcome. An evaluator not familiar with the area of activity of an AME faculty member (i.e. a psychology faculty may not be familiar with media engineering journals and conferences) can still approach the record of that faculty member in terms of the number of major, standard or minor products the faculty member has produced and compare that record to the records of other AME faculty.

III. Assigning credit for collaborative efforts

Many of the interdisciplinary AME teams working on complex problems are large and their research outcomes have multiple authors of varied contributions. For example, a recent paper on a pilot study for our mediated rehabilitation system had ten authors. Some of the authors had contributed significantly to the authoring of the system, the realization of the pilot study and the authoring of the paper. Some had contributed only to one or two of the areas or had minor contributions across all three areas. Traditional authoring conventions cannot accurately convey to evaluators the level of contribution of each person. Thus, the AME criteria include two approaches to listing authors in the evaluation system. The team writing the paper/creating a work can decide to take a traditional first, second, third author approach or an approach of grouping authors into primary authors, secondary authors and supporting authors. If the contributions of the main authors are clearly gradated, then traditional author listing must be used. If the contributions of main authors are of equal effort and significance, then group authoring must be used. The lead faculty author of the paper/work decides whether this is a group or traditional hierarchy effort and the order of the authors. For a faculty member or student to be listed as a primary author in group authoring, the research product must include a tangible, substantial contribution by the individual.

In evaluating the research record of an AME faculty member, the reviewing committees need to consider the number and categories of the research products (i.e. how many major, standard, and minor research products the faculty member was involved in) but also the level of involvement of the faculty member in each outcome (i.e. how many major products was the faculty member a primary author for).

IV. Evaluating and rewarding interdisciplinary connectivity

The complex research projects of AME require extensive collaboration amongst the faculty members of the unit. These faculty members come from diverse backgrounds. Thus, the AME criteria assign 20% of the weight of a faculty member’s evaluation to interdisciplinary connectivity: the ability of a faculty member to successfully collaborate with their colleagues and bridge different perspectives. The approximate evaluation weights per category of faculty activity are as follows: research 40%, teaching 30%, connectivity 20%, service 10%.

The AME on-line evaluation system uses the authors list of all the research outcomes produced by a faculty member or his/her advisees during a review period to extract the network of connections for each faculty member and for their advisees for that review period. The strength of the connection between a faculty member or an advisee and another member of the community is based on the number
of collaborative research products (i.e. published papers, released software, public installations) these two members have jointly worked on. The evaluating bodies are asked to review each member’s network in terms of size (number of connections), strength of connections and disciplinary make-up of connections. Evaluators are also asked to review the number of authors per research product and the number of disciplines per research product of the faculty member and his/her advisees.

V. Balancing interdisciplinary and disciplinary components of the evaluation.

Many of the AME faculty members have joint appointments with traditional disciplinary departments and are expected to connect the activities of these departments with the activities of AME. These faculty members have to combine strong interdisciplinary activity in digital media with a good record of traditional outcomes specific to their discipline. The AME criteria give indicative satisfactory activity profiles for faculty members based on their disciplinary background and joint appointment. For example, AME faculty members with joint appointments in engineering, need to have at least 15 high impact engineering publications (seven of the major and eight of the standard category) by the end of the fifth year of their appointment. They are also expected to have a primary role in the development of at least three functioning media systems that show wide adoption by the relevant communities or potential for strong societal impact. The connectivity profile of an AME engineering faculty member needs to include a balanced number of connections to faculty and students from engineering, science and the arts and needs to approach 100 connections per year (including connections of advisees) when the faculty member reaches their tenure review. The number of authors and disciplines per research product must meet or exceed current national mean numbers in those areas (currently at 3)[6]. External income expectation for AME engineering faculty is set at approximately 75% of the expectation in their joint engineering unit. By contrast, expectations for Media Arts faculty at AME include an equal balance of publications, functioning media systems and performances/public installations. Their external income expectation is set at 1/3 of the expected income of AME engineering faculty.

TOOLS FOR THE IMPLEMENTATION OF THE EVALUATION PROCESS

The use of these innovative criteria in the evaluation of AME faculty required the development of a customized on-line system. The system was developed by research professor Loren Olson with input from the administrative staff (Braciszewski, Bivona, Watt) and the Chair (the author). The system allows all faculty and students at AME to record their research activities on-line in a common format. While entering their records faculty and students can choose the category of each research product (major, standard etc) and enter the quantitative data for its categorization. They can enter the product’s coauthors and their author categories (primary, secondary, first, second etc.) so that their entry proliferates to the records of their coauthors as well. The system uses all entered data by faculty and students to extract the connectivity profile for all members of the AME network. Evaluators from the different Departments can log into the system remotely and browse and compare all faculty records. They can compare records of faculty members in terms of research outcome activity and categories (i.e. number of major or standard products), types of authorships (i.e. number of primary and secondary authorships), interdisciplinary connectivity profiles, external income, teaching record, service record and others (such as awards, patents etc). They can also compare records to the indicative activity profiles for each type of faculty (media engineering profile, media arts profile etc). Evaluators can then enter their review on-line so that it can be available to other evaluators. This minimizes the need to make physical records available to and organize meetings between evaluators that come from many different departments at different locations across campus.

RESULTS FROM THE USAGE OF THE CRITERIA

The AME interdisciplinary evaluation criteria and procedures have been used for all annual, probationary and tenure evaluations of AME faculty members in the past four years. Much of the information regarding the results of the usage is confidential and cannot be shared in a publication. Furthermore, the sample is too small in terms of faculty members (10) and years (4) to support the reporting of clear trends with confidence. However, overall observations of evaluees and evaluators regarding the criteria and process can be shared. Some preliminary observed trends can also be shared in cases where that does not compromise confidentiality of individual records.

The most important results to date from the use of these innovative criteria and procedures are:

- they have helped AME faculty reflect on and improve their records so they can better meet their appointment expectations. Records have shown a continuously improving balance between interdisciplinary and disciplinary outcomes. Mean interdisciplinary connectivity across all faculty members has shown a steady increase each year.
- they have helped evaluators from all disciplines have a better understanding of the activity of AME faculty and produce evaluations that are in-keeping with appointment expectations and more consistent across evaluators from different disciplines. Personnel committees in collaborating units find the criteria and system more challenging to use as they have little exposure to them in comparison to the evaluation criteria and processes of their own unit. However, the interdisciplinary AME personnel committee has mitigated the problem by successfully integrating disciplinary input into AME faculty evaluations while
maintaining a good interdisciplinary/ disciplinary balance in their reviews.

- the consistency of evaluations across disciplines and committees has increased the confidence of AME faculty in the evaluation process and has made them more comfortable with the concept of developing and being evaluated on an interdisciplinary, collaborative record.

- the evaluation process and results have helped the unit continuously improve its operation structure and the actual criteria. For example, trends seen in the evaluation results have initiated the reorganization of the unit’s collaborative research procedures and student co-supervising structures. Other identified trends have allowed the unit’s research committee to fine-tune the criteria used for classifying research outcomes. The criteria are being seen as a living document that is reviewed and updated every two years.

- the evaluation process has been getting easier each year for all involved (valuees, evaluators and administrators). This points to the fact that any introduction of new review procedures needs to be given time to mature and become widely accepted. Hastily abandoning new interdisciplinary evaluation procedures because of early difficulties in implementation can undermine the progress of interdisciplinary faculty activity.

CONCLUSION

Traditional disciplinary faculty evaluation criteria do not fully address the activity profiles of engineering faculty that are working collaboratively across disciplines for solving complex problems. Traditional evaluation of interdisciplinary faculty and especially junior faculty may hinder their success. Innovative evaluation practices that simultaneously acknowledge the breath and depth of interdisciplinary faculty activity and incentivize collaborative outcomes can facilitate participation of engineering faculty in large and diverse teams tackling grand challenges. Interdisciplinary evaluation practices, like the ones used at the School of Arts, Media and Engineering at ASU, are still at an early stage but are showing great promise. Increase in the number of programs using interdisciplinary evaluation practices and a longer time period for studying the effect of such practices is needed.

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