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Source: BioScience, 57(1) : 71-78

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/B570111

Constructing a Broader and More Inclusive Value System in Science

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A scientific culture that welcomes a diversity of participants and addresses a broad range of questions is critical to the success of the scientific enterprise and essential for engaging the public in science. By favoring behaviors and practices that result in a narrow set of outcomes, our current scientific culture may lower the diversity of the scientific workforce, limit the range and relevance of scientific pursuits, and restrict the scope of interdisciplinary collaboration and public engagement. The scientific community will reach its full intellectual potential and secure public support through thorough, multitiered initiatives that aim to change individual and institutional behaviors, shift current reward structures to reflect a wider set of values, and explicitly consider societal benefits in the establishment of research agendas. We discuss some shortcomings and costs of the current value system and provide some guidelines for the development of initiatives that transcend such limitations.

Keywords: scientific culture, diversity, science and society, reward systems, institutional structure

In the past few decades, there has been a growing call for scientists to continue traditional productive research careers but to also actively engage in education, public outreach, and policy development. This shift has been motivated by the need to reach and rely on an increasingly large and diverse educated public, by the emergence of scientific issues of global concern (e.g., climate change, the incidence of pandemics), and by heightened demands on research funding sources. Many individual scientists and some institutions have eagerly embraced efforts to expand the breadth of scientific endeavors and to foster a demographically diverse scientific workforce. Scientific societies routinely offer workshops in education and public outreach, and a number of funding agencies have incorporated broader criteria in their proposal evaluation processes. However, time is a critically limiting factor, and when scientists are forced to prioritize their efforts, mainstream scientific culture still favors a narrow set of outcomes that do not necessarily reflect the changing nature of the practice of science. To a large extent, this scientific culture—that is, scientists' shared values, norms, attitudes, customs, goals, and practices—sets the ground rules for success and participation in science. As such, it shapes us as individuals, the institutions we create, and our science.

This culture is fundamentally a product of scientists' individual actions and of the institutional structures we have created, reflecting our individual and collective choices and values (Longino 1990). Culture is a continuously evolving entity that requires its members to reflect periodically on its values, choices, goals, and practices. There is clearly a need for such reflection in science today, as the limited focus of our current reward structure does not favor the adoption of the emerging values of education, diversity, and public engagement (Boyer 1990). At times, our community is international, collaborative, and open to new ideas; at others, it is exclusive, parochial, and discriminatory. Here we argue that the ability of scientists to achieve the changing goals of science will require a critical evaluation of our scientific culture as well as the adoption of a broader value system.

In this article we have two objectives: (1) to discuss and illustrate key ways in which individual, group, and institutional practices—i.e., culture—influence the diversity and participation of the scientific workforce and the relationship between science and society; and (2) to offer some practical recommendations to develop and institutionalize a value system that

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balances multiple goals and suits the realities of scientific practice today. Our goals are to stimulate broad, inclusive thinking and productive discussion, and ultimately to encourage individual and institutional actions that will serve science, now and in the future.

The influence of culture on the scientific enterprise

Our scientific culture strongly shapes our beliefs, behaviors, and group practices, as well as the ways in which we interpret information and the ideas we choose to explore (Longino 1990, Sutton 1995). In turn, the choices we make in this regard determine the success or failure of attempts to attract and retain a diverse scientific workforce; the methods, range, and relevance of scientific pursuits; and the relationship between scientists and the general public (Branscomb et al. 2001, Rhoten and Parker 2004, Rhoten and Pfirman 2007).

Our current mainstream scientific culture values, and therefore rewards, a relatively narrow range of practices and outcomes. Most universities, many research institutions, and an increasing number of small, private colleges value a limited range of scholarship and associated activities, including primacy of discovery, number of publications in high-profile disciplinary journals and subsequent citations (e.g., Leimu and Koricheva 2005), acquisition of grants, invitations to present results at keynote sessions in disciplinary meetings, membership in social networks composed of high-profile scientists, service in key editorial positions and on panels at funding organizations, and demonstrably thriving research labs (as evidenced by the ability to attract a large number of students or postdoctoral researchers).

Given the tremendous time demands placed on individual scientists, the goals set by the scientific culture either explicitly or implicitly devalue activities such as teaching and limit the scope of socially engaged research and public outreach. Yet these activities are as important to the scientific enterprise as other, more highly rewarded practices, and they are critical for engaging the public in science. More important, our current measures of success keep us too busy to pause to consider either the value system that guides our scientific culture or its consequences. Here we explore in some detail the consequences of scientific culture, and of our current value system in particular, for both the diversity of the scientific workforce and the role of science in society.

Diversity and participation in science. Scientific values, such as a reward structure that reinforces the narrow scope of many disciplinary research fields and encourages competition by placing a premium on discovery and attribution of credit to individuals, may act to discourage a diverse scientific workforce (Barinaga 1993, Rhoten and Parker 2004, Niederle and Vesterlund 2005, Rhoten and Pfirman 2007). For example, recent research has demonstrated that women tend to be more interested in problem-oriented or socially relevant science that mandates an interdisciplinary approach rather than in research that is of limited scope or disconnected from societal issues (Branscomb et al. 2001, Rhoten and Pfirman 2007). (Note: Throughout the article, following Rhoten and Pfirman [2007], we use the term *interdisciplinary* to refer to "real-world" problem solving for which solutions are beyond the scope of a single discipline.) Whether such choices are simply the result of cultural differences between men and women or are an attempt by women to avoid the hierarchical, and often exclusionary, structure and competitive nature of mainstream science is still open to question.

Scientific culture may also affect the composition of the scientific workforce through the interpersonal interactions that play a key role in the establishment of the social networks necessary to succeed in science. Collegiality is often identified as a key element to success in academia, since colleagues serve as a support group, a center of information exchange, and a source of opportunities such as invitations to speak, appointments to committees, nominations for leadership positions in professional societies, and service on editorial boards and committees. Colleagues also function as peers who review manuscripts, proposals, and tenure packages (Hall and Sandler 1982, Grimm 2005). However, perceptions of collegiality as well as actual collegial behavior are often colored by unconscious beliefs (Wenneras and Wold 1997). Considerable accumulated evidence suggests that the underrepresentation of African Americans, Hispanics, and women in many scientific fields, and particularly in senior or powerful positions, is often due not to overt discrimination but to subtle exclusion of individuals in these groups from the collegial culture and atmosphere (e.g., MIT 1999). This is in part because people are typically most comfortable with people of similar background, socioeconomic status, age, gender, and race (Hall and Sandler 1982, Ginorio 1995), but also because unarticulated beliefs about specific groups color the perception of competence and leadership potential (Wenneras and Wold 1997, Valian 1998).

Exclusion from—or inclusion in—scientific networks can in turn profoundly affect careers, promoting some, but not all, scientists of comparable abilities. The importance of these social forces was well illustrated in a study demonstrating that competence ratings assigned to postdoctoral fellowship candidates were significantly influenced by a candidate's gender and association with a member of the evaluating panel—even though the affiliated panel member did not participate in the scoring of that candidate (Wenneras and Wold 1997). Inclusive networks and collegiality are also critical to mentoring. The absence of role models from social networks has been identified as a key barrier to increasing diversity in science (Xie and Shauman 2003).

Finding ways to better embrace diversity requires a change in the definition of collegiality, from the ability of similar individuals to interact cooperatively to the ability of a diverse group to work effectively and creatively in spite of differences in background or viewpoint. Encouraging a scientific culture that is more inclusive of different perspectives, strengths, and approaches stands to advance science by fostering innovation and flexibility and improving problem solving and decisionmaking (Guimerà et al. 2005, Handels-

man et al. 2005, King 2005). For instance, a recent study found that a greater number of newcomers to a scientific team resulted in higher levels of performance, as measured by the impact factors of resulting publications (Guimerà et al. 2005).

Women and underrepresented minorities constitute more than two-thirds of the US workforce (Bureau of Labor Statistics 1999), and job growth in the United States is expected to occur primarily in the science and technology sector; thus, if shortages of skilled labor are to be avoided, a diverse workforce must be cultivated (CAWMSET 2000). Fostering a more inclusive scientific culture is also likely to address scientific questions that are relevant to a broader segment of society by including researchers with a greater focus on problem-oriented science and by bringing to the table a wider set of perspectives and goals (Branscomb et al. 2001).

The role of science in society. For science to play an important role in resolving issues of global importance, a diverse group of participants is necessary, including those who work at different points on the continuum of basic to applied science and from global to local scales, as well as those who work to engage managers, policymakers, students, and the public. Although we recognize that not all science needs to address pressing socioeconomic issues, incorporating these multiple cultural values and scales of influence is critical for addressing the challenges science faces today (e.g., the increasing incidence of pandemics, dwindling energy supplies). The current reward structure in science, with its emphasis on primacy of discovery and on high-profile publications, can often lead scientists to devalue the longer-term socioeconomic needs, cultural context, or local consequences of global environmental problems (e.g., global climate change), particularly in developing countries. While the publication of new work in a high-impact journal is currently more highly valued than the publication of a technical report, the latter is more likely to allow for the extended sections on methodology that are crucial to repeating the study or applying the work in management settings. The dual priorities of publishing in high-profile journals and of understanding and managing a problem are not equally valued by the scientific community, yet both outcomes advance scientific understanding. Some institutions, notably land-grant universities, have embraced the need for diverse contributions by creating different types of positions (e.g., professors, extension specialists, farm advisors), each with different goals and evaluation criteria; however, even within these systems, there often exists a hierarchy in which basic science publications are valued more highly than other contributions.

Although scientists must be careful to maintain some autonomy from political agendas, science has never been isolated from society and has always been embedded within broader cultural values and assumptions (Longino 1990). The virtual absence of scientists from the political arena hinders not only the public perception of science but also access to research funds and thus scientific progress (Greenberg 2001). The National Science Foundation (NSF) recently shifted its criteria for successful proposals to embrace the value of the "broader impacts" of science, requiring some form of outreach, education, or application of proposed research activities. This deliberate change in evaluation criteria has been significant. However, despite the new criterion, most of the current reward system for individuals and institutions in mainstream science still values more traditional measures of success, such as number of publications (O'Meara 2005). Thus an individual who devotes a substantial amount of time to broader-impact activities can be penalized when it comes to tenure, promotion, or outside valuation of scientific endeavors.

Recommendations for developing a broader value system in science

Increasing the social engagement of scientists and the hospitability of science to a diversity of participants requires that we acknowledge, support, and reward multiple forms of scientific scholarship (Boyer 1990). We propose that success in this regard will hinge on concerted efforts in all aspects of scientific culture, ranging from individual behavior to institutional structure and funding incentives. Moving forward toward the adoption of a broader, more inclusive value system will require some difficult balancing of priorities. How do we define, embrace, and evaluate the broad set of skills necessary to accomplish a diverse range of scientific and societal goals? How do we find the proper balance between current or new measures of success and the cultural, individual, or societal costs of their adoption?

We suggest a three-faceted process that will foster the development of a broader value system. First, existing scientific culture needs to be critically evaluated both for individuals within an institution and for the institution as a whole. Second, institutions ought to adopt, implement, and evaluate a broader, more inclusive cultural paradigm—one that promotes diversity of all kinds, social engagement, and multiple goals of science as part of the institutional mission. Third, funding organizations can take steps to encourage, evaluate, and reward individual and institutional efforts in these regards. All of these endeavors will take commitment and considerable time and effort, but each is essential to increasing the social engagement of scientists and the hospitability of science to a diversity of participants. Here we make some suggestions for implementation and point to a few successful examples.

Evaluation of existing scientific culture: Individuals and beyond. The first step in evaluation is to gather data and information about the existing culture and values within institutions. Both quantitative and qualitative data are useful in identifying patterns and trends. For instance, longitudinal trends in the recruitment, retention, and promotion of underrepresented individuals can identify successful and unsuccessful approaches to fostering diversity. Surveys of the hospitality of the departmental climate can also aid in these efforts. Analyses of annual data on diversity, made public and available, that include numbers of males, females, and underrepresented groups by class (e.g., students, postdoctoral

associates, faculty by rank, meeting attendees, seminar speakers, committee members) have been crucial to identifying patterns and stimulating cultural changes in universities, especially at the institutional level.

An excellent example is the case study of the status of senior women scientists at the Massachusetts Institute of Technology (MIT). In 1995, a group of senior women scientists at MIT petitioned the administration to review the status of women faculty and to remedy inequities with their male colleagues. This group uncovered issues ranging from inequities in salary, access to resources, and teaching duties to more subtle co-option of ideas and exclusion from high-level committees and the male-dominated community. The data from this initial analysis were used to spur major efforts to address these inequities, and initially greatly improved many of the metrics. However, more recent data demonstrate that long-term trends in faculty diversity were similar to, or worse than, the initial measures. This retrospective analysis shows how essential initial data and long-term monitoring are in informing discussions. Also revealed in the later analysis was the crucial role of leadership in both initiating and sustaining the trajectory of change (MIT 1999, Hopkins 2006).

Qualitative measures of the social relevance of research programs or peer-reviewed publications could also be made. For example, agricultural extension science and outreach programs can be evaluated by the degree of land managers' participation in workshops and experiments or by the adoption of changes in land-management approaches, or both. In addition, the number of congressional testimonies on scientific issues and the degree to which research results reach the public media (e.g., newspapers, newsmagazines, radio, television) could be used as a measure of the potential social impacts of science.

Any evaluation of cultural patterns and values clearly demonstrates that cultural data are, at best, semiquantitative, and that many existing behaviors and situations are not clear-cut, especially when multiple perspectives are considered. Ensuring inclusive behavior and encouraging a broader value system are thus not simply about prescriptions and prohibitions—there is no fixed set of rules that will result in a broader, more socially relevant scientific community. While universal rules may work well in a limited range of situations (e.g., in prohibiting openly discriminatory behavior), they poorly serve the exploration of nuanced, "gray" situations and the examination of scientific culture (e.g., how authorship decisions are made, or how institutions should weigh interdisciplinary research in making tenure decisions). Thus, broadening the scientific value system requires a context-dependent evaluation framework that places individuals, their perceptions, and their interactions in a specific institutional context.

We suggest that an effective way to examine not only individual beliefs, values, and behaviors but also institutional leadership, values, and efficacy is through the use of case studies. Discussion of generic case studies can serve to open dialogue and expose assumptions. Often rules, values, behaviors, and patterns of scientific thinking are learned by following the examples of supervisors and mentors, frequently without explicit discussion or training. These values and attitudes often serve to reinforce the status quo (Davis 2005).

In using case studies, simply considering questions that highlight issues of inclusion, equity, and social responsibility in science, and then articulating answers to these questions and concerns within a diverse group, will begin to reveal beliefs, values, and prejudices. However, to make a new cultural paradigm operational requires both dialogue and, ultimately, action that supports espoused beliefs. For these case studies to be most useful, individuals must approach discussions with self-honesty about their goals and intentions, reflect and consider their own habits and teachings, listen to others, and then consider whether their actions should be altered. To effectively develop an enduring, inclusive culture and a broader value system, these efforts need to be coupled with specific institutional support and committed leadership that encourages and reinforces changes in individual behavior (MIT 1999, Hopkins 2006, NAS/NAE/IOM 2006). Below, we provide some suggestions for establishing a process to guide the development and adoption of a broader value system at the institutional level.

Institutional adoption and implementation of a broader value system. By valuing multiple forms of scholarship, educational institutions can prepare scientists for active participation in a diverse democracy while developing knowledge for the enrichment of society (Boyer 1990, Checkoway 2001). Recent research has demonstrated that encouraging multiple forms of scholarship facilitates closer congruence between faculty priorities and institutional mission, changes the reward system in a way that improves faculty retention and diversity, and enhances undergraduate teaching (O'Meara 2005). However, if the benefits of a broader value system are to be realized, institutions will need to implement policies to ensure that changes will be enduring. Garnering support from individuals in the institution and community and allocating resources are crucial to making change possible. Here we suggest institutional actions that are designed to increase social engagement and foster diversity in the scientific workforce.

Inclusion of social engagement and diversity as key to the institutional mission. Broadening the mission of scientific institutions to include these new values is an important first step. University mission statements typically outline the priorities of the institution in the three traditional areas of scholarship: research, teaching, and social service. For instance, a mission statement that reflects strong commitment to social engagement may read, "We ask community organizations to be our partner in setting and conducting our research agenda," while a weaker statement may only provide a vague rhetorical reference (Holland 1997). "Community" will mean different things for small community colleges than for land-grant institutions or large, urban research universi-

ties. However, clarifying the institutional commitment to social engagement and diversity is critical to long-term success in the adoption of a broader view of scientific scholarship (Campus Compact 1997). A successful example in this regard is provided by land-grant institutions, whose original designation for openness, accessibility, and service to people has more recently been expanded to include leading agricultural extension activities at the national level.

Allocation of resources for administrative support, student-based learning, and faculty development. Allocation of resources (money, time, and incentives) is the second largest obstacle to problem-driven, socially engaged science (Pfirman et al. 2005). The allocation of funds for the development of a nexus—a staffed clearinghouse or center, for example—can foster the social engagement of faculty. For instance, Bates College has formalized this work in the founding of the Harward Center for Community Partnerships (*www.bates.edu/harward-center.xml*). Staff at the center work to institutionalize the relationships of individual faculty with outside organizations, serve as an entry point for initial community contact and consultation, and provide students and faculty with information about and opportunities for service-based learning (see also Ward 1998). The Harward Center director is also active in educating faculty and administrators about the value of community-based scholarship and in finding appropriate outside reviewers for the tenure and promotion dossiers of faculty whose scholarship includes a significant component of community engagement (see "Evaluation and modification of faculty reward and promotion structures," below). Institutions can also foster socially engaged research by allocating funds to educate faculty on this broader view of scholarship and to allow educators to redesign courses to incorporate social engagement and diversity issues. For example, faculty could be granted travel funds to visit institutions that have a successful model of social engagement (e.g., *www.artsofcitizenship.umich.edu*), after which they could adapt their findings for adoption at their home institutions.

Creation of organizational structures that facilitate socially engaged, interdisciplinary research. The complexity of the challenges society faces requires approaches that are well beyond the scope of any individual discipline. Institutions could facilitate problem-based research and community-based scholarship by creating organizational structures that allow students to learn from and work with faculty from different disciplines, citizens, and nonacademic science practitioners. Many institutions are developing interdisciplinary courses, cross-school departments, science initiatives, or problem-based centers, which are all positive steps in this direction. However, care must be taken to facilitate work placement for students who, as a result of focusing on problem-oriented science, may take longer to find a suitable position (Rhoten and Parker 2004) after graduating. Liaison centers that connect students with stakeholders and facilitate community dialogue in the definition of research may not only strengthen community ties but also generate employment opportunities for students. In addition, collaborative agreements with other like-minded institutions with strong interdisciplinary programs could also facilitate the building of required interdisciplinary networks for those students who want to pursue a career in academia. We have given a few examples here; there are likely to be manifold creative approaches.

Evaluation and modification of faculty reward and promotion structures. Faculty activities are shaped by the institutional mission, departmental culture, and scientific community. Despite many calls for socially engaged research, the effect of disciplinary "turf" on promotion remains the biggest barrier to this kind of research agenda (Pfirman et al. 2005). Promotion and tenure are often in the hands of peers who still value traditional measures of success. Further, these peers may not be the right experts to evaluate the quality of an interdisciplinary scholar. In fact, about 30 percent of researchers pursuing problem-oriented questions reported that this focus had not helped, or had actually hindered, their careers (Rhoten and Parker 2004). In order to fairly evaluate interdisciplinary scholars, promotion and review criteria need to be more flexible. The development of specific criteria that departments can use to evaluate faculty performance will be important. For instance, the University of Utah has expanded the traditional definition of service to include community outreach activities that are directly related to the faculty member's area of expertise, are responsive to the articulated needs of the community, and provide students with opportunities for learning (Ward 1998). To be effective, these criteria must be viewed as consistent and compatible with the institution's mission and expectations. Ideally, research institutions wishing to increase the number of faculty members involved in socially engaged research would need to define these criteria up front and to identify the departments, facilities, and communities that can provide a home for these scholars and evaluate their performance.

Promotion of diversity through recruitment and retention of faculty, students, and administrators. Many institutions offer excellent guidance, often through diversity offices, on how to increase institutional diversity. In addition, a recently released study (NAS/NAE/IOM 2006) clearly and forcefully outlines the issues and provides guidelines for change. Here we summarize a few common and critically important actions that can be taken for the promotion of diversity in science and the recruitment and retention of faculty, students, and administrators from underrepresented groups. The importance of leadership in creating and maintaining diversity is a common and critical theme, as is the need to promote diversity at all stages of employee recruitment and retention.

At the recruitment stage, search committees need to be provided with specific guidelines regarding diversity. Given the unconscious biases that evaluators often have (e.g., Wenneras and Wold 1997), guidelines used in the hiring process need to cover not only organizational nondiscrimination and diversity policies but also the ways in which the applicant pool is generated, applications are evaluated, qualifications are

assessed, and offers are negotiated and made (NAS/NAE/IOM 2006). Case Western Reserve University provides an excellent example and good guidance for some of the steps and protocols (*www.case.edu/president/aaction/diversitytoolkit.html*). Guidelines should also include suggestions for addressing potential family issues, such as the availability of child care facilities and of career opportunities for spouses or partners. Another common theme is that key senior women and minority scientists must participate in, if not lead, hiring and promotion committees. Once candidates are hired, many steps for successful retention have been identified, such as a formal mentoring structure involving people in nonevaluative positions, which addresses not only the process of promotion and advancement but also workplace and family issues. Mentoring and support efforts are crucial to the success of these endeavors, since employees' perception of work quality and the supportiveness of the workplace have been demonstrated to be the best predictors of productivity (Bond et al. 1998).

Creation of opportunities for diversity education. Institutions can use creative incentives for developing courses, workshops, and lectures with diversity content. For example, textbook choices that highlight women's contributions, and classroom discussions of the social and cultural context of science, can help to improve perceptions of the scientific competence of women, provide role models for aspiring scientists, and ultimately affect women's decisions about a scientific career (Pascarella et al. 1997, Damschen et al. 2005). Some excellent examples of courses with diversity content in science and technology are provided by the Center for the Integration of Research, Teaching, and Learning at the University of Wisconsin–Madison (*http://cirtl.wceruw.org/DiversityInstitute/content_matters/*).

Facilitation by funding organizations. Funding institutions can play a critical role in influencing the culture of science. To a large degree, funding allocation decisions help shape what science we do and how we do it. For example, the integrative research grants from the US Department of Agriculture's National Research Initiative provide an opportunity and incentive for researchers to collaborate directly with managers in research and in the application of scientific knowledge. Funding agencies could place more emphasis on broadening participation and diversity in science and on supporting social engagement in scientific research. Some agencies have already taken steps in this direction. For instance, in addition to intellectual merit, NSF requires that grant applications describe how research will contribute to teaching and learning, increase the numbers of underrepresented minorities, enhance scientific infrastructure and scientific understanding in the broad sense, and benefit society. NSF's requirement that these impacts be discussed in each grant application represents a positive step. Publicly available assessments of the efficacy and impact of broader-impact activities by individual scientists and institutions, and certainly by funding agencies, could be powerful tools to encourage further progress. The approach taken by some funding agencies of requiring, as part of the research contract, a plan for outreach, inclusiveness, and relevance will need follow-up if it is to be used as an incentive. Holding grantees accountable for achieving the broader impacts of their grants could significantly increase participation and encourage multiple forms of scholarship. Here we suggest some further actions to encourage efforts in this regard.

Collection of data to evaluate compliance with broader impact criteria at multiple levels. Funding organizations could gather data on broader impacts from both individual researchers and institutions. Such statements should outline how individual faculty research encourages multiple forms of scholarship (including basic science) and fits into the overall mission of the university. Over time, this approach would facilitate a greater alignment of faculty research with the mission of the university, encourage institutions that foster social engagement, and provide funding agencies with valuable data to evaluate the impact of funding on institutional transformation. As an example, NSF has recently initiated an effort to measure the societal impacts of investment in research and development and to explore how organizational structures affect the creation and application of scientific knowledge (Mervis 2006). This effort will provide invaluable information for the development of policies that balance socially engaged and basic research.

Funding organizations could also request that grantee institutions provide annual reports of cultural data (e.g., the degree of participation, comparative pay, level of pay at hire, career development, and advancement of women and underrepresented minorities). Trends in these metrics could be used to provide an objective measure of the effectiveness of institutional policies in fostering diversity and participation, and ultimately to identify those organizations with the most successful policies. An evaluation of the impacts of institutional policies and structural changes on increases in the hiring and retention of women and underrepresented minorities would provide useful guidelines for the development of successful institutional models.

Identification of funds to foster interdisciplinary, socially relevant research. To some degree, funding agencies have already developed specific programs to foster socially engaged research. For instance, the NSF Integrative Graduate Education and Research Traineeship, or IGERT, program has been developed to meet the challenges of educating US PhD scientists and engineers with interdisciplinary backgrounds who want to pursue socially engaged research. A second NSF program, Partnerships for Innovation, aims to promote partnerships—among academe, the private sector, and government at all levels—that will explore new approaches to support and sustain innovation, foster diversity, and benefit regional and national economies. A more sustained, long-term approach would to be to allocate a portion of the indirect costs in each grant to efforts to increase social engagement and diversity. Institutions and individuals would need to work together to propose activities to which these funds could be

allocated. Clearly, the alignment of faculty research and institutional mission would greatly facilitate the process. For instance, funding could be used for new efforts or to expand the scope and reach of existing outreach efforts (e.g., Centers for Teaching and Learning, *http://cltnet.org/cltnet/index.jsp*). Other incentives could include postdoctoral and early faculty fellowships for underrepresented faculty (e.g., NSF CAREER grants or Minority Postdoctoral Fellowships) and high-level awards to recognize exemplary achievement in social engagement and in the retention and advancement of women and underrepresented groups.

Encouragement and dissemination of successful programs with broader impacts for society. A number of successful institutional programs have succeeded in establishing, sustaining, and improving a feeder system across the educational pipeline that facilitates the participation of a wider diversity of individuals (e.g., the Meyerhoff Fellows Program, *www.umbc.edu/meyerhoff/Graduate/;* Preparing Future Faculty, *www.cgsnet.org/Default.aspx?tabid=226*). These programs are designed to facilitate the transition from students to productive scientists and to break down individual and institutional practices to engage a diverse faculty. They do not simply advocate for inclusion of individuals from underrepresented groups in science but rather suggest systemic change that brings all aspects of diversity into the dialogue among scientists (e.g., University of Michigan Center for Research on Learning and Teaching, (*http://sitemaker.umich.edu/advance/CRLT_Players*). Funding agencies could point to these and other examples as models for institutional efforts in this regard.

Conclusions

Whether or not we intend it to, scientific culture has strong impacts on the focus of our science; on who enters, is retained, and excels in the profession; and on public support of science. It is critical that, as scientists, we apply our intellect and creativity to understanding our culture and its ramifications for our profession, and that we take time from our hectic schedules to do so. This requires careful rethinking of values and of how to implement change. We suggest creating a scientific working environment that recognizes, articulates, and discusses the value of diversity among scientists, not only with respect to status in a currently underrepresented group but also with respect to different priorities in approaches to scientific research, education, and social engagement. Cooperation among people with different skills and priorities will allow us to excel in creating new scientific knowledge. With greater possibilities for both using science to solve pressing world problems and advancing the basic science that is valuable on its own, we will have the critical basis for informed action on society's challenges. Valuing and rewarding activities that apply scientific knowledge to improve human livelihoods and to translate scientific findings into policy will do much to increase public trust in and support for science. Individual and institutional understanding and subsequent strong leadership and action are essential ingredients for change.

Acknowledgments

We thank F. Stuart Chapin III, Gustavo S. Azenha, Steward T. A. Pickett, Stephanie Pfirman, and three anonymous reviewers for invaluable comments on earlier drafts of this manuscript. The writing of this paper was a collaborative effort; all authors participated fully in its writing.

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doi:10.1641/B570111
Include this information when citing this material.