MURPHY Response to: Fostering Interdisciplinary Teamwork at Northwestern University
Henry Bienen, Northwestern University President Emeritus

In my response to President Bienen's presentation, I will take a somewhat pragmatic and empirical approach from a practitioner point of view. I am in awe of the significant accomplishments made by Dr. Bienen during his tenure at the Woodrow Wilson School at Princeton and later his esteemed career at Northwestern. One of his central themes while at both universities was establishing and maintaining interdisciplinary relationships and encouraging others to do the same. He was forming interdisciplinary teams before that term became a buzzword by igniting a spirit of interdisciplinarity and fanning those flames to create lasting teams.

Just a little about myself to set the context for my remarks: I am an environmental scientist by training and worked in that capacity for over 20 years as a researcher and manager in a state government science program. Three years ago, I came to work at the School of Pharmacy at Rutgers University, moving into a research administrative position, where both my management experience as well as my technical training enabled me to create and grow interdisciplinary teams. As an environmental scientist, I almost always worked in teams – I worked with social science researchers and policy makers for years before I understood how rare that was, before I understood that it was interdisciplinary. We just needed to work together, so we did.

However, we didn't always publish together, and that gets me to the issue of how to measure the benefits of interdisciplinary science. I know our interdisciplinary work resulted in better science and more robust science policy, but how do I know this? Although chemists, toxicologists and social scientists worked together, we published in different journals – chemists published the results of their component of the work in chemical journals, toxicologists published in toxicology journals, and the social scientist published in behavioral journals. But we learned from each other and much of the direction of our work was predicated on the results of each other. But if we use only journal citations as our measurement of success, then these benefits and the richness of the overall research would not be apparent. I think we need additional metrics to measure the efficacy of interdisciplinary work. Naturally, I don't know what those metrics are… yet.

- **Building and Maintaining Interdisciplinary Teams: Integration of Medical Schools**

At Rutgers University, the formal process of developing interdisciplinary teams in earnest has only just begun, and we are heeding the advice and example of Dr. Bienen and others as we move forward in this area. That's not to say that faculty haven't been collaborating with each other successfully for years or that we don't have some successful models of interdisciplinary research structures in place already – we do. For instance, the Rutgers Environmental and Occupational Health Sciences Institute is a multidisciplinary institute comprised of faculty from medicine, public health, analytical chemistry, biology, and environmental sciences and is still going strong after over 25 years in existence. But the process of forming teams has been done on an ad hoc basis rather than developed via a planned and systematic approach. Further, these efforts at collaboration have often involved faculty within the same

discipline or similar disciplines working together – in short, collaboration. But, interdisciplinary teamwork is more than the healthy collaboration between like-minded and similarly-trained colleagues within similar disciplines. It involves moving out of the comfort zone of one's specific expertise and working with colleagues in a very different field to advance innovation and knowledge to address a common problem.

Among the most interesting and productive types of interdisciplinary teams are those that involve the coalescence of the traditional hard sciences with the social sciences. Dr. Bienen is himself a social scientist and set to work immediately at Northwestern to develop a culture of interdisciplinary teamwork there not only within the humanities and social studies, but with the medical school and life sciences programs. As difficult as it must have been integrating the medical school in Chicago with life sciences in Evanston – researchers who speak the same general technical language – it can be far more difficult (though very rewarding) integrating the traditionally hard science faculty with social science faculty, particularly behavioral sciences. Given funding priorities at federal agencies like National Institutes of Health and the National Science Foundation, and given the nature of the research gaps that need to be addressed in the biomedical, computer science, healthcare, environmental, and policy fields, the development of interdisciplinary teams comprised of experts in various fields is not a fad or an experiment but a necessity. Indeed, it is not just government funders but foundations and corporations who are insisting on team-based projects to ensure the delivery of the highest quality research. And, they are right to do so.

As mentioned, Dr. Bienen states that it was essential to him when he arrived at Northwestern to integrate the clinicians and researchers from the medical school with the life sciences and engineering faculty in Evanston. Similarly, Rutgers President Robert Barchi is doing this very thing at Rutgers, having just merged two medical schools, a nursing school, and a school of applied health professions into the main Rutgers campus. Not an easy feat. Although faculty from the independent schools had already been working with each other collaboratively, this integration of schools has simplified the working arrangements and reduced the paperwork and administrative burden on faculty that plagued them when the institutions were separate entities. It has been only a couple of months and already we are seeing more intermingling of faculty in the biomedical world with those from data science and computing, engineering, social sciences and psychology. The intermingling is not accidental. Part of how this is happening is the installation of people like me in central administration. I look for connections and work to nurture and grow them. Central administration support can be beneficial to newly developing teams by providing the administrative infrastructure needed for faculty to span traditional departmental organizational units. Intermingling is nice but is not enough – science teams need active coordination and integration in order to work.

- **Fund it and They Will Come - Follow the Funding**

Increasingly, funding agencies are tailoring their announcements to encourage interdisciplinary team submissions. The National Science Foundation's INSPIRE program is specifically targeted to promote interdisciplinary research and education. IBSS (Interdisciplinary Behavioral and Social Science) research program and the related SBE (Directorate for Social, Behavioral & Economic Sciences) postdoctoral

research fellowship program encourage interdisciplinary proposals. And, of course, the IGERT (Integrative Graduate Education and Research Traineeship) program is NSF's flagship interdisciplinary training program, involving the training of US Ph.D. scientists and engineers by synergizing their disciplinary knowledge with interdisciplinary training.

The National Institutes of Health (NIH) also support interdisciplinary research through the Common Fund Interdisciplinary Research Program aimed at team science approaches spanning biomedical and behavioral specialties. One of the most powerful and significant actions NIH has taken to promote collaborative, interdisciplinary science is their relatively new multiple principal investigator policy, whereby more than one faculty can be the PI of a project. This is an absolutely critical step in changing the culture of independent, one-person projects that pervade the research landscape today and influence institutional policies on tenure and academic success. By allowing multiple PIs on proposals, NIH has enabled researchers to claim funding "credit" on collaborative projects. I have already seen firsthand the popularity of this among faculty who would not otherwise have worked together.

The Patient Centered Outcomes Research Institute (PCORI) moves well beyond interdisciplinary by requiring that research proposals submitted for funding include patients and patient stakeholders as investigators. That is, patients must participate in the research design and interpretation. In PCORI projects, patients are not simply study subjects. Rather, they are collaborators. The goal of PCORI is to help people make informed health care decisions by producing evidence-based information that results from research guided not only by traditional researchers and clinicians but patients, caregivers and the broader healthcare community. PCORI program officers report that patient involvement in the research project design has been the most difficult component for researchers to embrace because this is a population that they have never worked WITH before. The patients have been the researched, not the researcher. PCORI funding makes for some very interesting dialogue within the faculty teams. At Rutgers, we are still figuring out optimal approaches for including patients on research teams.

- **<u>Connectors, Team Leadership, and Goldilocks</u>**

One of the ways that the central administration at Rutgers is encouraging and enabling interdisciplinary research is by placing several "catalysts" throughout the University. I am one of them. We catalysts act like the "connectors" that Malcolm Gladwell describes in his book "The Tipping Point." Gladwell describes a connector simply as "the kind of people who know everyone." Now, Gladwell is talking about business and influence, but this model fits with what Rutgers is doing. As a research connector, I need to know a lot of faculty – either personally or by reputation. I need to get out and learn who are the faculty most amenable to working in a group -who are the junior faculty and who might be the more senior mentors. I need to know so that I can connect them. In fact, the first thing I did when I first came to Rutgers – to the Pharmacy School – was interview every research faculty member. This was a doable task at the school, as only about 50 faculty were actively involved in or interested in research. That's who I targeted. Once I got to know them, I realized I needed to find out more about other faculty from other schools as well as more about the clinicians, who were mostly not doing research but could be potential collaborators if approached with a collaborative opportunity, in order to maximize research team development. Having the appropriate expertise on board is necessary for the development of

competitive proposals to funders who are becoming more and more interested in interdisciplinary science projects. This includes not only basic scientists, but clinicians, patients, social scientists, and computing experts.

In my current position as Director of Research Development in the Office of the Vice President for Research at Rutgers, I provide research development services for all faculty from all disciplines. Although I do still strive to meet with individual faculty to learn about their research areas, I can't possibly meet with all of them. But I do meet with the other connectors at the university and have even "created" some connectors from both the administrative and professional side of the various schools and departments at Rutgers. By that, I mean that I have established contacts at the other schools who can serve in the capacity of a connector, but who is not identified formally as one. As we encourage our faculty to work on interdisciplinary teams, we work in an interdisciplinary way as well. A group of around 35 faculty and administrative staff meet every 2 months or so to, well, connect. The group is comprised of academic research deans, grants specialists, program coordinators, grant writers, budget specialists, and research development professionals. We talk about items of mutual interest and we look for ways to connect faculty through networking events, seminars and funder-specific topics. For instance, I recently brought together a group of faculty to brainstorm ideas in "Big Data." We brought the generators of large data sets in biomedical, healthcare, and environmental sciences together with the data analysis faculty in computer science, mathematics and statistics. None of them had worked together before then. We have had only a couple of meetings so far, but already several interdisciplinary collaborations have developed. Continued meetings and continuous support for these partnerships is needed for the faculty to be successful in these interdisciplinary endeavors.

I mentioned earlier that some individual faculty have, on their own, initiated the development of interdisciplinary teams – to a point. They have worked together with colleagues on similar projects within their discipline, and some have built truly interdisciplinary teams on important topics. In other words, they have collaborated with like-minded researchers. Less common are those who have have transcended their disciplines to work with colleagues from different disciplines. It is difficult for faculty to form true interdisciplinary teams within the academic culture of independence and competition. Scientists are trained and encouraged to work as individuals and have been trained to think that individual, independent success is of paramount importance. Again, from my practitioner point of view, I notice that faculty are not always forthcoming and open with each other when first brought together, and I think this is due to this pervasive training in individuality and independence. There is a healthy fear of "idea stealing" and "credit taking," particularly when another faculty member is coordinating the team. Idea and data sharing in new interdisciplinary settings are not quickly embraced. Removing the comfort of independence and individualistic work (which is what attracts many to science in the first place) can be stressful to faculty, and it is a very real and important stress to acknowledge. The team needs to manage the issues surrounding this stress in order to be successful. The advantage of the approach that Rutgers has taken – using "connectors" like me to bring the teams together – is that we are not competing with the faculty, and we do not show favoritism for one faculty member over another. It takes a while for the faculty to understand and appreciate that, but once they do, we can work together effectively.

The optimal interdisciplinary leadership, I find, comes from pairing a research administrator like me with a senior faculty member. This is the Goldilocks "just right" team leadership model, in my opinion, and is particularly effective for early state team development, especially in instances when the Institution isn't ready to commit to a formal Center or Institute, but there may be a group of faculty who might want to consider working together. It might be a group getting together for a specific funding opportunity, or it might be that several faculty see a topic of emerging significance and want to begin brainstorming with colleagues. In this model, the faculty lead is generally senior and well respected and inhabits a mentorship niche. The faculty lead can keep the scientific momentum going and quell any insecurities or internal bickering that might otherwise ensue among more junior faculty who may perceive the others on the team as competitors rather than collaborators. This hurdle of competition is ingrained within the culture of academe and is perhaps the hardest to overcome when first bringing faculty together. My role is to keep the group moving forward and on-task and coordinating their disparate efforts into a seamless construct. Frequent, working meetings and open sharing of materials and ideas are critically important in enhancing the collaborative spirit. The common themes to success, according to my Goldilocks model, pertain to team management and oversight. Having a strong faculty advocate alongside a research development administrator (like me) is the single best predictor of success of the team. I have tried to "force" teams of disparate faculty whom I was convinced could work effectively together. But unless a faculty member is actively and fully engaged, the effort will not be successful. When the faculty are engaged, it's magic – I can actually see the spark of discovery as they dialogue with one another. Moving past the perceived threats to autonomy and feelings of distrust toward a spirit of sharing and camaraderie is important, and time must be allocated for this step in order for the team to coalesce. Understanding that it's okay to disagree but not to disparage; it's okay to have different opinions but not to dismiss others' opinions. It is also very important for the team members to know that their Institution supports the team as well both financially and administratively, which is what Rutgers is striving to construct.

Centers and Institutes, Joint Appointments and Informal Teams

Under Dr. Bienen's leadership, Northwestern embarked on a major fundraising campaign resulting in the construction of major new and important structures on the Evanston campus including the Center for Nanofabrication and Molecular Self-Assembly, the Ford Motor Company Engineering Design Center, and the McCormick Tribune Center, and the Arthur and Gladys Pancoe-Evanston Northwestern Healthcare Life Sciences Pavilion. Further, the International Center for Advanced Internet Research (ICAIR) was also created at Northwestern. Dr. Bienen talks about how the development of such centers is integral to the fostering and nourishment of interdisciplinary relationships among faculty, and I couldn't agree more. Not only does Center creation build and legitimize the interdisciplinary relationship, the existence of infrastructure and seed funding enables the maintenance of the relationship. And maintaining the momentum is critical for continued success. However, we are not all as successful at major fundraising as Dr. Bienen, so setting up vibrant, funded Centers, while an excellent tool for jumpstarting and maintaining interdisciplinary relationships among faculty, is not always a viable tool.

Joint appointments can foster the development of small (but potentially powerful) collaborations among faculty, although they, in and of themselves, do not necessarily foster interdisciplinary collaboration, as Dr. Bienen points out by distinguishing "real" as opposed to "courtesy" joint appointments. My observation has been that many faculty appointed to multiple departments belongs mostly to one and are nominal to the others, and this can be problematic for collaborations. On the other hand, joint appointments CAN have a the desired impact of fostering interdisciplinary research if there are several appointments in both the units interact regularly with each other and there is frequent communication about expectations and responsibilities of both the faculty member and the units. Interdisciplinary joint appointments can be inexpensive and effective tools to develop synergistic relationships among different disciplinary units.

Centralization or Coordination? Herding not Usurping

There is a fear that interdisciplinary research at universities may lead to more centralization and therefore more interference of central into individual departments, with faculty having an ever shrinking voice. However, the formation and nourishment of interdisciplinary teams seems like a perfect niche for central administration – by providing seed funding or other administrative suppor for collaborative efforts initiated by faculty. Maybe additional input from a central unit to enhance the university's strengths rather than an individual department's empire-building is not so bad, and may even be desirable. Centralized programs to provide much-needed financial or personnel support to faculty can move research to a more interdisciplinary track –by freeing up faculty time from teaching or service duties to concentrate on the proposed project. Central may have access to information or services that individual departments do not.

- **Silos – Bridges, Ladders and Platforms**

I am sometimes confused when the issue of silos comes up. While disciplinary silos can block multidisciplinary collaborations, thwart cross-communication and isolate faculty, disciplines are invaluable and necessary. Academia is defined by these silos, which are critical for developing focused knowledge and expertise and for refining erudition in specific areas of scholarship. The concentrated intensity of silos enables academic institutions to cultivate expertise and train future scholars. Interdisciplinary research enables the spanning silos to enhance faculty effectiveness through synergies. There is no need to tear down the silos of disciplinary, but, rather, by adding ladders within, bridges across, and platforms above, we can leverage the deep knowledge of disciplines toward innovative trans-disciplinary solutions to scientific and policy problems and gaps.

The dynamic nature of interdisciplinary research means that connections are continuous and ever-adapting. Interdisciplinary research does not need to lead to new or reorganized university departments, degrees or training, though it does necessitate a discussion about how we as institutions make decisions about promotions and tenure and assignment of scarce resources. Interdisciplinarity is popular because it is effective, refreshing and fun. Practitioners like me are fortunate in that we are able to see the benefits of interdisciplinary teams - we see the active dialogue among the team members. We can actually witness the birth of innovation during team meetings.