Re-Thinking and Re-Engineering Incentives for Scholarly Activities Across the Research Enterprise in an Open Access Environment

Merrill Series on
The Research Mission of Public Universities

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Introduction

Mabel Rice

The Fred and Virginia Merrill Distinguished Professor of Advanced Studies and Director, Merrill Advanced Studies Center, University of Kansas

The following papers each address an aspect of the subject of the twenty-second annual research policy retreat hosted by the Merrill Center: *Re-Thinking and Re-Engineering Incentives for Scholarly Activities Across the Research Enterprise in an Open Access Environment.* We are pleased to continue this program that brings together University administrators and researcher-scientists for informal discussions that lead to the identification of pressing issues, understanding of different perspectives, and the creation of plans of action to enhance research productivity within our institutions. This year the focus was on opportunities and challenges of big data for research in public universities.

Our keynote speaker for the event was Dr. Joseph Steinmetz, Chancellor, University of Arkansas. In his presentation, he discussed how open access research and scholarship fits in with the larger research and discovery mission, and what obstacles need to be overcome to move it forward. He advocated for the promotion of open access including overcoming bias against open access journals, rethinking the system of tenure and promotion, and identification of ways to build open access systems with institutions sharing expenses and system development. Michael Huerta, Associate Director, National Library of Medicine, National Institutes of Health, was an invited discussant in follow up to his keynote speaker contributions in 2017.

Benefactors Virginia and Fred Merrill make possible this series of retreats: The Research Mission of Public Universities. On behalf of the many participants over two decades, I express deep gratitude to the Merrills for their enlightened support. On behalf of the Merrill Advanced Studies Center, I extend my appreciation for the contribution of effort and time of the participants and in particular, to the authors of this collection of papers who found time in their busy schedules for the preparation of the materials that follow.

Eighteen administrators, faculty, and students from five institutions in Kansas, Iowa and Nebraska attended in 2018, which marked our twenty second retreat. Additionally, executives from the American Speech-Language-Hearing Association and National Library of Medicine/National Institutes of Health attended this year. Though not all discussants' remarks are individually documented, their participation was an essential ingredient in the general discussions that ensued and the preparation of the final papers. The list of all conference attendees is at the end of the publication.

The inaugural event in this series of conferences, in 1997, focused on pressures that hinder the research mission of higher education. In 1998, we turned our attention to competing for new resources

and to ways to enhance individual and collective productivity. In 1999, we examined in more depth cross-university alliances. The focus of the 2000 retreat was on making research a part of the public agenda and championing the cause of research as a valuable state resource. In 2001, the topic was evaluating research productivity, with a focus on the very important National Research Council (NRC) study from 1995. In the wake of 9/11, the topic for 2002 was "Science at a Time of National Emergency"; participants discussed scientists coming to the aid of the country, such as in joint research on preventing and mitigating bioterrorism, while also recognizing the difficulties our universities face because of increased security measures. In 2003 we focused on graduate education and two keynote speakers addressed key issues about retention of students in the doctoral track, efficiency in time to degree, and making the rules of the game transparent. In 2004 we looked at the leadership challenge of a comprehensive public university to accommodate the fluid nature of scientific initiatives to the world of long-term planning for the teaching and service missions of the universities. In 2005 we discussed the interface of science and public policy with an eye toward how to move forward in a way that honors both public trust and scientific integrity. Our retreat in 2006 considered the privatization of public universities and the corresponding shift in research funding and infrastructure. The 2007 retreat focused on the changing climate of research funding, the development of University research resources, and how to calibrate those resources with likely sources of funding, while the 2008 retreat dealt with the many benefits and specific issues of international research collaboration. The 2009 retreat highlighted regional research collaborations, with discussion of the many advantages and concerns associated with regional alliances. The 2010 retreat focused on the challenges regional Universities face in the effort to sustain and enhance their research missions, while the 2011 retreat outlined the role of Behavioral and Social sciences in national research initiatives. Our 2012 retreat discussed the present and future information infrastructure required for research success in universities, and the economic implications of that infrastructure, and the 2013 retreat discussed the increasing use of data analysis in University planning processes, and the impact it has on higher education and research. The 2014 retreat looked at the current funding environment and approaches which could be used to improve future funding prospects. The 2015 retreat addressed the opportunities and challenges inherent in innovation and translational initiatives in the time of economic uncertainty that have an impact on goals to enhance research productivity. The 2016 retreat focused on the building of infrastructure to meet the changing needs in research. The 2017 retreat topic and discussions were on university research planning in the era of big date.

Once again, the texts of this year's Merrill white paper reveal various perspectives on only one of the many complex issues faced by research administrators and scientists every day. It is with pleasure that I encourage you to read the papers from the 2018 Merrill policy retreat.

Executive Summary

The Role of Universities in Promoting Scholarly Work in the Emerging Open Access World

Joseph E. Steinmetz, Chancellor, University of Arkansas

- There has never been as much change in our higher education institutions as we are currently experiencing. These changes include financial, student success, community outreach and area economic development. We are also required to think in ways to maximize the benefits that can be gained from these advances. One of the new, emerging movements is open access. This paper covers how open access research and scholarship fits with the university larger research and discovery mission, and what needs to be overcome to move it forward.

- Greater financial pressures on university budgets make it difficult for universities to commit to new initiatives such as open access. University libraries, key to open access initiatives, are really feeling the effects of less support and funding. There is a compelling case for open access to data--it could be good for research and discovery. The Human Genome Project is a notable success of open access for public good. Several successful open access projects have led to requirements to make some research freely available to the public. Another open access issue at universities is open access publishing. The cost of publishing has risen much faster than the funding, creating a difficult situation as universities will be forced to consider making cuts of journals that are vital to faculty and students in their fields.

- There are philosophical and technological obstacles to open access to data and publishing on campuses. A cultural obstacle to overcome is the buy-in to data sharing from researchers who generate data. Universities will need to develop partnerships with the private to sustain research missions, given flat federal funding. Data sharing for industry-related research will be challenging, as private industry will have an interest in keeping research private. Though, if our goal is advancement, we should be advocates for <u>all</u> data to be open access. Publishing in open access journal is not as prestigious as traditional publications, creating an obstacle for open access publishing as questions are raised about the effect on faculty reviews, promotion and tenure. Technological obstacles can impact open access efforts. Creating and maintaining an open access system, including the overall security, requires resources, which are dwindling at universities.

- The university's role in promoting open access scholarship should be discussed within a context of the campus priorities. Suggestions for additional roles universities can have in promoting open access include overcoming bias against

open access journals, rethinking outdated system of tenure and promotion, encouraging faculty to embrace open access data environment, and identify ways to efficiently build open access systems with institutions sharing expenses and system development.

Setting Realistic Expectations and Possible Career Pathways for Junior Health Professionals

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- Supporting career decision-making in healthcare and health sciences is enhanced when options are mapped and described. Laying out pathway options, describing expectations coupled with likely outcomes that highlight research, teaching, entrepreneurism and business options are useful for both junior health professionals and mentors.

- Career path direction decision-making is a challenge for many young healthcare professionals.[1-4] Lent et al. use a social cognitive framework to understand three linked aspects of career development: (a) the formation and elaboration of career-relevant interests, (b) selection of academic and career choice options, and (c) performance and persistence in educational and occupational pursuits.[5] Social cognitive career theory supports the notion that self-efficacy informs career choices,[4] but a central issue remains that exposure to career pathway options and more importantly, clarity on what factors contribute to success once on those paths, remain elusive for many young health professionals. Offering realistic expectations early in career choice decision-making is essential to ensure cost- and time-effective investment for both the individual health professional and the system in which they seek career growth.

- Providing a roadmap approach to career options that lay out opportunities, goals and expectations for health professionals with M.D., D.O. and Ph.D. degrees may be of utility for mentors, individual scholars and others seeking to support young faculty. While career decision-making is multifactorial and driven by unique individual and environmental factors, the figures and tables included in the paper have proved useful heuristic tools for mentees and health professionals as they graduate and consider career options. The choices made will determine the expectations or possibilities of having research as part of the work.

Valuing Collaboration and Collaborators

Jennifer Larsen, MD, Vice Chancellor for Research
University of Nebraska Medical Center

- "Team Science" is the term often used for the collaborative activity that requires larger teams with specialized expertise to solve complex problem in and outside of the biomedical arena. There are many reasons to value collaboration including the ability to better compete in Team Science, the ability to fare better in reviews of collaborate grants and manuscripts, and higher citation rates for collaborative manuscripts. An environment that values highly technical expert team members is likely to retain these individuals. Community members too are required for many teams, serve in various roles, and become higher education and research advocates.

- There are other many ways to show that an institution values collaboration. The University of Nebraska and University of Nebraska Medical Center have implemented ways to show they value collaboration -- requiring evidence of collaboration for pilot grant programs, including a metric for collaboration for specific awards, and providing a full list of collaborators in announcements. Another thing to consider is if the distribution of F&A demonstrates the value of collaboration.

- Valuing collaboration may depend on the type of collaborator. Three types of collaborators are discussed: core directors, biomedical informatics collaborators, and clinician and community collaborators. Core directors who possess a breadth of skills needed to direct service centers are an institutional asset. Promotion and tenure may be more difficult for core directors and for this reason, many institutions have developed pathways for promotion. UNMC is developing an incentive stipend mechanism for core directors. Biomedical informatics specialists bring their unique skills to research teams as collaborators. Highly desired in industry, these specialists can ask for an compete for salaries, titles or other resources. As clinician and community collaborators are required for more types of research, academic health centers are including these collaborators in their compensation model and considering other nontraditional ways to show they value their contributions.

- Faculty who serve as collaborators should have a clear path to promotion and tenure, or another reward that shows they are valued by the institution. As team science grows, institutions need to create a culture to support it. Instruction in how to function in a team is needed, as this skill will be important.

New Challenges and Opportunities for International Research Collaborations on a More Level Playing Field

Rodolfo H. Torres, University Distinguished Professor of Mathematics
University of Kansas

- The U.S. leadership in research and development (R&D) is being challenged, but at the same time new doors for international collaborations have been opened. T. Friedman's ten "flatteners" from his book "The World is Flat: A brief history of the twenty-first century" still apply today or have found a parallel version in international research collaborations. The ten flatteners are: collapse of the Berlin wall, Netscape (many countries have free internet access), workflow software, uploading (digital repositories), outsourcing, offshoring with American universities opening campuses in other countries, supply chaining, insourcing including recruiting and hiring international graduate students for US universities, informing (information tools), and "the steroids" such as digital mobile devices and now the cloud.

- The arXiv and the CMS Collaboration at CERN are two successful examples of open access and international collaboration. The examples speak of open collaborations, yet competition among countries in scientific research is escalating. Historically, the U.S. has led the world in science and engineering (S&E) with an emphasis on investing in science and engineering, research and development, and education. China and other Southeast Asian countries are now deeply investing in these areas and becoming bigger players. Though the countries and regions that have led in research and development expenditures continue a similar linear growth in expenditures, China has exceeded linear growth and now ranks second to only the U.S. in R&D expenditures. Several plots are offered which show how much Asia, and China in particular, have become much bigger players at the global level of R&D. Using linear regression projections, it is predicted that China will surpass the U.S. this year in gross expenditures in R&D and in 2020 it will surpass in terms of R&D expenditures as a percentage of gross domestic product. Several other metrics are presented which highlight China's progression in science and technology. The data show how much the U.S. relies on international students for its education and research programs in S&E.

- As other countries increase their investment in R&D, opportunities are provided to U.S. scientists and students. These investments provide such opportunities as international conferences and international exchanges of scientist and students financially supported by their countries of origin. The open access and free exchange of knowledge is supported by the Association of American Universities and the Association of Public and Land-grant Universities. Though, U.S. universities are challenged to balance openness with the federal export control regulations. Export control is a difficult compliance issue for many universities and more training, education and discussions are needed.

Recognition and Incentive: The Value of an Institutional Strategy for Faculty Awards

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Liz Lange, National Recognition and Awards Coordinator
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- Essential in considerations of open-access data and scholarship are implications for assessment of scholar and scholarship and, in particular, the role of open access on evaluation of researchers in the university environment and in particular on tenure and promotion. With the changes in how scholarship is pursued and evaluated, broader issues of evaluation in and recognition of achievement in the university are discussed in this paper.

- In 2011, a focus on awards became an institutional priority for the University of Nebraska (UNL). The goal of UNL was to double the number of faculty receiving prestigious national awards and membership in honorary societies. National awards and honors for faculty not only recognizes achievements, they enhance individual careers, builds department profiles, and increase the reputation of a university.

- The National Recognition and Awards Coordinator position is a full-time position that was established to promote, coordinate, and track awards. The Coordinator offers professional service across the campus in many ways from identifying opportunities guidelines, communicating with the award sponsor with questions, coordinating with nominators, compiling nomination materials, and help with faculty curriculum vitae. In addition, the Coordinator's work includes getting buy in for the value of this activity. The coordinator uses many effective strategies to catalyze the awards activities including an awards website, a promotions video, and a congratulatory letter from the Chancellor.

- UNL has exceeded the 2011 awards goal and has more than tripled the number of awards earned by faculty. The culture and leadership of individual departments plays a significant role in the awards success. Though there is still more work to be done, a dedicated position like the National Recognition and Awards Coordinator position at the University of Nebraska helps increase faculty awards and recognition and makes a difference to advance the university.

KU School of Medicine Mission-Based Allocation Model: aligning funding with expectations

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- A decline in state funding at a time of increased enrollment forced leadership at the University of Kansas School of Medicine (KU SOM)to reconsider how financial resources should be distributed to best align with the school's mission in terms of research, education and service. The University of Kansas School of Medicine, like many schools, based faculty salaries on an historical model. The historical model presents many disadvantages so KU SOM decided to abandon the historical model for distributing state funds and move to a new mission-based funding allocation model that aligns with the School's missions and values. This new model would distribute available funds in proportion to fulfilling the missions of the department and school. In developing the model, several assumptions were applied to ensure that the system was fair, transparent, equitable and reflect market realities.

- The mission-based model directly aligns departmental compensation to performance. One of the school's primary missions is educating medical and graduate school students, which is acknowledged in the allocation model. KU SOM identified the educational activities that are valued and the associated faculty efforts for the activities. Research value is based on the effort devoted to externally funded research activities. This method places greater responsibility on faculty to seek and retain external funding and to participate in educational activities.

- The primary driver for state funds coming to a department is the cumulative activities of faculty. These activities are known, and therefore, in theory it is possible to know the value of an individual. A hypothetical example is given of the relation of externally funded research effort and valuation of faculty under the missionbased allocation model. A question that arises is if there will be sufficient funding to support faculty salaries at competitive levels with the mission-based allocation model. Through assessment of a department, they predict that between research incentive funds and funds released from individuals with effort exceeding the capped effort that this department could maintain a competitive salary structure.

- Though the mission-based allocation model provides a means for distributing limited state funds with the missions of the school, other sources of funding should be identified. Overall, the approach is having a transformational impact on faculty engagement. In order to attain equilibrium and financial stability, there is a need to monitor and adjust elements of the model as situations demand.

From Collegial to Collaborative
The Long Road to Building a Sustainable and Standardized Research Technology Service

Gary L. Pratt, Chief Information Officer
Kansas State University

- In 2017, the author started as the Chief Information Officer for Kansas State, the nation's first operational Land Grant University. K-State published a visionary strategic plan with aspirational goals for 2025, with the goal of becoming a top 50 research university. Reporting directly to the K-State President, who formerly was the Chairman of the Joint Chief of State reporting to President Bush during the terrorist attacks, the author began his new position with a listening tour. On this tour, he spoke with many people to learn what was working, what was not working, and what they should be doing in IT.

- The IT environment at K-State is complex and led to many examples of duplicated systems, no formal sets of standards for providing services, few economies of scale, blind sides for needs of support, security issues, and users left on their own. The author chose to run a formal strategic planning process to create buy in. Working with a consultant, valuable input was gathered from more than 250 students, faculty and staff face-to-face, and 1,300 individuals through a web survey. What they found was that there were many challenges from a highly-decentralized nature of the institution. Coupled with budget cuts applied with no strategic application, the approach led to fighting fires and the inability for long-term sustainability.

- The decentralized culture that exists at K-State makes it difficult to provide a standard minimum-level of service, including supporting research. Researchers are spending a significant part of their start-up time on technology effort. Though the computer science department does run a high-performance resource, the service is informal and not utilized consistently.

- The development of the cyberinfrastructure needed to support research is a must. K-State will plan on following a standard strategic planning approach. A governance committee will be created to focus on developing and implementing a plan. Once a plan is developed, the focus will be on funding. The next few years will be an exciting challenge as K-State negotiates a path to develop and run the research technology environment for the twenty-first century.

The Role of Universities in Promoting Scholarly Work in the Emerging Open Access World

Joseph E. Steinmetz, Chancellor
University of Arkansas

I have been in higher education and at universities as a member of the faculty or an administrator for over 35 years. I can say with some confidence that during these 35 years, I have never seen a period of time when there has been more volatility and change in our institutions of higher education as there is currently. These changes include our financial models for operating the university, well-justified pressures to enhance student success as measured by increased student retention and graduation rates, expectations for greater research productivity, and a growing role in community outreach and engagement as well as regional and state economic development. As always, we are expected to provide a significant benefit for society in general as well as a direct benefit for the individual students who choose to attend our institutions. Superimposed on this is a rapidly changing technological world that while enabling new and exciting opportunities, also requires our students, faculty, staff and administrators to think in new ways to maximize the benefits that can be gained from these advances.

The world of open access is one of these new, emerging movements. There is no question that the open access movement has the potential to break down barriers that may impede the spread of knowledge and innovation. Yet I believe we still find ourselves negotiating some of the same old obstacles to change. In the words of Walter Lippmann, "we have changed our environment faster than we can change ourselves." (Lippmann, 1922). Here, I write briefly on what I believe is the role of our universities in promoting scholarly work in an emerging open access world. I will cover how open access research and scholarship generally fits in with our larger research and discovery mission, and what obstacles need to be overcome to move it forward.

Although I suspect most everyone has some grasp of the conversation about open access, I think it's worth quickly reviewing some of the factors driving this movement, particularly on campuses like mine. On our campus, as on many others, discussions about open access are happening on two different fronts. First, open access can refer to placing published data in a public archive that can be accessed by others. Second, many at the University of Arkansas as well as at other universities are also interested in open access publishing, a form of publishing that is largely free or lower cost than traditional forms of publication and also has the potential to enhance access to knowledge and discoveries. Both of these discussions may be important for the future of research and discovery.

A Current Issue: Greater Financial Pressures at our Research Universities

Before delving further into the topics of open access data and open access publishing, I think it is important to point out at least one major factor that seems to dominate our discussions at public universities these days—that is, the major change in how our universities will be funded in the future. Indeed, no conversation about changes in higher education, particularly at public universities, can occur without reference to how funding our public universities has changed over the years—it is the context in which we find ourselves.

I saw some data recently that I think will put this in context. Between 1961 and 2015, the Consumer Price Index increased 696%, which is not a particularly shocking number. Over the same time, however, the Higher Education Price Index (HEPI), increased a whopping 1,124%. The HEPI captures the major cost drivers in higher education. Importantly, as the HEPI inflation rapidly outpaced the CPI, over the same period of time we witnessed a drastic reduction in the support provided to universities by our states across the country. The University of Arkansas exemplifies this national trend. As late as 1999 at the U of A roughly 70% of our operating funds came from a state allocation. The remaining 30% came from tuition and a few other sources of revenue. Now this situation has more than flipped—our state support now makes up about 17% of our operating funds with student tuition and a few other sources of revenue (such as private donations) making up the balance of our operating budget. And we have it relatively good in Arkansas as our state commitment is higher than many other states; I know of several public research universities where the state contribution as a percentage of support is in the single digits and declining.

Another fact to consider is that virtually all public universities subsidize their research mission with general funds—Indirect Cost Recovery (ICR) is not enough to cover expenses related to the research infrastructure that is necessary to conduct research. I have often found it difficult to get faculty to understand this point; many are convinced that the ICRs they generate cover all research expenses. And, at many institutions this situation is exacerbated by the fact that some ICR funds are distributed back to individual investigators thus decreasing funds available to invest in necessary university-wide research infrastructure. Given that our general fund budget these days comes largely from student tuition, this means that at virtually all public universities, *student tuition and not state funds* are being used to subsidize research and discovery. And, as the availability of state funds shrink even further we are faced with growing pressure to do more with less. This sometimes forces us to make extremely difficult decisions on what we fund. And sometimes, this becomes a binary choice: Do we use our resources to fund student instruction or to fund research and discovery? Both are important at a research university. Since over the last several years we have raised tuition dramatically, a growing pressure has mounted to fund activities that support student success. At public universities students are the source of much of our operating funds. This means

that relatively fewer funds are available to support research and discovery. This financial model is clearly not sustainable for operating our public research universities.

So, what does all this have to do with open access? Our university budgets are stretched like never before making it difficult to commit to any new initiatives beyond the bare minimum, and this includes commitments to underwrite open access. And one place where financial pressures are really being felt is within our University Libraries. Libraries are key to open access discussions as their expertise in managing archives and access to publications is important. Libraries are feeling the pinch of reduced support and funding, particularly related to research and scholarship. From their perspective the sharing of research and materials across institutions and between scholars makes perfect sense. And this discussion is not limited to research and scholarship. Many universities are also discussing ways to share teaching resources in an open access environment as well.

Fiscal Challenges Aside Why is Open Access for Data Important?

While fiscal issues are important, money should not be the only factor driving discussions about open access. There is a compelling case for open access: open access to data could be good for research and discovery. Perhaps the poster child for the success of open access data is the Human Genome Project, which is regarded as a model for how open data can be used for public good rather than private gain. An oft-cited study by an MIT professor, Heidi Williams, found that "nearly 30% more genetic diagnostic tests emerged from sequenced genes that were always in the public domain, compared to genes that were temporarily withheld from the public with intellectual property rights after being sequenced by a private firm." https://sparcopen.org/impact-story/human-genome-project/

There are a number of other successes that resulted from this project, both economic and technological, which I will not review here. Perhaps most important for our discussion here, this project, as well as several others inspired by it, influenced the White House Office of Science and Technology Policy to issue a directive in 2013 requiring taxpayer-funded research to be made freely available to the general public. https://sparcopen.org/news/2017/fastr-reintroduction/ The goal was to accelerate scientific discovery and innovation. And this has subsequently led to the bipartisan Fair Access to Science and Technology Research Act, or FASTR, which is making its way through the House and Senate, as of this writing. FASTR would require agencies with annual extramural research budgets of $100 million or more to provide the public with online access to research manuscripts. This is driving a lot of the conversation around data open access on the federal level.

Why is Open Access Publishing Important?

The second open access issue that is being discussed on my campus as well as many other campuses is open access publishing. Much of this discussion is centered on the increasingly high cost of publishing research in a time when resources are increasingly tight. Consider

this: an institutional subscription to *Brain Research*, a journal in which I published my behavioral neuroscience research in the past, is currently $12,113 a year. It is published by Elsevier. I note that this not a particularly high price for an Elsevier publication, which can run in the tens of thousands of dollars. As the publisher of a self-reported 420,000 articles a year, Elsevier has been the topic of conversation over the last several years. For example, in a recent book, *The Open Revolution* (which can be downloaded free as a PDF, incidentally), Rufus Pollock has this to say about Elsevier:

> "Cleverly, Elsevier has inserted itself as an intermediary – a platform – between academic authors and academic readers, controlling many journals which are mini-monopolies in their fields. Increasingly, publishers like Elsevier are exploiting the very academic community they should serve, using monopoly power to hike prices year after year. Meanwhile, they depend for their content and much of the editorial work on the same scholars, who offer their publicly-funded labour (and their copyrights) for free. And since academics have little choice, because they are obliged to publish in "reputable journals", they are held to ransom as surely as the libraries that are obliged to subscribe to the journals" (Pollock, 2018, Pg. 14).

Our Dean of Libraries at the University of Arkansas, Ms. Carolyn Henderson Allen, estimates the cost of journals has gone up roughly 8-13% a year over the last 10-15 years, depending on the journal. This has created a difficult situation. Given that these costs are rising far faster than funding, libraries are being forced to make agonizing decisions about to which journals subscriptions should be maintained. Obviously, this is difficult—a variety of journals in a variety of areas are critical for our faculty and students to stay abreast of the latest developments in their respective fields. We anticipate some difficult conversations with faculty as deeper cuts must be made in the coming years, which can seriously injure our larger research mission. I bring this all up to emphasize the fact that there are external and internal pressures to move toward a more open publishing model that benefits our researchers and scholars.

Obstacles to Open Access on Campuses

There are obstacles on our campuses to open access to data and publishing and also some limitations that are related to a more general commitment we have made to research and scholarship on campus. I present some of these obstacles here. These obstacles can be divided into two broad categories. The first category could be described as philosophical or cultural while the second category can be described as technological (which includes, of course, financial considerations). I start with the philosophical/cultural obstacles related to creating and maintaining an open access system for data.

Any open access effort must have the buy-in and the backing of the community of researchers who generate the data. When I was starting out as a researcher, I

would have been reluctant to share my data. I had a strong sense of ownership of my work and would not have been comfortable sharing my data before I had time to properly work through it completely and exhaustively, which of course can take years. While some versions of FASTR seeks to extend the embargo period from six months to one year, that is still not a long time, especially for researchers who continue to scrutinize, mine and find new ways to analyze and think about published data for many years. For some there is a worry that their data set may be used as the basis of someone else's research, something that may be easier if the complete published data set is readily available to be mined by someone else. The fear I have heard expressed is that investigators, especially newer investigators, are vulnerable to larger and often better funded labs that could throw more money and people at a research problem that originates with the original data set that is published. By the way, I tend to hear this argument more often from senior faculty on behalf of more junior faculty than I do from my more junior colleagues. So, it seems paramount that we make our faculty comfortable with the idea that data sharing does not necessarily mean that someone else is going to swoop in and get famous from their work. I return to an earlier point I made: we should be arguing that science and discovery would proceed faster if data sharing was commonplace. And, perhaps collaboration would become more prevalent. *These are both good things, not bad things, for research and discovery*.

I am convinced that a very important way we will be able to sustain our research mission at universities is to develop more robust partnerships with the private sector. A number of businesses and industries have reduced their research and development efforts over the years and are increasingly more dependent on universities for this function. Federal funding for research has, for the most part, been flat the last few years and state support for research is virtually nonexistent in most states. Furthermore, it is difficult to predict the future of federal support for research. For example, increasing the federal deficit tends to hurt research eventually as this source of discretionary funding becomes less of a priority. All told, this means that there is a decreasing amount of money available from federal grants and university budgets to support research.

At a campus like ours, where we are determined to grow our research volume, we believe that we are going to have to diversify our research funding sources, and that means creating more partnerships with companies willing to support research, both basic and applied. We are pursuing this aggressively. While this will require a blending of research agendas, more than likely private industry is not going to be interested in feeding open access repositories and databases. Perhaps bits and pieces can be made public, but by and large they will have a proprietary interest in keeping some of the research private. And, again, if we are really interested in advancing science, discovery, research and scholarship, we should be advocating for open access to <u>all</u> data, not just those data sets generated with federal dollars. This will prove to be challenging for industry-related research.

There are also philosophical and cultural obstacles to open access publishing. Perhaps the biggest obstacle to publishing in open access journals is that they don't have the same prestige as long-established traditional publications. In part, this has enabled established publishers to maintain their stranglehold on scientific publishing. And, it is difficult to blame faculty for clinging to the traditional model of publishing when annual performance reviews and promotion and tenure are at stake. Many questions are raised by individual faculty and evaluation committees about open access publishing. Will individuals be punished for publishing in open access places instead of more traditional (and hence more reputable) publications? Will it harm their efforts to get tenured and be promoted? And when it comes to open access publication journals, how can rigor be ensured? How can the quality of publication be evaluated? At the very least, it is clear that new metrics need to be worked out to evaluate open access publishing. That is, new ways of measuring impact, which is what these kinds of evaluations are supposed to be all about. For some fields, this process is already being thought through.

There is a second category of obstacles, which are technological and, by extension, financial, which can impact open access efforts. Just as finances are driving the push for open access research in the libraries, they are also limiting the speed of its spread and the shape it can take. Creating and maintaining an open access environment means making strategic investments in the hardware and software needed to store, access, discover and share information. It also means ensuring networking capabilities, interoperability between colleges and campuses, both in state and out, as well as integration with national resources. It also means making allocations for maintenance, technical support, and the overall security of the system so that you have a firewall between what you want to share and what you don't want to share. This last point is extremely important if you are working with private industry or doing classified research. You do not want someone to sneak into your system and swipe the fruits of your efforts or severely damage your partnerships you may have established with other researchers or with industry. Security of the open access system is a very real concern.

All of the things I just listed above require allocations of time, money, training, and people. I refer you back to my earlier discussion about dwindling resources: this means making hard choices about how we spend limited resources. Recently, staff from our Office of the Chief Information Officer and High-Performance Computing Center made a pitch for investments of half a million dollars a year for the next four years in campus computing infrastructure. This is a relatively big request these days on our campus given the tremendous pressures on our budget from a number of other equally important projects. This proposal though has a lot of merit. Data-driven research has emerged in virtually every field and our computing center now serves an ever more diverse body of users. Here on our campus genetics researchers run small bits of code on hundreds of nodes and create thousands of small files to be

analyzed. Geoscientists build predictive models from terabytes or petabytes of data to build increasingly higher resolution predictive models. Large models of complex materials are created by engineers and physicists working together. Sociologists and geographers work with economists to build complex models of human behavior using data sources from around the world. They need the university to provide the computing backbone for these and a lot of other activities.

But in the end what does this $2M investment buy us as an institution? The honest answer is the bare minimum to serve our faculty's growing needs and, we hope, keep us competitive for federal grants. This minimum investment allows us to update our computing resources and to provide additional computational support for researchers. If we really wanted to get ahead of the curve, then our computing staff estimate we would need to make investments of an additional million dollars a year for the next four years for a total spend of $6M. This spend is in addition to any funds that we would need to invest in open access data and publishing systems. That is, resources needed to advance open access research are in direct competition with critical resources needed to maintain, not to mention enhance, our basic research mission.

A Role for the University

What is the university's role in all of this? First and foremost, any discussion of promoting open access scholarship should occur within a context of campus priorities. For example, here at the University of Arkansas we completed a comprehensive institutional planning process from which eight guiding priorities were developed and articulated. https://www.uark.edu/strategic-plan/index.php#guiding-priorities. While promoting open access research and scholarship is not a defined priority per se, it is a factor in some of the general categories that did emerge in areas like "Building a Collaborative and Innovative Campus," "Enhancing our Research and Discovery Mission," and "Investing in Faculty Excellence." More immediate concerns were identified, such as improving our competitiveness for federal funding and preserving our Carnegie Research 1 status. And for us, expanding our research capabilities and infrastructure has become a regional priority, as evidence by the Northwest Arkansas Council identifying research at the university as a major driver of further economic development in the region. http://content.nwacc.edu/publicrelations/presidentsoffice/Goals%20and%20Objectives.pdf

To jump start research we created the Chancellor's Discovery, Creativity, Innovation and Collaboration Fund – or the Chancellor's Fund for short. We have initially budgeted $1M annually to ensure high interest and participation. A year ago, we received 75 proposals and awarded 10 research grants to 30 faculty. This spring, we received 93 proposals of which we will fund 10-12. While it's too early to determine whether this program will lead to increased research funding, we can say that it is already accomplishing one of our main goals, which is to enhance collaboration on campus. Of the 93 proposals we received, 290 faculty were listed as Principal Investigators or co-PI's—faculty are

exchanging ideas, taking risks, and forging new partnerships. That's exactly what we wanted to happen. If those partnerships are funded and sustained through extramural funding after the initial award runs out, that is a step toward broadening our research and discovery efforts. And if those partnerships form the basis of a working partnership that extends well into the future, that is great, too. The point is, we made this investment as a result of our campus prioritizing collaborative and innovative research.

What else should universities be doing to promote open access? It's increasingly clear that the traditional model of academic publishing is not sustainable from a cost perspective and there is much to be gained by breaking down paywalls that are devastating library budgets and restricting access to information, particularly information that is publicly funded. I believe universities have a role to play in overcoming the bias against open access journals. And, the university has a clear role in promoting open access for data—it is good for research and discovery.

First and foremost, we must rethink our current system of tenure and promotion—it's outdated. We are using the same approach and almost the same metrics for the last century. We must figure out how to measure the impact of someone's work in an age that values open access, collaboration, and more links with industry, among other things. We need to think well beyond counting books, journal articles and grant dollars to new ways to measure impact, including ways to measure the impact of publishing in open access journals. Doing so will help alleviate some tenure and promotion fears that are related to publishing in open access sources. If faculty don't see open publishing as injurious to their career, they are more likely to embrace it, and advocate for investing in the hardware, software and expertise needed to support it. And, until new tenure and promotion norms are established nationwide that make open publishing and data sharing more attractive, there will be little momentum on individual campuses to move in this direction. In short, this is not an issue that can be resolved by an individual campus.

Second, we also have to encourage our faculty to embrace an open access data environment. Even though I have heard some of our faculty express a fear of sharing their data widely, I am not sure this fear is actually well-founded. But nevertheless, it needs to be dealt with. Perhaps the use of data sets by others should be a measure of impact—like counting citations is for traditional journals. And, I am sure we can devise ways to require an acknowledgement of data bases used in the same way we require referencing and citations.

A final thing for universities to consider: we also need to identify where cost efficiencies may exist, particularly in building a state-of-the-art open access system. Partnerships with others might go a long way to realize these efficiencies. The University of Arkansas is part of a system that includes several 2-year and 4-year institutions. Collectively, we have used the system to leverage lower costs in things like our Learning Management System and, more recently, a common Enterprise Resource Planning system. I

spent time at Indiana University and Ohio State University and also saw shared systems work effectively for the Big Ten conference schools through the Committee on Institution Cooperation (now called the Big Ten Academic Alliance). An example of this is how a variety of lesser-taught languages are shared across these institutions. Perhaps these are models for building an open access system across universities—that is, universities sharing expenses and system development. In fact, this kind of shared model may be useful in a number of areas as we try to find more innovative ways to fund and operate our universities. We should be collaborators, not competitors.

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Setting Realistic Expectations and Possible Career Pathways for Junior Health Professionals

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Supporting career decision-making in healthcare and health sciences is enhanced when options are mapped and described. Laying out pathway options, describing expectations coupled with likely outcomes that highlight research, teaching, entrepreneurism and business options are useful for both junior health professionals and mentors.

Career path direction decision-making is a challenge for many young healthcare professionals.[1-4] Lent et al. use a social cognitive framework to understand three linked aspects of career development: (a) the formation and elaboration of career-relevant interests, (b) selection of academic and career choice options, and (c) performance and persistence in educational and occupational pursuits.[5] Social cognitive career theory supports the notion that self-efficacy informs career choices,[4] but a central issue remains that exposure to career pathway options and more importantly, clarity on what factors contribute to success once on those paths, remain elusive for many young health professionals. Offering realistic expectations early in career choice decision-making is essential to ensure cost- and time-effective investment for both the individual health professional and the system in which they seek career growth.

Providing a roadmap approach to career options that lay out opportunities, goals and expectations for health professionals with MD, DO and PhD degrees may be of utility for mentors, individual scholars and others seeking to support young faculty. While career decision-making is multifactorial and driven by unique individual and environmental factors, the figures and tables included here have proved useful heuristic tools for mentees and health professionals as they graduate and consider career options. The choices made will determine the expectations or possibilities of having research as part of their work.

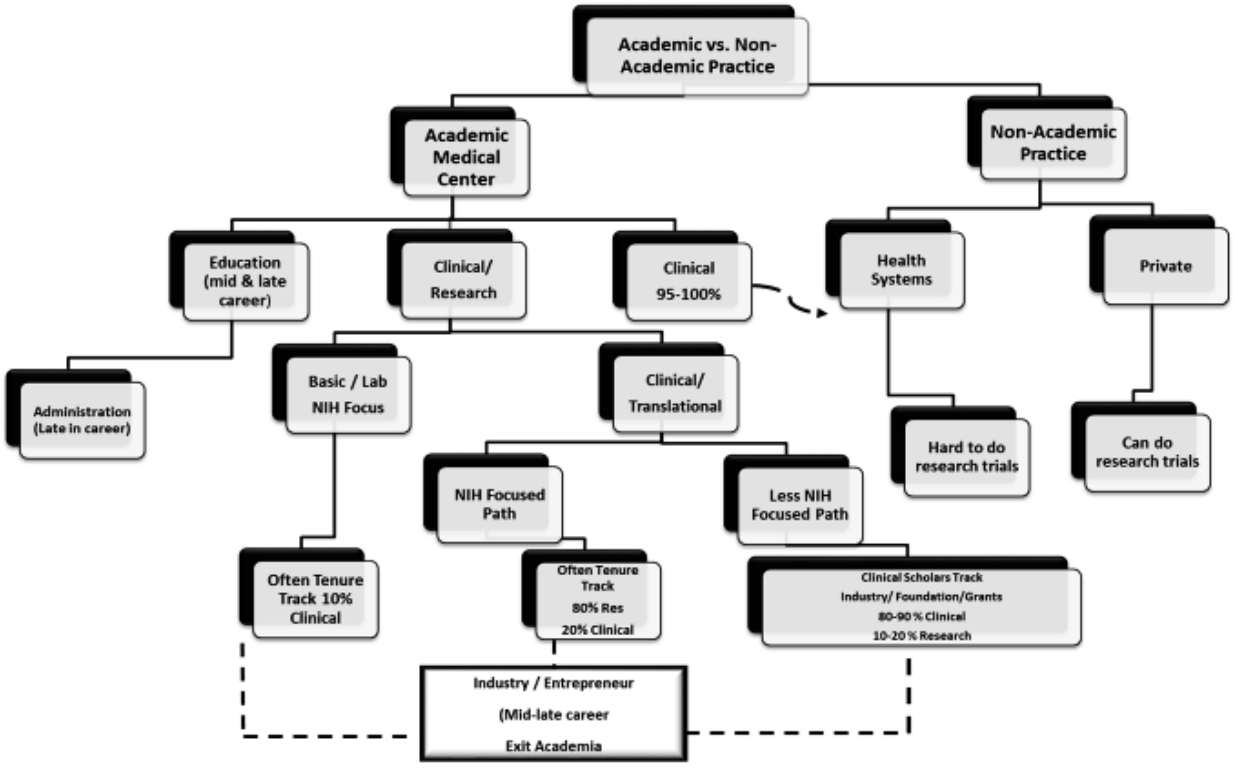
Opportunities and Career goals for MDs/DOs

Graduates from medical school have a variety of career options.[6] They need to decide if they want to join a practice in an academic setting or a non-academic setting (Figure 1). If they chose a non-academic practice, then the decision is if they should join a private practice or a health system practice. The proportion of U.S. graduates planning full-time clinical practice careers has declined to about 50% which is attributable to graduates' preference for part-time clinical practice, demographic factors and debt.[6] As private practice models are rapidly disappearing from the American medical landscape, employment in health systems and in alternative settings is expanding. Private practice does remain an option for some MD/DO graduates, often depending on

geographic location. A private practice can either be as a solo practitioner or with a small number of other physicians or with a larger multi-specialty group practice. In this setting, it is possible to be involved in research activities, especially as part of industry-sponsored pharmaceutical trials. Some private practitioners can devote a considerable amount of their time to industry-sponsored trials. The motivation is to both be on the cutting edge of biomedical research and to be able to offer their patients new drug trials. Because income can be generated from being involved in the trials, participation may be cost-neutral or even positive. However, participation in industry-sponsored trials usually cannot be done when physicians are just beginning their career. It usually takes some time for the physician to be recognized as an expert in a particular area and for pharmaceutical companies to identify them as a potential site leader for a trial. Once involved in trials, if one is successful (i.e., the physician is able to recruit participants and report data as required), the opportunities increase. It is possible although not common for physicians in a private practice setting to do their own investigator-initiated trials (IIT), and to be a site for other's IIT studies once they are recognized as leaders in the field. Finally, while publishing in the private practice setting is not needed for career advancement, it is certainly an option for those interested in being part of the discovery process.

Physicians in the non-academic model can join a health care system to practice medicine as shown in Figure 1.

Figure 1. MD/DO career and practice pathways



This can be a for profit or not for profit system. This is rapidly becoming the dominant practice location and model in the United States.[6] Depending on the health care system, it can be difficult or easy to get involved in clinical trials and research. In fact, some systems allow and encourage involvement in research. But others hire physicians exclusively to be involved in clinical income generating activity and they discourage or prohibit physicians from participating in clinical trials as it takes their time away from their revenue goal. If a decision is made to join an academic medical center (AMC), usually affiliated with a university, then there are more options. One option is to see patients and do only clinical work. This is analogous to those in a health care system that do only clinical activity, and it is difficult but not impossible for physicians on this pathway to get involved in research. Their chances for involvement in research are a bit higher than for physicians at a for profit or not for profit health system. Some physicians at an AMC get one half day a week off for "administrative time" which can also be used for "discovery time." This can allow involvement in writing cases or perhaps being an investigator or collaborator in a clinical trial. These physicians are usually on what is called a "clinical track" and they do not receive startup money for research endeavors when they are hired, nor do they get protected time to conduct research.

If the physician is on a hybrid clinical and research track, then there are several options. One is the path of a "classic" physician – laboratory scientist who has a wet lab research focus. For these physicians, the goal is to obtain NIH and other funding to support their work. Usually these physician scientists spend no more than one half to one day a week in clinic and the rest of their time is dedicated to pursuing research. This is invariably a tenure track position. An emerging path that is becoming more common involves physicians who want to pursue a career in clinical and translational research that does not have a wet lab component. These physicians are involved in in depth clinical study of a disease or health area that can lead to NIH clinical intervention trials. To be successful on the clinical/translational research path with the goal to obtain NIH or other funding requires the same amount of research effort as the classic physician scientist in a wet lab. Both the laboratory-based and non-lab physician scientist require startup packages when they are hired to be successful. These packages will usually carry an investigator for two or three years and by that time they are expected to have secured funding to support themselves and their team members.

The last pathway depicted in Figure 1 allows research time for a physician is often called the clinical scholar track and this is probably the most common pathway at most universities for physicians. These physicians, while primarily seeing patients, decided to join an AMC so they could be involved in the discovery and research enterprise at some level. These are not wet lab based physicians but rather their research pursuits are usually in the realm of clinical translational projects. If these physicians desire to be involved in discovering more about patients' diseases and health, presenting data at meetings, publishing papers or being involved in clinical trials, this pathway provides such options. Their clinical practice generates most of their salary, with lesser contribution from grant funding. Some of them eventually do their own investigator initiated

studies at their local university, but these can expand with external funding to multicenter clinical projects. This group represents most of university physician faculty. It is a challenge for them to able to find sufficient time needed to engage in discovery activities because of their busy clinic schedules. University leadership and mentors need to be creative in helping to make time for conducting research. These physicians can begin by getting into a clinical trial research (usually initially an industry-sponsored study). Over time, as their reputation grows as an academic physician in a certain area, they then get invited to be in more and more trials, including being a site leader for an NIH clinical trials led by colleagues at other universities. With enough experience in these endeavors (along with concomitant publications, presentations and grant writing opportunities) some faculty can successfully write their own NIH or comparable funded study.

Financing Time for Research in an Academic Health Center

With each level of involvement in research activities the faculty member is encouraged to bring in some research dollars that can essentially "buy themselves out" of some of their clinical activity. The goal of some of these clinical scholars is to start with perhaps a day off a week when they first get hired to do discovery research activities. This amount of time off from clinical activity needs to be supported by the university and the department. If research funding results, then the faculty may be able to create more freedom from clinic responsibilities. Some clinical scholars over time can eventually be 50 percent clinical and 50 percent research. These faculty are usually not on a tenure track, but again this is very university dependent. When a clinical scholar is first hired they generally do not get any large degree of startup funds or protected time other than a day a week. Sometimes the young clinical scholar can request a portion of an existing clinical research coordinator's time if they anticipate getting involved in trials immediately. The expectation is that within a year or two they would be supporting a portion of the research coordinator's effort out of the revenue generated from research income and eventually they could support a full-time coordinator of their own.

Figure 1 also shows that some physicians over time can gravitate to other endeavors in a university involving education or administration. In addition, physicians who have had some experience doing research, either in the lab or clinical translational research, can exit to work for industry or to become entrepreneurs and begin their own startup companies.

What is Expected?

Table 1 describes what sorts of scholarly activity and goals physicians who plan to do some degree of research should be striving for at various stages of their career. (Many of these milestones apply to PhDs, and some specific activities germane to their career development are included.) While not comprehensive, Table 1 includes some of the potential grant mechanisms and funding sources that are geared for health professionals as their career grows.

AGE		GRANTS/FUNDING	ACADEMIC RANK
Late 20's – Early 30's • Case Reports • Case Series • QA/QI • Publish dissertation-related paper(s) • Present research at local, regional, national meetings • Seek opportunities to publish with mentor and others	• Complete Degree; defend dissertation • Obtain Boards	• Med Students TL1 / T32 • Residents/Fellows R 25/T32 Foundations • Pre-doctoral MD/PhD select F, K, R and T awards	Med Students Residents Fellows Doctoral Candidates

Mid 30's – Early 40's
 	
• Establish mentor team
• Write abstracts
• Review papers
• Write Measurement /Endpoint papers
• Conduct meta-analyses
• Review/Criteria papers
• Conduct follow-up dissertation-related studies
	• Get in pharma trials
	• Get in disease group consortium trials
	• Use expertise to augment disease focused or population focused studies
	• Intensify national networking
	• Obtain MSCR, MPH, MBA
	  • Join interdisciplinary teams/"do" team science
	  • Branch into additional research topical areas
		Career development awards
		
		• NIH K23, K08, K01,CTSA, KL2, F05, F30, VA
		• Foundations
		• Institutional Pilots
		• R03, R21
			Assistant Professor
			
			Postdoctoral Fellow

Mid 40's • Investigator Initiated Trials (IIT) – single site, small, pilot • Ask/collaborate to be in other's multisite IITs, esp. NIH/PCORI • Serve as a reviewer; get on a study section		• NIH R21/R01 Foundation • CTSA KL2 • VA Merit • More Institutional grants	Associate Professor

• Begin mentoring students/trainees/junior faculty • Increase number of first author publications		
Late 40's – Early 50's • Initiate multicenter IIT – 1st pharma, then federal • Initate or expand into international networks if appropriate • Continue publishing and increase number of high impact journal publications	• NIH RO1/FDA /other Federal • Patient Centered Outcomes Research Institute (PCORI) • Industry • Philanthropy	Professor; Department Chair
Mid 50's • Lead a consortium/program project • No more abstracts; increase number of senior author publications • Write a book • Serve as a journal editor • Lead an NIH or other study section • Continue to connect to mentees as they move ahead in their careers	NIH U and P awards Limited or no institutional grants	Professor; Endowed Chair
• Late 50's – Early 60's • Start a website/Organization • Stop reviewing (or be selective) • Accept invitations to travel and lecture more nationally/internationally • Focus on supporting mentees by reviewing their work (see above in younger cohort(s))	Raise more money	Distinguished Professor; Ex-Chair • Research • Administration
• Mid – Late 60's & 70's • Serve as Board Member/ Academic Society Leader	Continue to raise money and support research and institutional mission	Retire /Emeritus

Table 1. Select typical activities and milestones for research health professionals by decade.

When physicians are in medical school, residency and fellowship (20's and early 30's) their focus is to get their degree and pass board examinations. Scholarly activity during early career years can be case reports and case series. Some medical students have some laboratory research experience and a small number begin their training on the MD/PhD pathway which is much more research focused. Some grant programs exist to allow a medical student to do a year of research and obtain a Master of Public Health or a Master of Science in Clinical Research (M.S.C.R.) while in medical school. There are some NIH-supported grant programs to university departments that encourage residents and fellows to spend concentrated time on research.

If a physician joins an AMC after fellowship training, the amount of time spent on research of course depends on the track and career path he chooses as described above. In general, this is the time as an assistant professor that is spent writing abstracts to present to national meetings and to be visible academically. This will lead to getting into industry-sponsored trials and other consortium trials. Some junior faculty can pursue a M.S. C.R. over a number of years if they are interested in a research career. All faculty at this early stage can apply for institution-sponsored pilot grants for projects. The physicians on a NIH focused pathway need to apply for career development grants (K22 for clinical research/ K08 for laboratory research).

Having obtained some research success as an assistant professor is important to result in promotion to the associate professor level. At this point it is possible to embark on one's own investigator initiated clinical trials and he will more frequently be asked to be on colleagues' IIT multicenter trials from around the country. NIH-focused physicians need to be obtaining their own independent funding beyond the career development grant level and the goal is to ultimately obtain an R01 grant. At the professor level one has the experience and leverage to develop, obtain funding for, and run a multicenter IIT. This can happen before one reaches this career point but it is a reality that often this does not happen until one is well into their 40s. It takes time and experience to get proficient at this type of complicated clinical and translational research activity. This is a time for significant networking, including possible international collaboration. It may become easier due to reputation and research accomplishments to obtain large grants from industry and philanthropy to do IITs. When one enters the later years of an academic career, one can pursue larger funded projects such as complex center and multicenter awards. Applying for local institutional pilot grants is best left to more junior faculty at this point. Career pathway decisions remain crucial and opportunities may arise in research administration which can limit continued research discovery. Finally, tension between continuing the pursuit of research success and associated satisfaction with decisions to retire come into play.

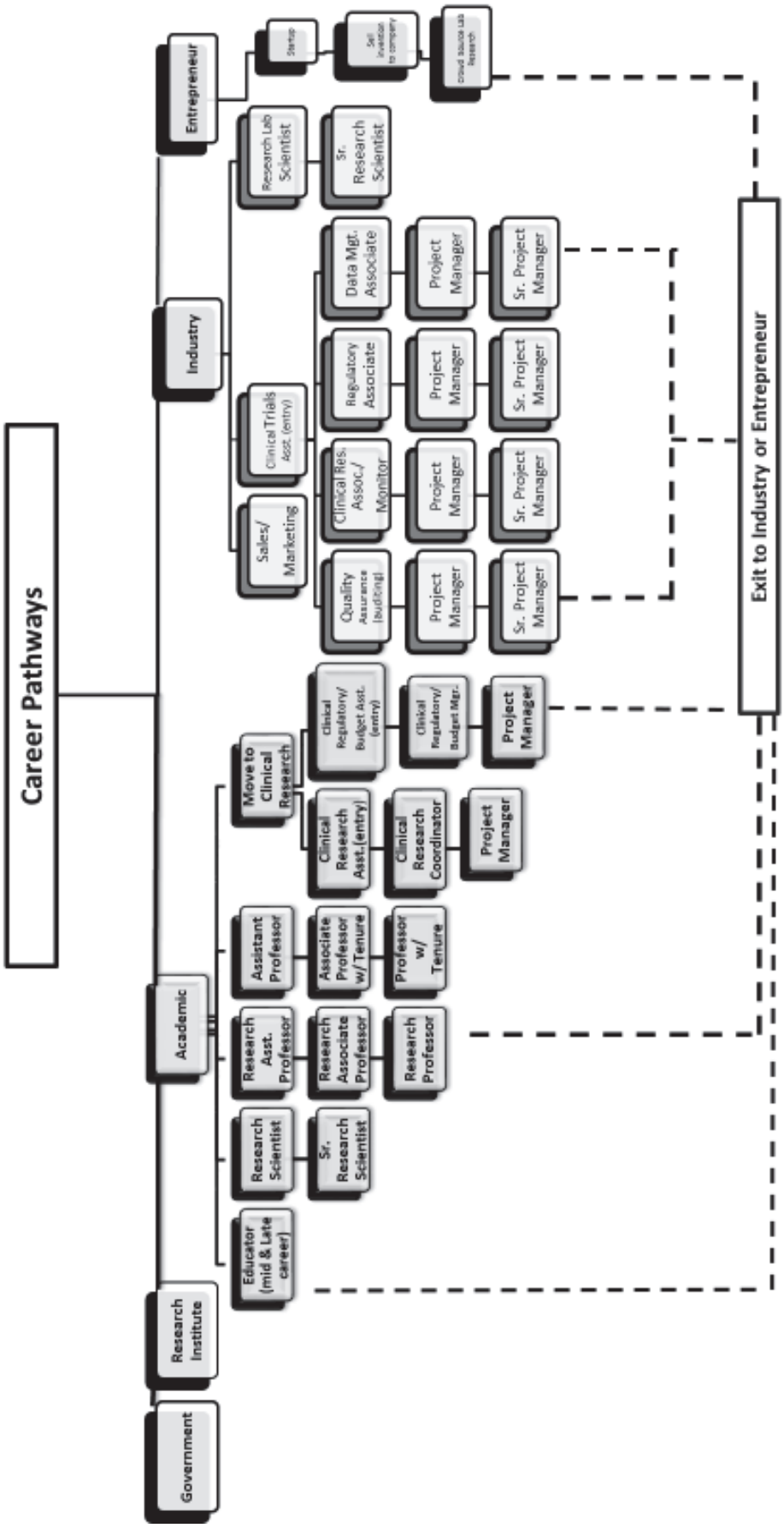
PhDs in Health and Healthcare

Whatever their intentions when students enroll in graduate school, career pathways are often molded by immersion in the graduate school culture.[7] Unlike the educational pathway that results in an MD/DO, graduate students may recognize that earning a Master's degree in programs such as business, public health, education, and

social work, may lead to health-related career opportunities that they seek, and they may stop there with their higher education.[8] Deciding to pursue a doctoral degree hinges on a relatively long term commitment to study in a specific field of choice. That singular decision – to seek a degree in chemistry, biology, anatomy, sociology, engineering, etc.– sets the first, pivotal step on the path to career development and career options. After obtaining a doctoral degree, some graduates continue in training as postdoctoral fellows in an academic setting, but this is highly variable depending on the field of study. Some academic disciplines have a long tradition of offering postdoctoral fellowships while in others, such training is rare. For PhDs, acquiring a job in academia is considered the highest form of success (especially as the competition for tenure-eligible positions is finite and competition for those limited positions is fierce). Doctoral candidates often are urged to have a "Plan B" to find a position in the non-academic world. By considering this a fallback option, such planning communicates that working in an alternative setting like in a health system or as staff supporting the conduct of research is less prestigious and less desirable (even if it might be more lucrative). Focusing on doctoral-level biomedical science graduates, a recent study suggested that students who choose nonacademic careers may be perceived as simply leakage from the desired pipeline, a metaphor that perpetuates the negative perception that these scientists represent failure.[9] This bias is changing, and biomedical and behavioral sciences researchers are encouraged to seek research positions outside of academia.[10]

Beyond a traditional faculty appointment in academia, other options include positions as a non-tenure track research assistant professor or a non-faculty position as a research scientist. Some doctoral graduates can move into the field of clinical trials research as study staff personnel (i.e., project manager/director) on a clinical research team. There also are jobs in the regulatory management of the clinical trials enterprise in the research offices that support the clinical research teams.

Figure 2. Common MD/DO and PhD career pathways



Some career pathways for PhDs are comparable to or the same as pathways for MDs/DOs. Figure 2 depicts five career options that health professionals may follow. While the connections appear linear, some health professionals move between options over the course of their careers, and sometimes back again. Career pathways can be fluid, but generally health professionals' training and personal preference determine the sphere in which they prefer to practice, teach, conduct research or develop/invent health-related enterprises.

One option open to both clinicians and PhDs is in laboratory and biomedical or health research that is done at freestanding, non-university research institutes. For example, working for a Clinical Research Organization (CRO) can provide a young career PhD the opportunity to explore their interests in the management and conduct of clinical trials. Some PhDs go directly into industry and there are a variety of job opportunities in this realm. One can continue to work in the wet lab as a research scientist or one can move into the field of pharmaceutical clinical trials in which there are several roles including quality assurance, clinical research associate and then clinical research monitor, regulatory associate and data management. Doctoral trained professionals also can find health and healthcare career opportunities working for or leading health-related nonprofit organizations, serving in community health and service organizations, public health (local, regional and state agency) and for think tanks/policy institutes. All these pathways can over time lead to research-related project leadership as well as publication opportunities., At any point in time, a doctoral trained professional can exit the academic, nonprofit or industry world and become an entrepreneur.

Summary and Words of Advice

No matter if one is a MD, DO or PhD, the pursuit of a career in research and discovery can be very rewarding on many levels. The motives to pursue such a career path range from altruistic (helping humanity), practical (you need a job) to narcissistic (to feel important). Regardless of the motive, successful researchers excel generally at networking early in their career, getting their name visible by presenting their science at academic meetings and working in a team science environment. Working in isolation is not a path for success; all of the pathways depend on the ability to collaborate, negotiate win-win solutions and persistence.

Using all available resources to make research successful is crucial. Finding a good mentor and nurturing a mentor team over time is very important. Finding a long-distance mentor(s) outside of the individual's institution or company can be equally important for long-term career success. These mentors bring objectivity and a novel network of colleagues who may be instrumental in building on a career path. It is also important to connect with patients and patient organizations who are involved in the disease /health area being studied. Getting them involved early and often in research projects and asking them what type of research needs to be done in the field can be illuminating and rewarding.

Write, Write, Write!

Unless junior professionals publish research findings, the likelihood of a long, successful research career diminishes. If candidates do not have publications to put on their CV, they will have great difficulty getting grants funded or in being promoted. Early on, writing abstracts, case reports, methodology papers and dissertation-

related papers is advisable. Write the early results and do not neglect writing negative data and negative trials. Write review papers, too, as these frequently get cited and they focus attention on emerging expertise which leads to recognition of the professional as a thought leader in the field. Pivotal papers are important but no one should wait for the "big one." Continuing to steadily publish builds reputation, and even less impactful papers are valuable along the way. As the young professional develops, it is advisable to have several active projects going at the same time. This diversifies the individual's research portfolio and provides multiple opportunities to publish with different teams on different aspects of research interests. If a paper is rejected from a first-tier, high impact journal, do not abandon the paper but instead, seek publication in another journal. In this regard, open access publications have value, but seek guidance from mentors given the emergence of predatory open access journals. [11-13] Review all options to make scholarship and research findings known, including using earned media from your institution or company to highlight the work. Do not pass up the opportunity to present research at local, regional and national meetings or to use growing relationships to patient and community-based organizations to share findings. Building momentum and working to maintain momentum by writing, publishing, presenting and partnering are keys to success for all the pathways described.

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Valuing Collaboration and Collaborators

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Collaboration and Team Science

The time required to move an innovation from the laboratory and into practice is measured in decades and often leads to failure (1). NIH created the National Center for Advanced Therapeutics https://ncats.nih.gov/programs to house the Clinical and Translational Science Awards Program and other initiatives intended to propel new ways to reduce this time, in part, by creating better 'hand-offs' between laboratory/bench scientists, clinician-scientists, and community health practitioners. Improved translation of research is just one strategy to move biomedical advances more quickly from concept to practice. Many problems we have yet to solve in and outside of the biomedical arena are complex. They require larger teams with specialized expertise to solve them, particularly to acquire and analyze data sets. This collaborative activity is often called Team Science. The research suggests inclusive teams where all members are valued improves the profile of the research (2).

Why Value Collaboration?

There are many reasons to embrace collaboration—to better compete in Team Science, as noted above, is the first. Another reason individual investigators should value collaboration is that collaborative grants and manuscripts often fare better in review, and manuscripts with more collaboration, have a higher citation index (3). Collaboration is also a strategy to achieve independence for early career scientists. By working in collaborative research teams, they will learn from and be mentored by a wider variety of faculty as they develop and acquire pilot data for independent funding. They will also learn to function within and possibly better lead a team in the future. Being included on other grants is also a strategy to bridge funding "gaps", which occurs more often as funding is more competitive. Some promising investigators who don't have a team to support them are dropping out because they don't see a light at the end of the tunnel, particularly if they think success only means a straight line to independent funding and they aren't are on it.

In Team Science, highly technical expertise is not only required but critical. These team members with expertise in biostatistics, biomedical informatics, and use of high-end instrumentation, will predominantly or always be collaborators. An environment that values these team members will be more likely to keep them, for they are highly sought after and can easily leave and find other teams and institutions to join that do.

Community members are also required for many teams, particularly those working on new solutions for community based implementation, as well as health services, health outcomes and quality improvement projects. These members serve in many roles, as coinvestigators, collaborators, consul-

tants, "cheerleaders", problem solvers, and strategists. They include community leaders and activists as well as community-based health care or public health providers and administrators. Understanding what they want from the collaboration is important as it is likely quite different from technical experts or other team members, but their roles are equally important. Universities should value these collaborators as much as any others because these same community members become higher education and research advocates, and help universities translate the value of research to their state legislators as well as provide training sites for university students.

Knowledge of how to create the best and most effective teams is an important research topic unto itself. Team science and teams are essential to workplaces outside of universities, including hospitals and other health care facilities, manufacturing, and research institutes. Working in a team has other benefits. Finally, being part of a team reduces the stress associated with high impact health care and reduces burnout which now plagues many health care organizations. While research is highly competitive, being a member of a research team may also decrease the stress associated with research careers, although this has not been well studied.

Do institutions value collaboration?

Academic health centers and other universities reward faculty for the activities they value most. Research Faculty learn early what is required to achieve salary increases from their department or college, including promotion and tenure, space assignments, and nominations for awards, internally or externally. Protected time (for research), access to development funds, graduate students and stipends, and choice of education assignments may be equally important to many faculty. With this lens, do institutions reward collaborators and collaboration activities?

Most will admit that promotion guidelines provide a clearer path for independently funded investigators than collaborators, but collaborators in most universities are being promoted more easily than they were in the past. Likelihood is improved when the institutional policies for promotion and tenure more clearly define the criteria required for collaborators, with either a separate path and/or very specific examples. Being awarded tenure can be harder, as this assumes and requires that the faculty member is highly valued by the institution over time. Historically, this requires evidence of independent extramural research funding, but criteria are changing at some institutions when the collaborator has longstanding history of covering their salary, even in the absence of independent funding.

Even when the criteria are clear, roadblocks can occur long before a candidate's packet reaches the university-wide promotion and tenure committee. Chairs, members of division and department promotion and tenure committees, and even mentors are still rooted in the value of more traditional pathways and discourage or reject candidates who are not independent investigators and discourage them from even considering promotion. As a result, the faculty member might not feel valued before they even seek promotion and tenure and begin to "look around".

Training of the members of promotion and tenure committees is just as important as the criteria and policies for promotion and tenure.

There are other ways to show the institutional value for collaboration. Many University of Nebraska pilot grant programs require evidence of collaboration and many aim at new collaborations. At University of Nebraska Medical Center, we include a metric for collaboration in our Distinguished Scientist Research Awards and encourage collaborators to be nominated for them. We are also working with public affairs to consistently include the names of all collaborators, not just the team leader, in announcements of successful research teams. Separately, we routinely and publically highlight faculty with unique technical expertise, who are often active collaborators. The research space metric used for assignment of space is based on research expenditures, which allows us to value investigators funded by subcontracts as collaborators, as well as those funded as principal investigators by assignment of space.

Yet "value" is defined in the eye of the beholder. Most faculty collaborators express the desire to be valued like other faculty members by traditional mechanisms such as promotion, tenure, and salary. But individual faculty might value something else more. Thus, to demonstrate value to an individual faculty member with a particular skill consider asking them what they value most and you might find they are looking for funds to develop a new technique, to travel to a specific conference, or to relocate their office or laboratory in relation to others. When trying to demonstrate that an individual is valued, consider asking them what they value most first.

The institutional F & A rate is negotiated with the federal government to reimburse an institution for the true costs of providing infrastructure to support organized research activity. Within our university, all colleges and institutes receive a distribution of the F & A generated by their faculty's research because those units often share the financial and administrative burden of supporting research, including regulatory compliance, physical research facilities, and grant administration. Some but not all Centers receive F & A distribution for the same reason. Some universities and institutions also share returned F & A with the principal investigator, particularly if they are expected to pay for resources such as research space, occupational health screening or other regulatory activities. This often brings up the question of whether F & A should be shared among the units of the co-investigators in another college or unit just as the F & A is distributed to co-investigators on grants administered at another institution. There is no one answer or strategy on how or if distribution of F & A demonstrates the value of collaboration. Institutions must first decide how F & A is spent before deciding if it is warranted and what scheme is most fair and easily administered.

Valuing collaboration may depend on the type of collaborator.

<u>Core directors</u>

Service centers, or research "cores", that bill federal grants, must meet all state and federal guidelines. Some cores work regularly with commercial and even international

clients and develop into independent, "start-up" businesses that require no institutional support. Cores that function within the university and are predominantly focused on serving the needs of investigators at their home university are more likely to require subsidization to end the year without a deficit. In fact, to meet federal guidelines for a service center, any "profit" (excess revenues over costs) must be rolled over into the operations for the following year and taken into consideration when setting the fee schedule going forward.

We expect a lot from core directors. Core directors must have the technical skills to understand the applications and approaches for using the technologies they manage and be able to apply them to a variety of types of research. They must be familiar with up and coming technologies to understand when they are becoming obsolete. They are expected to have or acquire substantial financial skills to resource existing and any new technologies, develop and administer a budget, and set fair prices to meet their budget for the financial operation of service centers. They must know all relevant federal guidelines and when working with international customers, export control regulations, as well. Most importantly, they must have excellent communication and problem-solving skills to hire and retain the best employees, address and resolve problems, even when the customer is highly anxious, frustrated, and/or angry, and market their resource and services, to sustain or expand their customer base and achieve financial sustainability. A core director with all those skills is an institutional asset, and often participates as a research collaborator, as well.

But do core directors feel as valued as other faculty or researchers? It should be noted that core directors may or may not be faculty, and may serve as a core director either full or part-time. While salary is the main avenue to show value, promotion and tenure may be much more difficult. To address this, many institutions have developed pathways for promotion of full time core directors. At UNMC there is a supplemental faculty compensation program for faculty whose salary are on grants, but full time core directors are not eligible. Importantly, the incentive should align with the desired goal and placing their salary on grants may or may not be the outcome most desired for the core director. For this reason, we are developing an incentive stipend mechanism for core directors that aligns with meeting and exceeding the expectations of a core director, to include metrics such as expanding customer base or providing access to new technologies or reducing the cost of core operations. However, if retention is the primary goal for a particular core director, it is important to ask them what they most need, as some core directors might prefer a developmental account to create new applications and techniques relevant to their area of expertise.

<u>Biomedical informatics collaborators</u>

Defining biomedical informatics remains difficult as there are many to choose from, but it describes a broad range of techniques and expertise critical for biomedical science data acquisition, transfer, merging, anonymization, analysis, and storage (4). The types of data

available are both broad and large ('big data"), from laboratory read outs (e.g., -omics data), geographic and environmental data, image and video inputs, and electronic, image, and other health data with its own set of privacy and confidentiality rules. Even individual image, video or genetic data can be large, terabytes, which make moving, sharing, analyzing, and storing them more difficult, whether stored on site, or in "cloud-based" or other sponsored repositories.

No university has all the biomedical informatics expertise they need. The field itself is still rapidly growing and changing with the data being acquired and analyzed in new ways such that many, including leaders, are self-taught. Informaticists or biomedical informatics experts often have and use both programming skills and content knowledge for the data they are handling, such as biostatistics, bioimaging, geographic information systems, or public health systems.

These biomedical informatics specialists often bring their unique skills to research teams as "collaborators". Some may also have their own independently funded research program while others serve only as active collaborators, but are required for many large grant programs. As these same experts are often highly desired by many industries, they can ask for and compete for higher salaries, leadership positions or other titles, graduate students, or new resources that clearly demonstrate their value to the institution.

Clinician and community collaborators

Clinicians are another type of collaborator required for more and more types of research—to help develop research questions or interpret results, acquire patient data or biologic samples, successfully move research into a clinical trial or useful device, or implement it into a real world setting. Community based- and academic clinicians, in turn, also value being part of a team when it is solving a problem they care about to positively change health care outcomes or practice. Yet health providers have less time for research, whether in a traditional clinical practice or an academic health center, even with funding, because of time constraints and practice requirements.

Academic health centers increasingly realize they need to include this type of participation in their compensation model if they value this type of collaboration so clinicians are not penalized for participation, as well. Community based clinicians may not need or want to be on grants where they have to track their effort. Other ways to show value may be nontraditional and depend on where they work. Providers in communities with known workforce shortages may see participating in research as an opportunity for access to trainees who might then learn about that community and consider working or living there long-term. Being part of a rural community means you often have less access to specialists for informal consultation, so that may be one of their goals. Some clinicians need or desire release time from clinical duties by their health system to participate. Some practitioners value access to library services, continuing medical education credits, or becoming an adjunct faculty. Finally, they may want to participate in the discussions around writing or

presenting the work at regional or national meetings, as well as being a coauthor.

Summary

Collaboration is integral to most types of biomedical research, and most researchers serve as collaborators during their career trajectory. Some researchers start out as collaborators and grow into a research leader role. Even research leaders will also participate as collaborators on some projects throughout their career. Faculty who serve predominantly as collaborators because of their unique skills essential to many research teams should be equally valued with a clear path to promotion and tenure or what other recognition or rewards might be needed to show them they are valued by the institution. This may require a change in culture at the promotion and tenure committee or within the faculty at large. In some cases, new mechanisms for reward specific to the type of collaborator or changes in institutional policies and programs will be required. Finally, as team science grows, institutions not only need to create a culture that values collaboration, but teach the next generation how to function effectively within a team as this skill will be as important to their future success as grantsmanship or any technical skill they are learning today.

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New Challenges and Opportunities for International Research Collaborations on a More Level Playing Field

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A frequently cited quote from Thomas Friedman reads *"When I was growing up, my parents told me, 'Finish your dinner. People in China and India are starving.' I tell my daughters, 'Finish your homework. People in India and China are starving for your job.'"* The world in which we live has drastically changed in some regards and in particular in what respects to science and technology. We do have new international partners and competitors in these areas and the way in which we interact with them is going through drastic transformations. The U.S. leadership in research and development (R&D) is being challenged, but at the same time new doors for international collaborations have been opened.

More than a decade ago T. Friedman singled out in his celebrated book, "*The World is Flat: A brief history of the twenty-first century*"[1], ten "flatteners" responsible for leveling the playing field in terms of commerce and the global economy. These still apply today in a certain sense to or have found a parallel version in international research collaborations with updated meaning. Namely:

- *Collapse of the Berlin wall* → we have experienced the collapse of "the Chinese wall" too, meaning Chinese students and scientists can freely leave their country now and so can foreigners visit China without much restrictions.
- *Nestcape* → of course many new web browsers exist now and, in many countries (though not all), there is "free" access to the internet.
- *Workflow software* → research tools like Dropbox, Google Drive, etc., have become the norm to share collaboration materials.
- *Uploading* → digital repository of articles and scholarly work have proliferated within discipline specific areas (e.g. arXiv.com), universities (e.g. KU Scholar Works), and the government (PubMed Central).
- *Outsourcing* → collaborative research is distributed among scientists in countries around the world (e.g. CERN – European Organization for Nuclear Research or the Human Genome Project).

- *Offshoring* → American universities continue to open campuses in other countries.
- *Supply-chaining* → like in Friedman's reference to companies using technology to improve distribution and shipping, technology is changing too the way we conduct research.
- *Insourcing* → recruiting and hiring of foreign graduate students and postdocs is fundamental for U.S. universities to carry out their educational and research programs.
- *Informing* → Google and Wikipedia have of course given easy access to a lot of information including advanced scientific and scholarly topics.
- *"The steroids"* → digital mobile devices and now "the cloud" not only revolutionized business and the financial world, but also the way we communicate and storage research information and data.

These "flatteners" together with the investment in science and technology in many emerging economies have indeed made the playing field in R&D more level or at least opened up opportunities for countries not traditionally leading the world scientific research enterprise. We will explore in the rest of this note some of these aspects, providing some examples, data, and metrics.

Two Successful Examples of Open Access and International Collaboration

Numerous ongoing initiatives have had a tremendous impact in scientific research and continue to represent great opportunities for international collaborations. Let's look at two specific examples: the arXiv and the CMS collaboration at CERN.

The arXiv is an open access digital repository hosted by Cornell University Library funded by Cornell University, the Simons Foundation, and member institutions. As of the writing of this article it provides[2] *"open access to 1,474,421 e-prints in Physics, Mathematics, Computer Science, Quantitative Biology, Quantitative Finance, Statistics, Electrical Engineering and Systems Science, and Economics"*. The arXiv was created in 1991 and the total number of articles downloaded from the site through November 2018 exceeded 1.2 billon[3]. The following table[4] of the fifteen heaviest user institutions in 2016 is evidence of the international aspect of arXiv.

	Institutional domain	Number of article downloads
1	cern.ch	462,283
2	u-tokyo.ac.jp	400,296
3	mpg.de(*)	393,252
4	cam.ac.uk	328,921
5	mit.edu	313,570
6	berkeley.edu	284,317
7	ethz.ch	247331
8	princeton.edu	233,363
9	kyoto-u.ac.jp	230,047
10	ox.ac.uk	228,319
11	columbia.edu	183,097
12	ic.ac.uk	165,614
13	caltech.edu	161,805
14	in2p3.fr	161,534
15	nus.edu.sg	157,073

* mpg.de includes downloads from several institutions in Germany.

This free repository has made available at the click of a mouse up-to-date research pre-publications to the whole world, exponentially accelerating the sharing of knowledge and new discoveries in the disciplines covered by arXiv.

The CMS Collaboration operates and collects data from the Compact Muon Solenoid particle detectors at the Large Hadron Collider (LHC) in CERN (*Conseil Européen pour la Recherche Nucléaire)*. One of the largest international research collaborations ever, as of October 2016 CMS involves[5] 2885 physicists (of which 922 are students), 995 engineers, and 279 technicians in 198 institutes across 45 countries and regions in 6 continents. The LHC is the largest scientific instrument in the world.

The remarkable achievements of this project, including the discovery of the Higgs boson (a new elementary particle with fascinating properties) are evidence of the need for international collaborations for the most ambitious and complicated experiments in science. At the same time, the collaboration has allowed for the participation of scientists from some countries around the world which would have never had resources to conduct such high-tech research otherwise. This has resulted in access to human capital and brilliant minds worldwide while in turn also contributed to the scientific progress of less developed countries.

Some Worldwide Metrics and Trends

While the previous examples speak of open and embracing inter-

national collaborations, competition among countries in scientific research also exists and has been escalating over the years. Moreover, while keeping the lead in many areas related to science and technology, the U.S. has started to lag or is predicted to soon lag in some commonly used metrics of research activity and productivity when compared to new international competitors, in particular China.

The National Science Board (NSB) *Science and Engineering Indicators (Indicators),* provides a wealth of information about science and engineering and research and development in the U.S. and the world. The Indicators are a congressionally mandated report which is intended to be factual and policy neutral. According to the most recent report[6],

"The United States holds a preeminent position in S&E in the world, derived in large part from its long history of public and private investment in S&E research and development and education. Investment in R&D, science, technology, and education correlate strongly with economic growth and with the development of a safe, healthy, and well-educated society.

Many other nations, recognizing the economic and social benefits of such investment, have increased their R&D and education spending. These trends are by now well-established. S&E capabilities, until recently located mainly in the United States, Western Europe, and Japan, have now spread to other parts of the world, notably to China and other Southeast Asian economies that are heavily investing to build their scientific and technological capabilities."

In the views of Maria Zuber, NSB Chair and Vice President for Research at the Massachusetts Institute of Technology[7], *"This year's report shows a trend that the U.S. still leads by many S&T measures, but that our lead is decreasing in certain areas that are important to our country,"* adding *"That trend raises concerns about impacts on our economy and workforce, and has implications for our national security."* We include here some key graphs, plots, and information from the *2018 Digest*[7] version of the report.

In the plots in Figure 1[8,p.5] we see several aspects of R&D at the global level which show how much Asia in general and China in particular have become much bigger players. Plot A shows that worldwide expenditures in R&D have grown almost linearly from around $700 billon in the year 2000 to almost $2 trillion in the year 2015. Although in all the countries or regions with the largest R&D expenditures such expenditures continue to grow in a linear fashion too, we see in Plot C that China's expenditures have not followed such a trend and speeded up to become second only to the U.S.. At the same time the share of worldwide R&D during the same period has changed substantially: Plot B shows that, while North America had the largest share in 2000, Asia has the largest one in 2015. Plots D and E also show how the biggest growth in R&D has geographically moved to Asia. China, South Korea, and India were the countries with the largest annual average growth (Figure E) and together with other Asian nations they accounted for

about 50% of the contributions to worldwide R&D growth (Figure D). China alone accounted for 31% of such worldwide contributions. However, in R&D intensity (R&D expenditures as a percentage of GDP), as shown in Plot F, China had not reached as of 2015 the level of the US. On the other hand, South Korea surpassed the US in R&D intensity after 2009. Following linear regression projections, it is predicted that China would surpass the US this year in terms of gross expenditures in R&D and in 2020 it would do so in terms of R&D intensity.

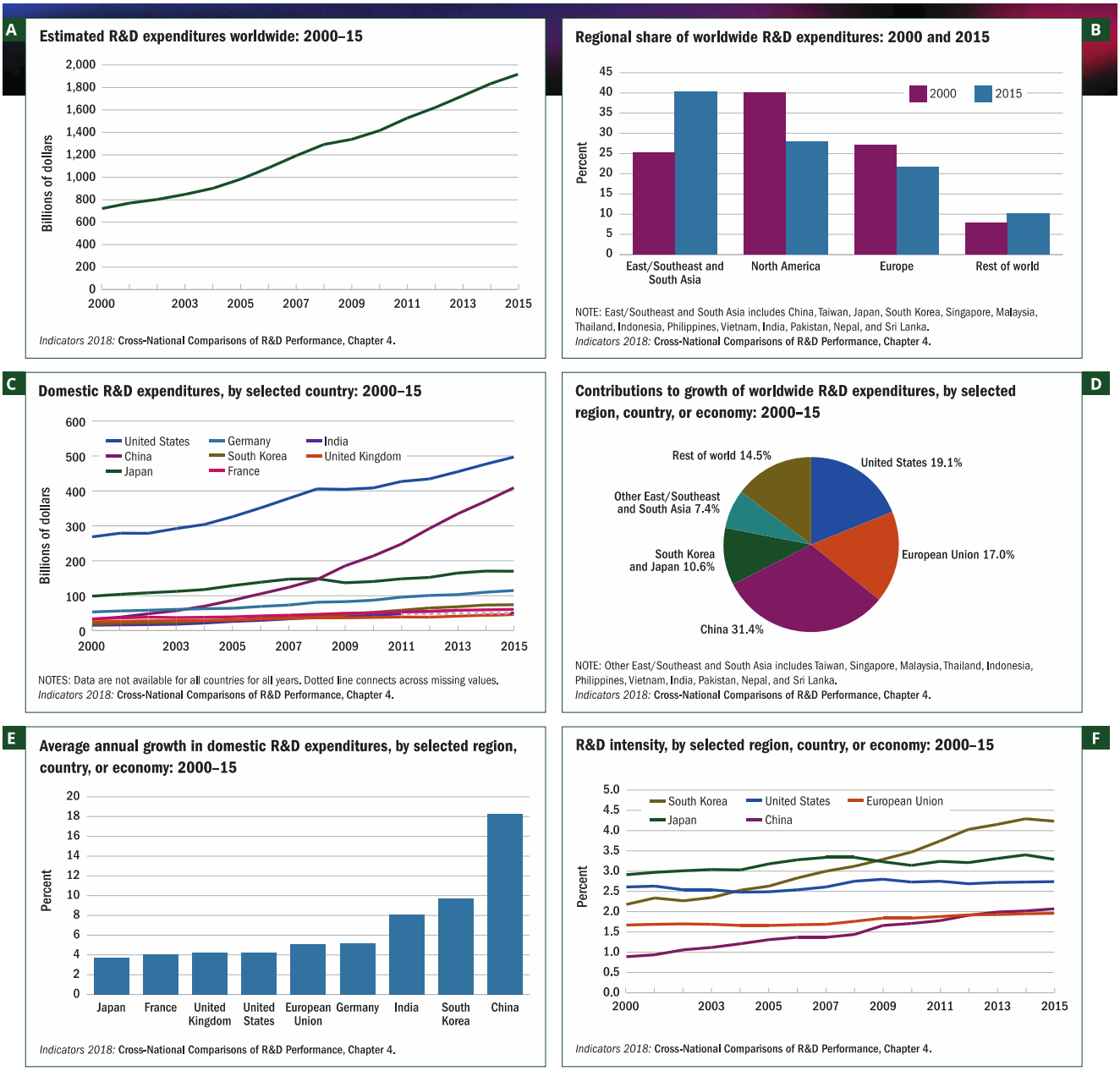

Figure 1 - Science and Engineering Indicators 2018 Digest - www.nsf.gov/statistics/digest/

Several metrics related to science and technology capabilities are plotted in in Figure 2[8,p.9]. Of particular note is again the fact that China has surpassed already the US in terms of S&E published research articles (Plot A). The rapid growth of China in other metrics is also reflected in the other plots of the figure.

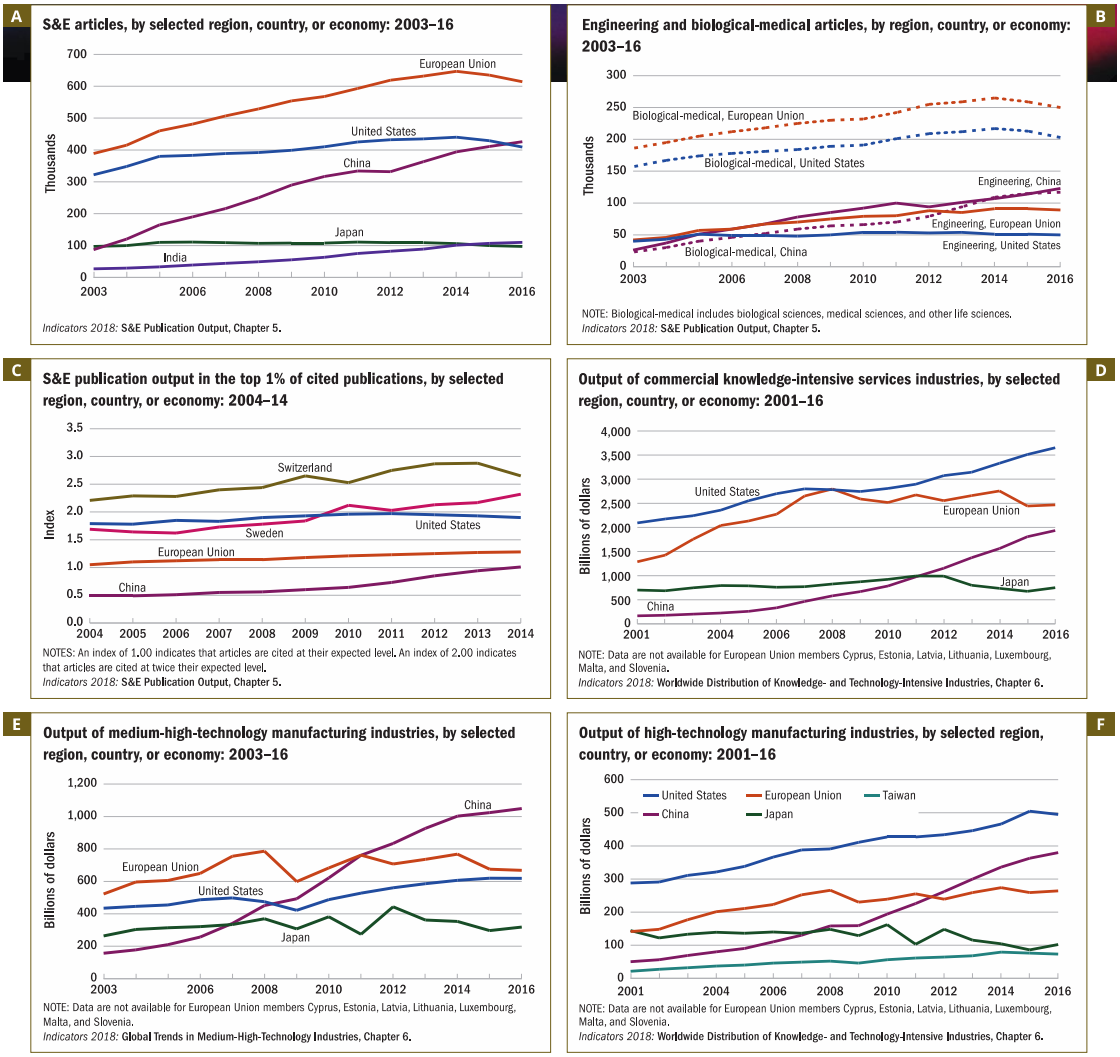

Figure 2 - Science and Engineering Indicators 2018 Digest - www.nsf.gov/statistics/digest/

Global S&E education follows similar trends in China and we see in Figure 3[8,p.13] its rapid growth regarding bachelor's degrees awarded in S&E fields. For example, in 2014 the number of degrees awarded in China more than double the number in the U.S.

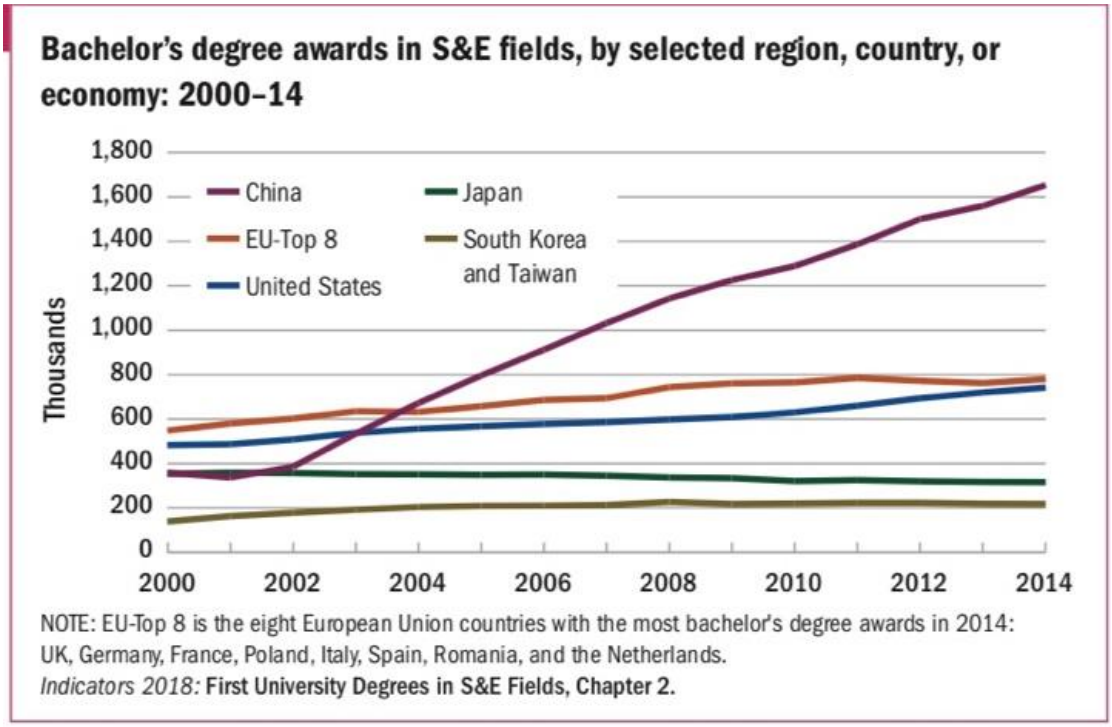

Figure 3 - Science and Engineering Indicators 2018 Digest - www.nsf.gov/statistics/digest/

The U.S. still produced more PhDs in S&E fields than China as of 2014, but it did so by relying on temporary U.S. visa holders who accounted for more than a third of the recipients of those degrees. See Figure 4[8,p.13].

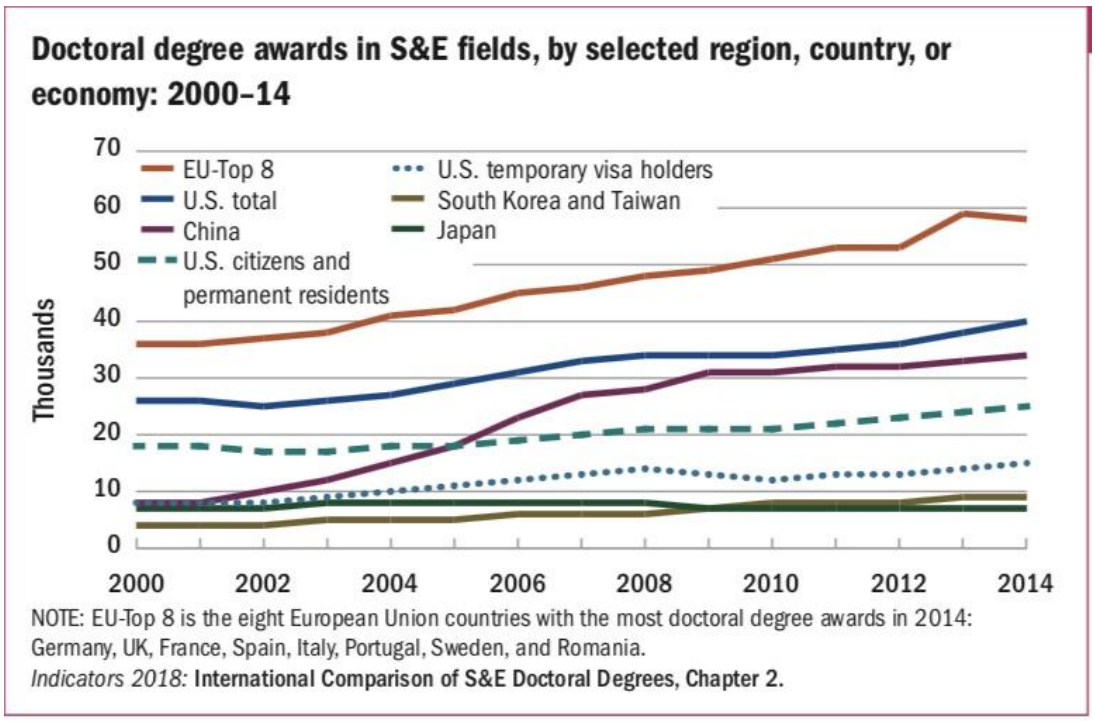

Figure 4 - Science and Engineering Indicators 2018 Digest - www.nsf.gov/statistics/digest/

Additional data from the Indicators[9] related to international students is quite revealing too. We extract the following points:

- *Since 2008, enrollment of international students in S&E fields has been rising, while graduate enrollment of U.S. citizens and permanent residents has declined overall.*
- *In 2015, international students accounted for 36% of S&E graduate students, compared with 26% in 2008.*
- *In 2015, international students earned more than half of the doctoral degrees awarded in engineering, economics, computer sciences, and mathematics and statistics.*
- *In fall 2017, 69% of the international S&E graduate students in the United States came from China and India, similar to prior years.*

These data clearly show how much the U.S. relies on foreign students to carry on its education and research programs in S&E.

Increasing Funding Opportunities in Other Countries and Balancing Open Access with Technology Protection and National Security

Not only Europe and Japan continue to invest in collaborative projects but also new opportunities for research funding are being developed in Brazil, China, India and other countries. While the investments of these countries in R&D increase their competitiveness and their share of the worldwide research enterprise, they also provide opportunities for U.S. scientists and students. An increasing number of international conferences in S&E take place outside the U.S. and are substantially funded by governmental and private organization in the host countries. This provides resources for U.S. scientists to visit those countries and establish new collaborations. At the same time, it is more and more common to find at U.S. institutions international students, postdoctoral fellows, and scientists participating in long stays financially supported by their countries of origin. These international exchanges happen then without financial investments from U.S. resources and hence are very much welcome by universities.

The open access and free exchange of knowledge is fully supported by the Association of American Universities (AAU) and the Association of Public and Land-grant Universities (APLU). In fact, the recent AAU-APLU Public Access Working Group Report and Recommendations[10] "*summarizes actions that universities and federal agencies can take to advance public access to data in a viable and sustainable way.*" In particular, the following broad goals are supported by the report:

- *Providing public access to research data in the most useful ways to society;*
- *Minimizing the administrative burden on agencies, universities, and researchers;*
- *Allowing exceptions for privacy, security, and intellectual property (IP) concerns;*
- *Prioritizing data quality and its rigorous evaluation as a foundation in preparing, documenting, and releasing data;*
- *Balancing the substantial costs of data access against the benefits of access;*
- *Recognizing that data types and accessibility needs vary across disciplines, requiring a flexible approach; and*

- *Considering the community of interest and duration of usefulness for the data in question and making retention and access requirements clear.*

Having open access data in the U.S. in a format easily reachable through internet tools, means also that data and research would become completely open to the whole world. Because of the diversity of activities and countries involved in international exchanges, it is becoming an increasing challenge for U.S. universities to balance openness with the federal export control regulations. As stated in the report Dual Use Research of Concern in the Life Sciences[11,Ch. 3] from the National Academies, the National Security Decision Directive 189 (NSDD-189) states[12]: *"…to the maximum extent possible, the products of fundamental research remain unrestricted."* However, when more applied, dual-use, or specific areas of research are involved there are federal regulations and agencies that control exports of research and technology. In particular,

- The U.S. Department of Commerce's Bureau of Industry and Security (BIS) administers the Export Administration Regulations (EAR) that govern the export of commercial and dual-use goods;
- The U.S. Department of State's Directorate of Defense Trade Controls (DDTC), administers the International Traffic and Arms Regulations (ITAR) that govern the export of defense articles, defense services and technical data;
- The U.S. Department of the Treasury's Office of Foreign Assets Control (OFAC) administers country-specific economic and trade sanctions that often include restrictions exports to targeted countries.

Unfortunately, it is not uncommon to read in the news that individuals and/or institutions get fined or legally prosecuted for violations of export control regulations. A recent White House Office of Trade and Manufacturing Policy report [13] points to this data: *"the annual cost to the U.S. economy continues to exceed $225 billion in counterfeit goods, pirated software, and theft of trade secrets and could be as high as $600 billion"*. While some defense and commerce related research and the resulting technologies are clearly identifiable for export control restrictions, it is more difficult to do so with scientific discoveries in areas of fundamental research. Universities need to better train their faculty and students regarding export control regulations to avoid sometimes unintentional law violations.

Conclusions

The world has indeed flattened in terms of economic development and hence, not surprisingly, also in terms of scientific research and technology. While the U.S. has a head start in many areas related to R&D, other nations are catching up and have serious ambitions to become leaders in the research arena. The U.S. has traditionally opened its doors to the best minds, both students and scientists, from around the world and still relies on foreign students to fill its doctoral programs in S&E. New opportunities exist for international collaborations and some have already proven to be very productive. The use of modern technology and means of communication has facilitated such collaborations. Yet there are concerns

about what research and technologies should be protected and how to maintain a balance with the emerging philosophy of global open access to data and research. Export control is a difficult compliance issue for many universities and more training, education and discussions about the topic are needed.

In the words of Tom Wang, chief international officer and director of the AAAS Center for Science Diplomacy, American Association for the Advancement of Science (AAAS)[14], *"Ultimately, the United States has always recognized that it needs and benefits from more international openness. To maintain global leadership in science and technology in the 21st century, the United States must remain a champion of engagement and cooperation, not isolation"*. American universities, the organizations that group them, and government agencies should continue to work together to find the right balance protecting the U.S. national interests while allowing for the important and mutually beneficial international collaborations that our universities conduct.

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Recognition and Incentive: The Value of an Institutional Strategy for Faculty Awards

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Framed within current developments and future expectations for open-access data and scholarship in research universities, considerations of the practice and meanings of interdisciplinary and interinstitutional research will continue to expand. Inherent in considerations of open-access data and scholarship are implications for assessment of scholars and scholarship and, in particular, the role of open-access on evaluation of researchers in the university environment, and in particular on tenure and promotion. This raises broader issues of evaluation and recognizing achievement in the university, in the context of changes in how scholarship is pursued and evaluated.

In 2000, the University of Nebraska-Lincoln's (UNL) convened a Future Nebraska Task Force to imagine next steps for the nature, scope, and quality of the institution's research enterprise with consideration of ways to incentivize and recognize excellence. The committee's corresponding report, *A 2020 Vision: The Future of Research and Graduate Education at the University of Nebraska-Lincoln,* outlined the characteristics of a "vigorous academic community." It read, in part:

> "A vigorous academic community finds ways to value, celebrate, and make visible in the everyday life of our institution its outstanding academic achievers... it has often been said that an institution becomes what it celebrates and honors and we cannot become an institution of high academic success if we do not honor those individuals and teams among us who achieve success in their scholarly endeavors… When we do showcase our best faculty, everyone feels better, not worse: it's exciting, thrilling, self-satisfying to know that people this good are our colleagues and it encourages a culture in which people take pride and add to their own stock of self-esteem via the institution's achievements, stature and reputation. And when this is done on a regular basis, and in all areas of scholarly endeavor, it creates a collective experience of institutional pride that breeds even more success."

It is in the timeless spirit of this almost 20-year-old report that UNL began to focus more intentionally on promoting awards activity in 2011. Indeed, focused pursuit of national awards and honors for faculty is a hallmark of a culture that incentivizes, recognizes, and celebrates outstanding achievement while at the same time producing collateral advantage through enhancing individual faculty careers, building departmental profiles, and advancing the reputation of the university as a whole.

Rationale

A recent *Science* article (May 2017) lays out the important role of awards in a faculty member's career. Benefits of applying for awards include increased visibility and improved networking and collaboration opportunities as well as an opportunity to practice the skill of promoting oneself. Further, taking the time to compile the nomination package and connect with mentors provides a structured opportunity to reflect on and assess professional progress and any corresponding gaps, especially in early career stages. Perhaps from a broader perspective, awards can also serve as an important institutional retention tool. In addition, awards are consistently and increasingly an important indicator in and component of scholarly production and institutional rankings. All of these benefits in mind, it is also important to note the overall positive nature of awards–simply put, awards make people feel good and offer an opportunity to celebrate a career's hard work and excellence, an outcome with value and incentive in and of itself.

Further, a relatively recent line of incentive economics research (e.g. Frey & Neckerman, 2009; Chan, et al., 2014) explores the connection between awards and faculty performance as well as the utility of awards as a means of motivation for researchers, in particular in comparison to monetary recognition. Among other findings, these papers note that awards are a viable and effective instrument in encouraging and advancing research performance and that, following receipt of awards, research productivity and citations increase in a statistically significant way. While researchers note the complications and limitations of any approach attempting to isolate the impact of external incentives on performance and motivation, with these conclusions in mind, it may be helpful for institutions to consider this research when contemplating various award, recognition, and incentive strategies.

At Nebraska, the focus on awards became an institutional priority in 2011. In his State of the University address that year, then-Chancellor Harvey Perlman emphasized the need for increasing our academic stature and challenged the campus with ambitious goals for increasing growth in research and economic development. Specifically related to awards, the goal was to double the number of faculty receiving prestigious national awards and memberships in honorary societies.

Role and services

To implement and operationalize this work, UNL leadership collaborated on the structure and centralized support by establishing a full-time position dedicated to promoting, coordinating, and tracking awards. Three senior leaders—the Senior Vice Chancellor for Academic Affairs (today the Executive

Vice Chancellor and Chief Academic Officer), the Vice Chancellor for Research and Economic Development, and the Vice Chancellor for the Institute of Agriculture and Natural Resources—shared the cost of establishing the position, making professional services and expertise available across the campus. The National Recognition and Awards Coordinator is administratively housed in the Office of Research and Economic Development (ORED) as the role is most closely aligned with its research development activities.

A variety of barriers inhibit faculty from pursuing awards, such as faculty humility or concerns about competition, lack of knowledge about the existence of awards or how to apply, learning to navigate the process and needed patience when not successful the first time, and legitimate time concerns and restraints for both faculty and administration. The availability and expertise of the National Recognition and Awards Coordinator at Nebraska relieves some of the more practical concerns while offering a resource for managing logistics of application and university-level recognition.

Operationally, the Coordinator takes a broad approach to the national awards universe and offers professional services across campus, including:

- Identifying opportunities that align with faculty expertise
- Facilitating nomination process nuts and bolts, such as:
    - Review of guidelines and eligibility, including analysis of past winners
    - Communicating with the award sponsor with any questions
    - Coordinating with nominators, both internal and external
    - Editing and drafting nomination materials to tell a compelling story of career impact
    - CV coaching, tailoring, and editing
- Monitoring progress toward deadlines
- Tracking institutional submissions and receipt of awards
- Reporting results to university leadership on a quarterly basis

In addition to supporting nominations, an important component of the Coordinator's work involves an ongoing effort to shift the institutional culture around the value of this activity. In part, this involves consistently communicating the value of awards to faculty and administrators (see a description of communications activities below) and recognizing faculty and their administrators when the process has a successful outcome.

Strategies and communication

The National Recognition and Awards Coordinator position deploys multiple strategies to catalyze this type of activity at Nebraska, for example:

- Conducting outreach across the university through presentations and individual meetings.
- Analyzing past award data and guiding focused planning
- Targeting certain departments and faculty members for nomination
- Sharing success and celebrating award winners through strategic communications

- Working with university leadership to develop consistent messaging and outreach

It has become increasingly important to partner with institution-wide communications offices, especially the centralized University Communications as well as unit and college offices, to ensure that awards are widely publicized. This is a critical component of the awards strategy; if the awards are won in isolation, without any publication or recognition, it limits the overall incentive and resulting cultural impact.

We have also developed a strategic set of collateral materials, including a comprehensive awards web site with a listing of award winners, a promotional video, and professionally designed flyers. The web site, launched in August 2017, has proven a useful tool for promotion, with positive response and participation from faculty. The awards listing is regularly updated through various resources, including Academic Analytics data and direct communication with individual faculty and departments.

The campus video, featuring faculty and administrators speaking to their personal experience with awards, has also proven an effective approach in promoting awards and engaging institutional leadership to shape and share the message. Along with perspectives from several award winners and a Department Chair, the video includes UNL's current Chancellor, Dr. Ronnie Green, who inspires and incentivizes action by speaking to both the personal and institutional value of awards. The video was first shown at the annual ORED Research Fair Awards Breakfast in November 2017 and has been used on the web site and in smaller meeting settings since that time. It was also part of a campus-based online *Nebraska Today* newsletter feature article outlining institutional awards success in fall 2017, which generated a good deal of positive attention for the National Recognition and Awards Coordinator and the awards strategy.

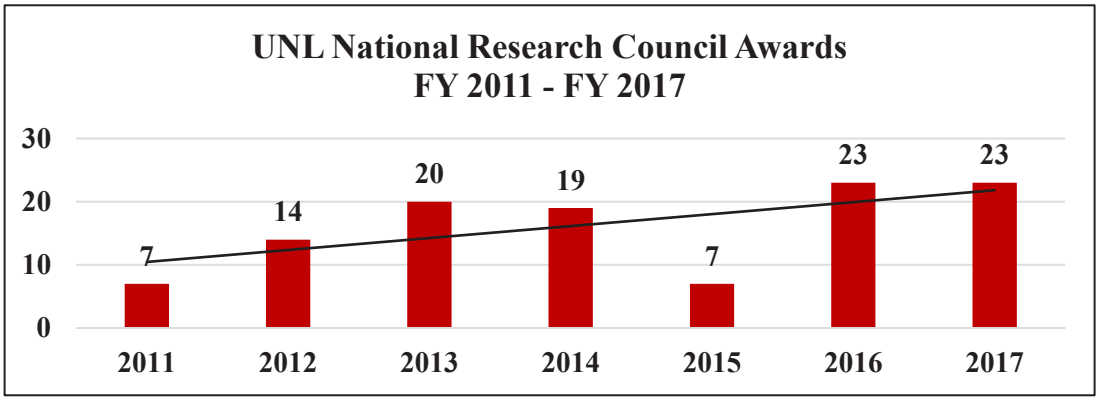
A final strategy that has paid unexpected dividends is a personal letter of congratulations from Chancellor Green to individual award winners, which includes more specific information than just the award title, for example, text from the announcement and specific testament to the award winner. The letters are sent on a bi-monthly basis, with copies to Deans and Chairs, and the response has been overwhelmingly positive. The Chancellor regularly receives replies of gratitude, demonstrating the impact of this personal form of recognition. Chairs have also noted how meaningful the letters are to all faculty, especially to early career faculty. Most recently, a letter was quoted in a communications piece announcing a Fulbright Scholar award, extending the Chancellor's message to a wider audience. This relatively simple recognition sends a signal that the highest levels of leadership are paying attention to and care about individual awards and careers, which further incentivizes award activity.

Results

The awards story at Nebraska demonstrates the kind of results that are possible when an institution invests focused time, resources, and energy toward pursuit of this goal. Since focusing on national recognition and

awards, UNL has exceeded the original goal set in 2011, having more than tripled the number of awards earned by faculty as recognized by the National Research Council (NRC). (The NRCS maintains a list of over 1,300 awards recognized as "highly prestigious" or "prestigious.").

The data outlined here focus on NRC awards as a benchmark from which to measure progress. That said, award efforts include all national awards important to individual careers and within disciplines. For example, the list of awards maintained by the NRC does not focus as heavily on teaching, service, or creative activity, so a broader approach is needed to be inclusive and representative of the kinds of scholarship that builds a career across the academy.



Beyond structure and quantitative results, seating a position like the National Recognition and Awards Coordinator and aligning the resources for them to do the job is not enough. To shift institutional culture, a qualitative activity, the value of the awards has to be articulated at the highest levels of leadership, as described above, and this message must be shared with all of campus on a regular and strategic basis.

Model departments

The culture and leadership of individual departments plays a significant role in awards success. Many times, Chairs and Heads drive awards activity for a department, as they are most familiar with faculty strengths and career trajectory. Several departments at Nebraska take a strategic approach to award nominations, through either an established awards committee or a committed Chair.

For example, the Department of Communication Studies in the College of Arts and Sciences has a long history of awards success. Since 2011, the department has won 15 national or international awards, including many of the top awards from the National Communication Association (NCA). The department's chair, Dr. Dawn O. Braithwaite, is known for her committed, thoughtful approach to awards and for nominating faculty members and preparing younger faculty to be competitive when the time is right. She carefully tracks awards and deadlines and works in advance to line up nominators and supporters. Dawn has also been deeply involved in NCA and

other associations, having served as President and in many other capacities and, at the same time, building a professional network that we know is so critical to awards success. She has also worked with the national association to research and expand their list of awards for which members can apply. In fact, Dawn is so well known for her work with awards that the Central States Communication Association recently named an award *after* her. The inaugural Dawn O. Braithwaite Award for Qualitative Research was presented at the April 2018 meeting. This demonstrates the impact of awards leadership on a department and discipline.

Another successful department, Biological Systems Engineering, has a track record of successfully nominating its faculty for awards, with a recent string of awards from its professional society the American Society of Agricultural and Biological Engineers (ASABE). Since 2012, the Department has won 13 of ASABE's major awards and, since 2014, four faculty have won all of the most prestigious early career awards (across teaching, research, and service categories). The National Recognition and Awards Coordinator worked with ORED Communications to highlight these achievements through an article, "*Blueprint for Success: Department's Culture Creates Model for National Awards Success*." Sent as a feature in ORED's monthly newsletter, this article held up an exemplar department and described for all of campus how its approach to and strategies for awards have been successful in building its profile.

Next steps and conclusion

Though Nebraska has made much progress within the awards arena, there is ongoing room for improvement. For example, there are several high-performing departments, as measured by other metrics, which do not yet focus on awards. Moreover, there is a need to target the humanities, social sciences, and performing arts, both as a welcoming entry point into ORED and as a strategy to diversify the type of awards being pursued.

To further institutionalize this activity and to drive success through individual departments, we are currently developing a structure and program to promote awards more directly to departments and Chairs through a "department awards committee startup package." This package will offer best practices around awards committee make up and function as well as strategic support offerings to alleviate some of the pressures for departmental executives. In part, this targeted outreach will focus on humanities and social sciences to meet other needs for growth. There is also an ongoing need to diversify nominees and help faculty think about and build their external networks as an important component of being award ready.

There is always more work to be done, but the ongoing potential of awards at Nebraska is clear: a dedicated position like the National Recognition and Awards Coordinator can serve as an enzyme—catalyzing activity across campus to incentivize and increase faculty awards and recognition and making a difference to advance the university.

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KU School of Medicine Mission-Based Allocation Model: Aligning Funding with Expectations

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The past decade has been challenging for public universities that rely predominantly on state funding for their general operations. Most have seen significant and sustained decreases in state funding. As demands have grown for other programs, higher education funding has declined; since 2008, per student spending has declined in nearly all states, in some cases exceeding 50% [1-3].

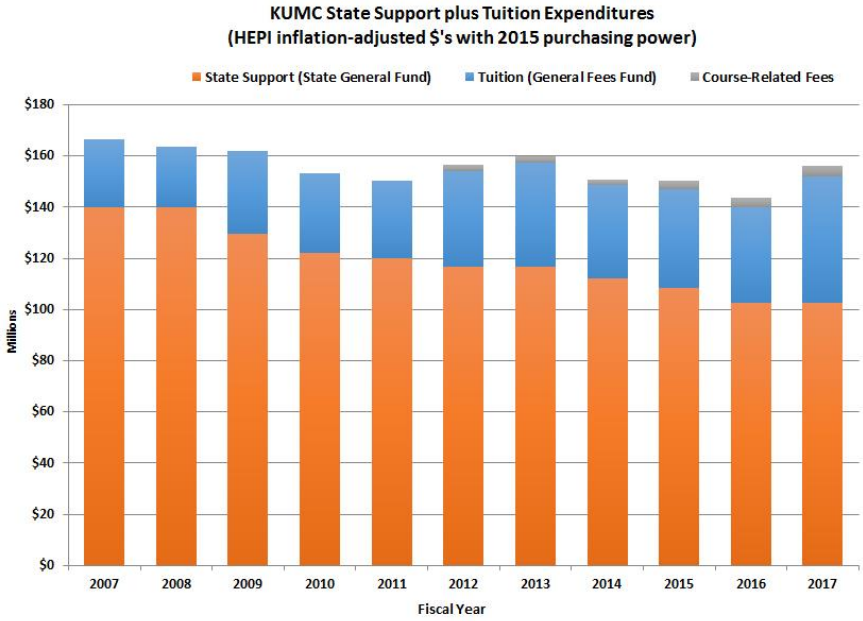

Figure 1. State of Kansas support of the University of Kansas Medical Center. Adjusted per Higher Education Price Index to 2015 dollars.

Medical schools have not been spared. In the case of the University of Kansas School of Medicine (KU SOM), state support declined nearly every year between 2007 and 2017. In 2017, the inflation-adjusted annual state allotment to the University of Kansas Medical Center was $40M less than it was in 2007 (Figure 1). To some extent, this decrease was offset by increases in revenue from tuition and fees, such that the decrease in overall funding was approximately 7%. However, during this period student enrollment increased by 23%. The decline in state funding at a time of expanding demand forced University leadership to reconsider how financial resources should be distributed so that they best align with the school's missions in terms of research, education, and service.

The 'historical' funding model

Like many schools, faculty salaries at KU SOM were based on an historical model. State funds were designated to support individuals – that is, a 'state line' was provided for a particular faculty member based on prior years' allocations, adjusted to reflect any major changes in overall funding from the state.

The historical funding model had certain advantages. Perhaps foremost is its predictability. Although some sources of salary support, such as effort on federal and foundation grants, research contracts and clinical trials, are not fixed, the bulk were relatively stable under the historical model. This facilitates financial planning at the departmental and personal level and provides an assuring measure of predictability to chairs developing their departmental budgets. However, the historical model has two very significant shortcomings. First, not all historical salary lines were created equally. Faculty who were recruited in better times when state funding was high, tended to hold more robust lines which were less dependent on external resources, and were further augmented by state-mandated raises (a rare occurrence in recent years). In contrast, recruitments that took place more recently, when less state funding was available, depended more on riskier external resources to make up larger proportions of their salary. This shift toward funding proportionately less salary with state resources has been further compounded by a relative absence of raises associated with state salary dollars. Thus, within the historical model we see considerable variance in state commitment. While this may not be problematic in good times, when external funding is lost these more recent hires are impacted disproportionately and see greater reductions in salary support. Because the numbers of women and minorities recruited to academic medical schools have increased substantially in recent years, the historical model carries with it the potential for de facto wage discrimination to these groups.

Another limitation of the historical model is that it does not necessarily reflect levels of productivity or support for the School's missions. While chairs did hold the power to adjust salaries in the KU SOM historical model, these were difficult discussions and departments frequently lacked clear compensation plans that could drive the outcome. The lack of a relationship between effort and compensation vis a vis the historical model did lead to very real discrepancies in compensation for individuals performing comparable duties. Inevitably, such discrepancies lead to a perception of unfairness and faculty dissatisfaction, which in turn can lead to lowered productivity and/or problems in faculty retention.

A particular limitation of the historical model, applicable to the present situation where budget cuts are the norm, lies in how the reductions are applied. In this model, budgetary cuts are typically implemented as across the board reductions to mid-level units (departments). While a chair could choose to apply cuts in accord with specific formulae, this traditionally has not been the case. Accordingly, individuals or units that are seeing higher levels of productivity are negatively impacted to the same extents as those who are not as productive.

Transition to a mission-based funding allocation model

In the early part of the current decade, school leadership was faced with making a decision: given the probability of more budget cuts, should KU SOM

maintain the historical allocation model or transition to a model that is fairer and better encourages faculty to focus on activities that are directly aligned with the School's mission and goals? The decision was made to abandon the historical model and replace it with a new mission-based funding allocation model that encourages alignment with the school's missions and values; a similar approach was piloted previously on a departmental level [4]. The mission-based allocation model would selectively distribute available funds in proportion to performance with respect to fulfilling the missions of the department and school. The objectives of the mission-based allocation model were to: 1) encourage advancement of educational and research missions; 2) better align funding with productivity; 3) reward and retain the highest producers; and 4) provide tools to ensure sustained successes of departments and the school. In developing the mission-based funding allocation model, the architects applied several primary overarching assumptions to ensure that the system would be fair, transparent, equitable, and reflect market realities. These include:

i) Funds are not allocated to individuals but go as a block grant to the department. Funds are not directly linked to individual faculty by the school but rather are intended to reflect the overall productivity of the department.
ii) All relevant faculty activities are considered to fall into 3 categories: education, research and service. Service does not include clinical service, which is reimbursed separately under a Physicians' Service Agreement with the KU Health System.
iii) Educational effort includes Undergraduate Medical Education (UME) and graduate level (Master's and PhD) educational activities conducted within the School. Graduate Medical Education (GME) is funded separately from the KU Health System and is not included in the model. Allocation for educational activity is the sum of the time spent actively engaged in the activity plus a pre-determined amount of time for preparation.
iv) Research value is based on documented externally funded effort. While we recognize that effort is expended on activities that are not externally funded, a purpose of the model is to drive and prioritize efforts aimed at procuring external awards. Because funds flow to the department as a block grant and are not directly associated with specific activities, chairs vis a vis their departmental compensation plans can use research-value allocated funds to support activities not directly funded by the model but which are valued by the department.
v) Service is considered to be aligned with either educational or research domains. A fixed percentage (10%) of computed research and educational effort is added to the total to reflect service effort.
vi) For the purposes of establishing appropriate valuations, all salary benchmarks are set as the median for a given academic faculty rank in a specific discipline in accordance with the AAMC salary survey data for Midwest public medical schools. To reduce variability (in particular any year to year decreases), we take the average for the preceding 3 years and apply an inflationary adjustment of 4%.

vii) All determinations assume that the work year (1.0 FTE) comprises 2070 hours (52 weeks minus 6 weeks vacation /holiday/ sick, with a work week of 45 hours).

viii) For activities easily tied to a given faculty member such as research effort, the allocation value is computed based on the actual rank. For activities that are more difficult to assign to a given faculty and/or may change with some frequency (e.g., didactic teaching), the weighted average rank within the department is used to compute the salary benchmark.

ix) Departments are expected to develop their own salary compensation plans that best align with the values within the department, as determined by a faculty-driven plan. This is encouraged to vary from that of the SOM allocation model in order to better reflect departmental values and promote department financial sustainability.

Educational value

The education of medical students and graduate students is one of KU SOM's primary missions and is acknowledged as such within the allocation model. We based the value associated with educational activities on national benchmarks and on discussion and input from individuals who have intimate knowledge of the activities in question. Table 1 depicts examples of primary activities valued under the model and the relative effort assigned to them.

The values ascribed to a given department are derived from an online educational course tracking software tool which provides information as to numbers of students, credit hours, instructors and department of record, etc. These data are refreshed proactively based on any anticipated changes in instructional activities involving UME and graduate school teaching.

Table 1. Major Drivers of Educational Values

- Didactic lectures in medical and graduate curricula
  - 1 hour medical school or graduate school lecture + 3 hours preparation
- Upper-level didactic course directorships based on class size:
  - <10 students = 4 hr multiplier;10-25 = 5 hr; >25=6hr, X credit hours, X weeks (0.1-0.15FTE)
- Educational leadership receives additional credit
  - E.g., Program Director = 0.1FTE+10h/student
  - PhD mentor = 0.1FTE; MS mentor=0.05FTE
- Educational service computed as 10% of total educational effort

Research Value

Research value is based on effort devoted to externally funded research activities. These include studies funded by the National Institutes of Health, foundations, clinical trials, and research contracts. For inclusion as validated research effort, 3 criteria must be met:
1) the effort must be explicitly committed, such that a level of actual effort is specified in an external or internal contract that is approved by our Research Institute and school administration, 2) funds in the form of salary support must be derived directly from the project and allocated to the faculty member in proportion to the committed effort (which may be capped as appropriate to the policy of the funding agency); 3) the paid effort must be certified by the investigator at regular intervals and corrected if in error. Research effort includes roles as principal, multi- or co-investigator or any other roles as Key Personnel, core director, center director, research mentor, etc. This allocation component to the department, reflecting funded effort, can be appropriately viewed as a research incentive.

Certified committed effort is matched incrementally up to 0.35 FTE on a one-to-one basis at the applicable salary benchmark. Thus, for an investigator committing 1 calendar month to a project, the department would receive 0.083 FTE of the rank and discipline-specific AAMC benchmark for the faculty member in question. For an investigator with 0.35FTE committed effort, the value is 0.35, and for a PI with 0.7FTE committed effort, the value would also be 0.35 FTE at the benchmark.

Eligibility of different academic tracks for participation in the mission-based model

KU SOM has a number of function-specific faculty tracks that are tailored to the many roles of faculty at an academic medical center. These include a clinical track (sole or primary focus on patient care and Health System responsibilities), clinical scholar track (patient care and scholarship), educator track (educational focus but with scholarship component), research track (research focus but may include educational activities), and tenure track. Promotion along all tracks is determined by contributions to education, research/scholarship, and service as appropriate to each track [5].

As originally conceived, the mission-based funding allocation model recognizes primarily efforts of tenure track faculty, who received credit for educational activities plus are eligible for the 0.35 FTE research incentive. However, educator track and clinical scholar track are also eligible for the research incentive component. All tracks accrue credit to their department for any educational contributions, which are valued as the weighted mean salary benchmark for that department. Thus, it is appropriate (and expected) that research and clinical faculty be recognized for their educational contributions to the department. It is also anticipated that research track faculty perform significant service as representatives of the department, and the department is provided with a research service allocation of 0.035FTE (10% of the 0.35 FTE research effort).

Additional allocations to departments

In addition to funds aligned with faculty activities, additional funds are also allocated to support department administrative infrastructure and general operations; these funds are determined in large part by the size of the department. Similarly, the department chair receives an allocation for her of his

administrative duties that comprises a floor (0.1FTE) plus increments for each faculty member in the department (in larger departments, this may be divided among division directors). Other state-allocated funds outside the model that may be directly allocated to individual faculty include compensation for roles such as director of a school-based core, program, center, or institute, or for a 'super-educator' who may be critical for the operations of the medical school curriculum. Other examples include faculty serving in administrative role who may report to the dean or executive vice chancellor.

How do model-allocated funds translate into faculty salaries?

The primary driver for state funds coming to a department as an annual block grant is the cumulative activities of the faculty. Because these activities are known, it is theoretically possible to calculate actual values associated with the activities to determine an individual's 'value'. An example of this is presented in Figure 2. This figure compares the valuation of combined research, educational and service activities for an associate professor on the tenure track with that of an individual of comparable rank on the research track. This example assumes that both individuals maintain some administrative and/or educational activities totaling 0.3 FTE, which might include a core directorship, mentoring PhD and/or MS students, a course directorship, and UME and/or graduate student didactic teaching. The bench-mark salary for a tenure track associate professor using 2016-2017 data was $120,000 per year excluding fringe benefits.

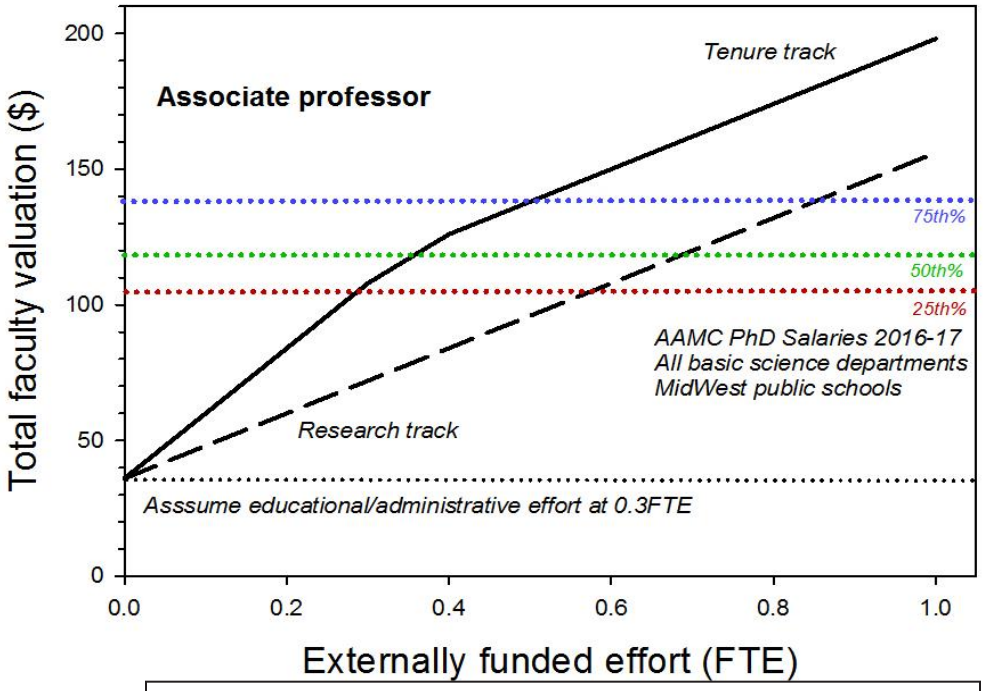

Figure 2. Hypothetical example of the relation between externally funded research effort and valuation of a tenure track or research track faculty member under the mission-based allocation model.

In the absence of any research funding, the value of the 0.3 FTE in non-research activities brings $36,000 to the department, and this increases directly as a function of funded research effort. While value for a research track faculty increases linearly, that of the tenure track faculty increases more steeply due to the 'research incentive' contribution to the department. Accordingly, a value corresponding to the 50th percentile of AAMC salary rankings is achieved when externally funded effort attains 0.35 FTE for tenure track, or 0.7 FTE research track.

According to this approach, it is also possible for faculty valuation to significantly exceed the median benchmark salary. As a tenure track faculty member increases his or her externally funded effort, value to the department continues to increase such that, at 70% external funding, value is approximately $160,000 for an associate professor (well above the 2016-2017 AAMC median benchmark of ~$120,000). For research track faculty, salaries may include compensation for any educational activities or administrative roles, and value increases in direct proportion to externally funded effort.

It may be tempting for a faculty member to see the computed valuation as their 'true worth' or for a chair to simply use the school's calculations to determine a faculty member's salary. This is discouraged for the following reasons:

- Departments require additional funds for expenses such as bridging a faculty member's salary when funding is lost; assuming every faculty member holds a 5-year R01 and that not every renewal application is successful, up to 20% of faculty are at risk of losing salary support in a given year. NIH does not permit directly linking salary support to funding, so additional salary support is necessary to maintain salaries at an accepted level when funding is lost.
- Even in the absence of a principal investigator losing a major grant, effort may vary as a result of loss of grants where investigators play a more minor role. Hence, having a mechanism by which to 'smooth' normally occurring peaks and valleys is advantageous.
- The value placed on any given faculty member could vary quite a bit as a result of funding loss or, for that matter, dramatic success. Most Human Resource departments have policies that discourage massive year to year variance, or wages that are substantially above or below certain norms without rigorous justification.

Because of these and other considerations, departments are encouraged to employ a compensation plan that returns to the externally funded faculty member state funds that are less than the actual value realized by the department under the allocation model. Thus, in the example above where 0.35 FTE of funded effort was sufficient to attain valuation comparable to the AAMC 50th percentile, it would be appropriate instead to require 0.4 or 0.45 FTE funded effort to achieve that level of compensation. The result would be a displacement of some state funds by externally funded effort, and those state funds would be held centrally for the purpose of providing a pool of reserve funds to maintain faculty salaries during a funding hiatus.

In the case of individuals who are highly successful in obtaining external funding, the bulk of their salary normally would be derived from committed effort

on grants. However, these individuals generally are high performers typically engaged in a greater array of activities, and may be susceptible to recruitment to other institutions. In such instances, salaries exceeding the median benchmark seem quite appropriate and the availability of some of the displaced school dollars provides a mechanism for achieving the higher salary.

Clearly, the reliance of individual departments on retention of funds derived from mission-based activities funded under the allocation model will vary as a function of resources available from other sources such as endowment, clinical revenue, commercial enterprises and so forth. Thus, one size does not fit all and the appropriateness of trying to impose a single plan for all departments would not be feasible. At the annual departmental evaluations, we ask chairs to provide a 5-year business plan, as well as a copy of the department's compensation plan, so that we can be better assured of the department's financial sustainability.

Feasibility of mission-based allocation model expectations

A question that arises is whether the expectations of the model can be realistically met within the current funding climate. We have conducted assessments over time to determine the feasibility of maintaining an external funding level sufficient to support faculty salaries at competitive levels. Figure 3 shows external effort of one of our foundational sciences departments for the period from July 2014 through April 2018. During this period, all effort for faculty varied from about 0.57 to 0.45, well above the model's benchmark value of 0.35 FTE (red line). Similarly, the 'capped' effort (i.e., the highest level of effort capped at 0.35 FTE, thus reflecting funds distributed to the department as the research incentive component) varied from about 0.34 to about 0.28 FTE. Accordingly, even in the absence of other

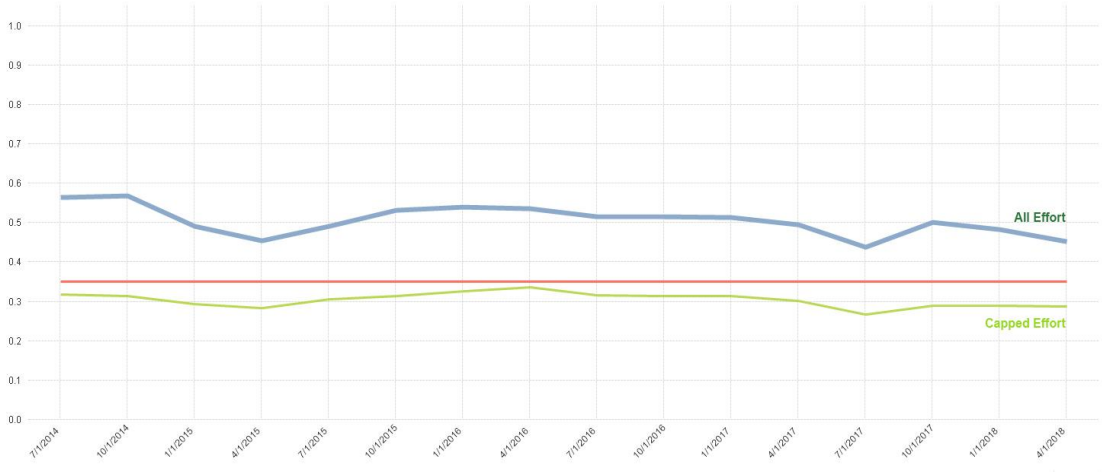

Figure 3. Cumulative research effort (FTE) for one foundational science department in the School of Medicine. Total average externally funded research effort is shown in blue. Because the contribution of any given faculty member to the research incentive funding is capped at 0.35 FTE, the green line shows the average for all faculty with a maximum possible value of 0.35. The red line shows that maximum attainable capped value for the research incentive component.

resources, we would predict that between research incentive funds and funds released from individuals with effort exceeding 0.35 FTE, that this department would have no difficulty in maintaining a competitive salary structure.

Are we moving the needle?

A rationale for implementing mission-based funding is to drive behavior in directions that are well aligned with the goals of the school. One of our major goals is to enhance research programs, and to do so requires higher levels of external support, with a focus on funding from the NIH. Increased funding can be achieved by submitting greater numbers of applications, by submitting applications requesting higher levels of funding, or both. Regarding applications' budgets, historically KU SOM grant application budgets generally have been lower than those of peer institutions (data from Academic Analytics). This is likely due in part to investigators underestimating their actual effort on projects; absent pressures to fully account for one's effort, a smaller budget may be seen as a selling point with reviewers.

If the goal of enhancing research activity is succeeding, then one would expect to see initially greater numbers of applications, and larger amounts requested as investigators depict their actual effort on grants more realistically. Since implementing the allocation model in Fiscal Year 2016 (which began July 2015), the numbers of submitted applications fluctuated but did hit a 6-year high in FY18 (Figure 4, top). The size of requested budgets showed a substantial increase in FY16, which sustained through FY18 (Figure 4, center). The extent to which the larger requested budgets and numbers of applications have affected overall funding levels is complex, and monitoring over a longer period of time will be necessary in order to fully appreciate the impact. Nonetheless, after seeing a drop in overall funding in 2015 attributable to conclusion of some major grants and some faculty departures, there has been a steady increase in funding since implementing the model and FY18 showed a 6-year high in overall NIH funding (Figure 4 bottom).

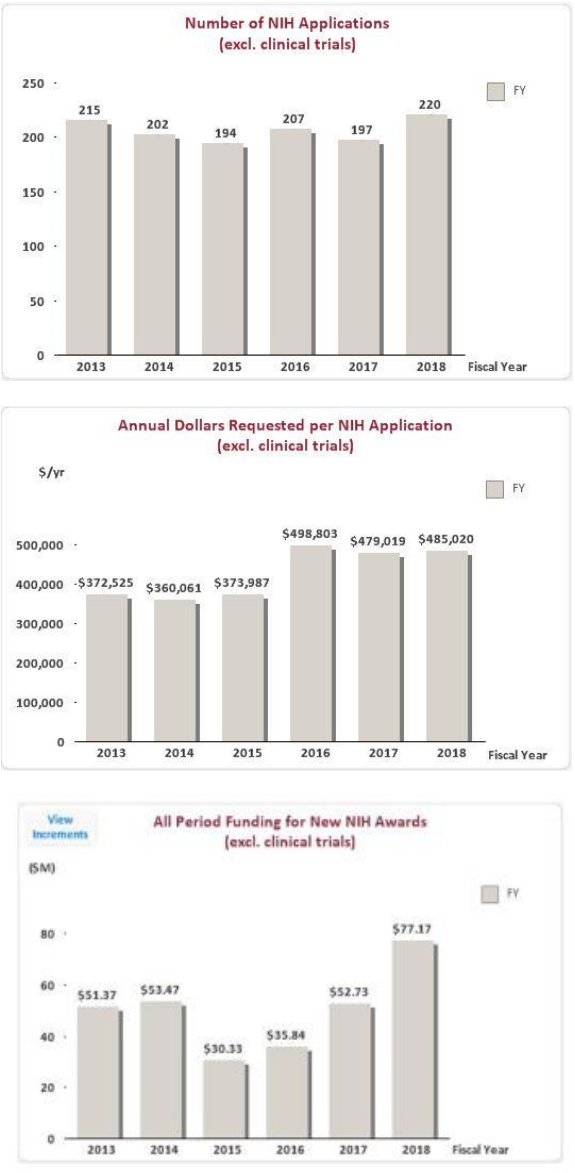

Figure 4

Implications for departmental operations

The implementation of mission-based funding has significant implications regarding the operations of clinical and basic science departments. As regards clinical departments at the KU SOM, some funds from the clinical practice are available to support the research and educational missions. It is expected that these, as well as other funding sources such as endowment, be used to further enhance programs that advance the objectives of the school. These alternative funding sources should be applied to augment departmental finances in a manner that provides enhanced flexibility within the context of fulfilling the school's and department's missions.

Typically, basic foundational science departments operate with a tighter margin and, while endowment funds are often available, these departments lack the financial flexibility of clinical departments. In some cases, educational activities can be significant model allocation sources, such as when there are programs with large numbers of masters' or PhD students (an MPH program would be an example). This generally does not apply to traditional wet-lab programs where the capacity to accommodate large numbers of students engaged in laboratory training is limited.

The assumptions included under the mission-based funding model provide some insight into how basic foundational science departments may evolve in the future. The expectation is that all faculty maintain active research programs unless they are dedicated administrators or key educators. In a department that is operating optimally, faculty will maintain $\geq$0.4 FTE externally funded research effort. Clearly, if a significant number of faculty are chronically un- or under-funded, this will have dramatic impact on departmental finances and could jeopardize financial support of all faculty; regular departmental reviews, annual faculty reviews and assessments, post-tenure review, and mechanisms to fairly implement salary adjustments that align with changes in productivity need to be in place.

There is a high probability that all researchers, at one time or another, will experience a hiatus in external funding. The impact of a funding lapse for a given faculty member can be mitigated by maintaining greater numbers of active awards as PI, and by serving on multiple other awards as co-Investigator. Nonetheless, funding lapses remain probable, and it is essential to have mechanisms in place to ensure that a temporary loss of funds does not mean firing valuable and highly trained staff or interrupting training of a graduate student, post-doc or fellow. Once a laboratory is shuttered, the likelihood that an investigator will be able to resume an active externally funded research program is greatly diminished. Accordingly, a key consideration is that KUSOM maintains a robust bridging program to provide interim laboratory support until alternative funding may be secured. This program commits those funds necessary to ensure that essential staff are maintained at a level so that productivity continues. Three times a year, applications for bridging support are accepted and reviewed by the SOM Research Committee, and the investigator's and department's current financial resources assessed. If requirements, such as submitting applications for external funding, are met, and the Committee

feels the application is meritorious, a recommendation for funding is made to the Executive Dean and support is provided. However, because interim faculty salary support is the responsibility of the department, this necessitates availability of pooled departmental funds.

While there is general agreement that the values associated with various activities are justifiable, the transition from historical funding to model-based funding was not easy in all cases. Different departments experienced increases or decreases in allocations relative to prior years depending upon whether or not they were historically, on average, over- or under-funded. Those that had been most generously over-funded saw the greatest impact of the transition to the new model. Given the significant implications that budget shifts have on personnel and department operations, a decision was made to 'smooth' the transition to the new allocation value over 3 years, in effect temporarily shifting some funds from those with increases to those with decreases. Additional challenges have come as tracking tools have improved leading to better data that can impact distributions, and better understanding as to how we categorize and value certain activities. Clearly, a stable model free from unanticipated excursions in valuation is the goal.

It is also important to note that state funds represent only a fraction of the overall financial portfolio of the KU SOM. The contemporary medical school and its departments are forced to look increasingly to funds other than state allocations, which may include endowment, tuition and fees, contracts, commercialization, services, revenue from IP, and so forth. Hence, while the mission-based allocation model provides a means for aligning limited state funding with the true missions of the school, chairs must be prepared to identify and seek funding opportunities from what may have been considered as non-traditional sources under the historic funding model.

Summary

With financial pressure rising with reduced state funding, KU SOM sought an alternative means for distributing funding that was better aligned with its missions, and a mission-based funding allocation model was developed. The mission-based model directly aligns departmental compensation to performance. Accordingly, it places greater onus on faculty to seek and maintain external funding and to participate aggressively in educational activities. KU SOM believes that this approach is having transformational impact on faculty engagement. Nonetheless, there is also a need to monitor and adjust elements of the model as situations demand in order to attain a new equilibrium and financial sustainability.

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From Collegial to Collaborative
The Long Road to Building a Sustainable and Standardized Research Technology Service

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Setting the Stage

Kansas State University (KSU – K-State), founded in 1863, is the nation's first operational Land Grant University. It is home to 24,000 students and 1,400 faculty, with over 250 undergraduate majors and programs and 160+ graduate degrees and certificates. Five years ago, KSU published a visionary strategic plan with very aspirational goals for 2025.

K-State 2025 Visionary Plan states as its first theme: "Research, Scholarly and Creative Activities, and Discovery (RSCAD)" – with a thematic goal: "Create a culture of excellence that results in flourishing, sustainable, and widely recognized research, scholarly and creative activities, and discovery in a variety of disciplines and endeavors that benefit society as a whole." Ultimately, K-State aspires to reach the goal of becoming a top 50 research university (Kansas State University. (2011). K-State 2025: A Visionary Plan for Kansas State University).

In October 2017, I started as the Chief Information Officer (CIO) for K-State. The CIO position, in the past reported to the Provost. A new President chose to change that reporting structure so that the CIO reported to him. The President, General Richard Myers, was in 2001 the Chairman of the Joint Chiefs of Staff reporting to President Bush during the 9-11 terrorist attacks – the highest ranking military officer in the United States leading the response to these horrible events. He not only understands the business of information technology (IT), he led cyber-security at the national level, and knows what it means to make IT strategic to the organization. … no pressure.

Once coming to Kansas State University, I began a listening tour, talking with hundreds of individuals from across multiple campuses (students, staff, faculty, governance groups, and executives) to learn what was working, what was not working, and what we should be doing that we currently were not doing in IT. As expected, I heard a lot. … A LOT!

To add to the complexity of the K-State IT environment, 50% of the institution's 300+ information technology staff do not report to me (central IT). There are over 30 islands of IT setting their own direction, implementing their own standards, running their own enterprise applications, and on and on.

See any potential for issues? This environment led to many examples of duplicated, sometimes competing sys-

tems. There were no formal sets of standards for providing services, leaving significant concerns, including a lot of "haves" and even more "have-nots", few economies of scale for purchasing, quite a few blind sides for needs of support, the potential for issues with security, and users left on their own to figure out how to get help.

Having done this at three other higher education institutions, I knew that I could probably write an IT Strategic Plan based upon the information I learned on this multi-month listening tour. However, I also knew that doing this would make a plan based on the world according to Gary. Although well focused and aligned with the needs I heard expressed, this is not the way to create buy-in. I had to run a formal strategic planning process.

I moved quickly to a formal procurement process and brought in an outside consultant. My leadership team worked with this consultant to develop script drafts for different constituent groups; students, staff, and faculty that represented various business and academic units across K-State. Once finalized, we had the consultant use these scripts to perform formal information gathering sessions (focus groups, key-stakeholder interviews, and a web survey) getting participation and valuable input from well over 250 students, faculty, and staff face-to-face and 1,300 individuals through the web survey.

What Did I Find?

"A series of cottage industries brought together by a common need for parking" Ron Bleed.

As mentioned above, the challenges from the highly-decentralized nature of the institution include many duplicative systems, differing views on what standards individual IT units should follow, little or no consistent expectations of compliance to federal, state, local, or campus laws and policies, multiple data centers of varying capability, significantly differing levels of support (making for a lot of "haves" and even more "have nots"), and on it goes.

Coupled with this, the institution has suffered from budget cuts for several years; some coming from the state cutting state appropriations, and some due to a declining enrollment. Budget cuts have been applied across the board with no strategic application, happening with the expectation that there is no reduction of services with less funding – do more with less. This approach has degraded services, led to an extremely high-operations tempo and the feeling that all efforts were focused on fighting fires. Even though one can shoot from the hip accurately, it cannot be sustained for a long-term. All this with an ever-increasing usage of technology on both the academic-side and the business-side of the house.

The Problem

With the decentralized culture that exists at K-State, it is difficult to provide a standard minimum-level of service. This was not only true in supporting the business parts of the institution (business and finance, student services, enrollment management, facilities, construction and planning, etc.), the teaching and learning environment, and faculty scholarship; it was true in supporting research.

I heard consistently from researchers (PIs, faculty, and scientists) and associate deans for research at all of the

colleges that there was no standard research support. Researchers were left on their own to determine the best approach for managing the data lifecycle (capturing, storing, working with, securing, compliance, and curation) and providing access to high-performance computing. Researchers are spending a significant part of their start-up time figuring out how to handle the research technology effort. In some cases they are building their own environments (many of which do not have the full capabilities to support the research project), individually working with a cloud vendor, or using institutional standard business environments (i.e. administrative network storage - not setup for this purpose).

To clarify, the computer science department does run a high performance computer Beowulf cluster called BeoCat (we are the Wildcats after all). Great custodians of their resources, they make it available to all who ask for no cost (other than frequent requests to add a resource to the grant request here, but this service is informal and not utilized consistently).

What Now?

Following a framework similar to that identified in the EDUCAUSE Review article *Building Research Cyberinfrastructure at Small/Medium Research Institutions*, we plan on following a standard strategic planning approach. First, we need to do a full assessment of our current structure. We plan to ask a variety of questions:

- What research technology support do researchers need?
    - Assistance with:
        - Data Collection
        - Storage
        - Data Analysis
        - Compliance with security expectations (CUI, GDPR, etc.)
        - Archiving
        - Curation
    - High Performance Computing cycles
    - Training
    - Scheduling
    - Cloud or on premises
- What is working well now?
- What isn't working well?

Working in collaboration with the Provost/Executive Vice President for Academic Affairs and the Vice President for Research, this input will be analyzed and a formal plan will be developed, with prioritized actions. A major component of this plan needs to include support strategies with clear lines drawn on who does what. The development of the cyberinfrastructure needed to support research is a must. The creation of a governance committee with participation from faculty, associate deans of research, members from office of the Vice President for Research and the office of the CIO will focus on developing and implementing this plan.

Once we have a fully fleshed plan, understanding the costs and developing a strategy for funding must become a focus. This includes a hybrid plan for on premises, cloud-based, and partnership solutions (Agee, A., Rowe, T., Woo, M., Woods, D. (2010). Building Research Cyberinfrastructure at Small/Medium Research Institutions. EDUCAUSE-Review).

There is a need to hold researchers accountable to the expectations of the institution and the granting source. Ensuring the academic freedom for

researchers to follow their own path to a solution, yet providing the basic cyberinfrastructure services and support is an interesting balance.

As we develop the right-sized plan for this cyberinfrastructure, find the funding to implement and sustain it, and have a plan for scaling it to achieve the institution's 2025 goals for research, we "need to find a balance between centralizing IT operations and providing sufficient flexibility and freedom to allow researchers to innovate 'at the edges' in individual departments and laboratories" (Hacker, T. J., Wheeler, B. C. (2007). Making Research Cyberinfrastructure a Strategic Choice. EDUCAUSE Quarterly).

The next few years will be an exciting challenge as we negotiate our path to developing and running the research technology environment for the twenty-first century.

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Notes