

University System of Maryland Status and Future of the Research and Innovation Mission

Fall 2014 Operating Budget Retreat

The purpose of this paper is to help frame the issues for the Board's discussion on the future of the USM's research and innovation mission. In addition to providing background information on the USM's strategic goals for research and innovation, and the progress made on them since the adoption of the strategic plan in 2010, the paper also seeks to tee up potential strategies the Board and USM institutions might engage in to revitalize—or reboot—the USM's research and innovation efforts. Finally, for each of the strategies discussed, the paper posits a number of questions that the Board and USM leadership might explore, beginning with this session but continuing over the coming year, as they move to develop and refine a new USM research and innovation agenda.

I. Introduction to the Issues

Maryland's "home field advantage" in R&D funding — A double-edged sword

Sponsored research, and federally-sponsored research in particular, is a core strength of Maryland's economy. At almost \$16 billion annually, Maryland comes in just second to California (\$18B) and well ahead of the next closest competitor states -- Virginia (\$8B), Massachusetts (\$6B) and Texas (\$5.5B) – in total federal R&D obligations. As the USM strategic plan makes clear, the USM believes that this heavy federal investment in R&D activities and R&D-related facilities gives Maryland, and its higher education institutions, a "home field" advantage when it comes to attracting federal research dollars. Between the USM, Johns Hopkins, and Morgan, Maryland's research universities account for almost \$3.5 billion per year in federal research-related spending, placing the institutions in this relatively small state fourth behind only those of California (\$7.9B), New York (\$4.5B), and Texas (\$4.4B).

However, Maryland's close ties to Washington and the federal research agencies can have negative as well as positive benefits. In times of cut backs to federal spending Maryland, because of its dependence on federal funding, can be disproportionately affected. That is what we currently see happening. The immediate trends in federal spending, particularly spending by mission- and defense-related agencies, has negatively impacted Maryland's economy, weakening the bottom lines of those Maryland universities that rely on federal funds to support basic and applied research and Maryland's for-profit businesses/companies that are dependent on federal contracts and federal workforce-related spending. Looking to the future, while federal R&D spending has largely stabilized over the past two years, we don't expect it to rebound to pre-2012 levels any time soon. In addition, the mix of federal agency "winners" — those whose research budgets are increasing (albeit at a much smaller rate than in the past) — may change. Whereas defense and health (i.e., NIH) received the lion's share of increases in the past, those agencies slotted to receive the biggest percentage increase in their R&D under the president's most recent (FY 15) budget request, according to analyses prepared by AAAS, included Energy, Commerce (NIST), and Agriculture.

The USM's R&D goals under the 2020 Strategic Plan

The USM Strategic Plan established a very aggressive goal of doubling the System's Research & Development (R&D) efforts over 10 years (going from \$1.2 billion in externally sponsored R&D in 2010 to a projected \$2.4B in fiscal 2020). This was one of four economic development goals/strategies outlined in the plans designed to broadly secure and enhance Maryland's economic health and competitiveness. The others goals included creating 325 new companies, broadly instilling a culture of innovation and entrepreneurship throughout our institutions, and increasing by 40 percent the number of new STEM graduates produced by USM institutions. While the R&D goal was acknowledged at the time to be a stretch, the percentage increase it projected was in line with what the USM had accomplished over the prior decade, and more importantly it helped justify the investment in research faculty and facilities envisioned in the plan (which priced out to almost \$100M in additional state support for research-related operations over the first five years of the plan, as well as an additional \$100M in capital improvements).

The current status of the USM's Strategic Plan goals

The USM is approaching the halfway point of its 2020 strategic plan. It has achieved significant results on most of its strategic plan goals—already surpassing those related to STEM growth and Course Redesign—yet due in large part to the slow recovery of the national economy and the lack of support in Washington for increased federal spending, the USM has not achieved much traction toward its 2020 goal of doubling extramural research. For the most recent year (FY 14), USM total expenditures fell to \$1.1B, under the 2010 benchmark year level of \$1.2B.

At the same time, the USM is not without research-related achievements over the past five years. The creation of MPower (not contemplated in the Strategic Plan), in combination with the BOR's focus on improving research commercialization and technology transfer, has given the USM new collaborative structures with which to compete for funds and coordinate institutional efforts/resources. The addition of almost 100,000 net assignable square feet (NASF) in new research space since 2010 (with an additional 130,000 NASF on track to open by 2017), in combination with the additional research facilities scheduled in the CIP approved by the Board and the Governor, is helping to rebuild the USM's research infrastructure. New initiatives and collaborations, such as creation of the National Cybersecurity Center of Excellence and the USM's collaborative partnership with MedImmune, both announced in FY 14, are helping those USM institutions associated with such initiatives recruit new faculty and diversify sources of R&D funding. Finally, faculty salaries, whose growth had been constrained during the worst of the economic downturn, have started to rebound and are now increasingly competitive with those for faculty at similar institutions within peer states. Taken in combination, these individual achievements can be seen as building blocks for future USM success in R&D.

Understanding the true cost of doing large scale, competitive research and innovation

An additional factor that must be considered in any discussion of the research and innovation mission is the cost associated with it, including competing at the international level. While the federal, government, along with other sponsors, underwrites the direct costs of any campus-based research it authorizes (paying for faculty time spent on a project as well as the support of any graduate assistants or instrumentation and equipment that can be directly attributed to it), the level of support it provides for

the indirect costs associated with such research (the infrastructure-related costs critical to enabling a research project to be undertaken on a campus but which can't be attributed solely and specifically to the project) are inadequate to meet the real indirect costs to an institution in terms of the wear and tear on facilities, the need for affiliated core facilities, the growing burdens of regulatory and compliance requirements, etc. And of course, the federal government typically does not pay costs associated with efforts to transfer the knowledge and ideas generated by faculty — the impetus for so much of the innovation that drives our economy — into the market place. These costs, like those associated with recruiting high quality faculty researchers and research teams, must be borne by the institutions and the USM, and the key to addressing them is having effective capital and operating plans in place at both the campus and System level.

Given the challenges the USM faces in meeting its R&D goals, the current climate for increased research spending in Washington, the cost of doing research, and what the System has been able to put in place in terms of new facilities and new initiatives over the last five years, it seems appropriate at this point in the strategic plan to stop and assess where the System is headed under the plan's R&D goals, whether they remain appropriate, and, if so, how best to move toward achieving them in the time remaining.

II. A Strategic Reboot – Identifying New Opportunities, Strategies, and Goals for Strengthening the USM's Research and Innovation Mission

"Pockets of research strength exist at each USM research institution, but the overall quality of our research programs and the "bench strength" of our research faculties are not as deep and uniform throughout each institution as they need to be."

"When it comes to dependence on federal research spending, we are like Detroit of fifty years ago."

...Comments taken from USM institutional leaders in recent conversations

The USM's research institutions (UMB, UMCP, UMBC, UMCES) historically have had highly competitive research programs in areas related to physics, engineering, computer science (including cyber security), mathematics, information technology, medicine, and the social and environmental sciences. Such programs have helped grow the reputation of Maryland and the institutions as centers of high quality basic research. They also have provided the USM with a solid base of research funding that has held relatively steady during the volatile years of federal spending recently experienced (extramural funding has exceeded \$1 billion for seven straight years).

However, the assessment of those most familiar with the USM institutional research efforts – the campus leadership – is that significant "gaps" remain in the depth and breadth of quality within many USM research programs, including at its flagship research institutions. Some of these gaps are in basic areas, like the life sciences—gaps that are surprising for a University System with Maryland's reputation. The gaps are also in areas that hold significant potential for new discovery and research breakthroughs, and as such represent areas that Maryland cannot afford to fall further behind in. Finally, an additional

concern among the campus research leaders is the belief that while federal funding for basic research will always be a critical element in Maryland's R&D portfolio, we must seek ways to diversify our R&D portfolio to ameliorate some of the risk inherent in overdependence on any one funding source.

Strategies for Building Excellence in the USM's Research and Development and Innovation Mission.

Through conversations with the research and academic leadership at USM campuses, as well as other national leaders in academic research, the USM has put together a list of potential strategies the Board and campuses could investigate pursuing to "reboot" our R&D vision and build communities of excellence. These strategies are offered as topics the BOR explore in the coming year.

- 1) *Be more coherent in deciding which opportunities to go after.* A strategy the USM could better employ is to strategically identify and target a limited number of high level, cross-System initiatives. This would mean selecting 4-5 initiatives that fulfill one or more of the following conditions: 1) they play to the existing research strengths of the institutions (such as in cyber security, vaccine development, or quantum computing) and thereby increasing the likelihood of success, 2) they are complementary to the research strengths/foci of other departments on campus or at partnering USM campuses, and 3) they have the added benefit of potentially allowing the institution(s) to cross fertilize with existing programs/faculty and thereby address "gaps" in the quality of related programs/faculty on their campus (or partnering campuses).

Some areas that USM institutional research leaders have identified as potentially meeting this targeted research strategy include, in no prioritized order, the following:

- a) Cyber Security (including Homeland Security)
- b) Quantum Computing
- c) Brain Behavior and Human Performance
- d) Autonomous Systems (from health to defense and including robotics and augmented reality)
- e) Infectious Diseases and Vaccine Development
- f) Cancer Research
- g) Drug and Medical Device Development
- h) Environmental Technology
- i) Computer Science and Virtual Reality
- j) Big Data and Health-Related Information Technology
- k) Energy Efficiency and Transformation

These areas, which certainly do not represent an exhaustive list, should be looked at as a starting point for discussions on how to target opportunities in a more coherent way. For example, as campus leaders have pointed out, an initiative targeting neuroscience (as part of the brain behavior and human performance area on the list above) would meet this strategy by not just playing to current—and complementary—USM strengths in medicine, imaging, behavioral science, and computing but also could present a unique opportunity to use faculty brought in under the initiative to close gaps in knowledge or expertise existing in other departments.

- 2) *Go big in recruiting: focus on research teams rather than individuals.* While most universities, including most USM institutions, historically have sought to build research strength by hiring one faculty scholar/researcher at a time, periodically and as resources and opportunity allowed, institutions with sufficient resources/reputation also have been able to achieve more dramatic impacts in a particular area by focusing on research group hires. These institutions identify and target a world class researcher in a particular area and then negotiate with him/her to bring an entire research team to campus. Such a strategy has been employed successfully in recent years at UMB (as in the case of Claire Fraser Liggett) and at UMCP (in building the Health Disparities Group at the School of Public Health), and offers the key advantage of being able to be accomplished in a relatively short period of time.

Questions the Board and the USM institutions should ask as they explore this strategy over the coming year include:

- How do you identify individuals/teams for targeting?
 - What does it take to recruit a world class scholar and his/her team in terms of resources/time?
 - How do you build a team around her/him and integrate it smoothly into current departmental/college structures?
 - What role do graduate students and their support systems play?
 - And more generally, what is the expense of doing research on the scale envisioned in this strategy? Do indirect cost recoveries (ICR) adequately cover the cost of non-direct expenses associated with research? Are institution's current core facilities sufficient for the scope of projects envisioned, and what additional regulatory or compliance burdens might institutions face?
- 3) *Use the size and the strength of the System as a whole to overcome individual campus or department limitations.* As one USM research leader noted, in recruiting a researcher or research team, the size of an institution's research program matters since it is a key predictor of both the resources likely to be available and opportunities for scholarly collaboration. However, the close proximity of most USM campuses, along with the unique levels of expertise that each has developed, means that USM institutions have the opportunity to compensate for what any individual campus lacks in a particular research area by working together to offer potential hires a range of resources and collaborative opportunities not found on any but the nation's best campuses. By focusing on what the individual called a "phased array approach to recruiting and hiring," USM institutions collectively could overcome concerns related to any single institution's resource availability or programmatic expertise. For instance, in seeking to hire a researcher or research team with an interest in advanced statistical modeling of the interplay between environmental policy and nutrition, and how the resulting interactions may contribute to health disparities among inner city populations, the institutions could market the complementary strengths of UMCP's health and computational program, UMB's and UMBC's expertise in health, nutrition, and

social equity programs, and UMCES' strength in environmental policy. Further, the policies and processes that UMB and UMCP have pioneered in moving to expand joint appointments, largely as a result of MPower, offers an existing vehicle for the all USM campuses to more widely exploit this "power of a system" advantage.

Questions the Board and the USM institutions should ask as they explore this strategy over the coming year include:

- How can strategic institutional collaboration on faculty hiring be more easily facilitated?
- Do Systemwide policies and practices remain in place that inhibit institutions from easily collaborating to jointly recruit or hire faculty/research teams?
- Is there a way for research institutions and comprehensives to share graduate students and/or postdocs? For example, might a graduate student who wants to study at a research institution be awarded a graduate assistantship at a comprehensive to work with undergraduate students on the graduate student's research project? Or could a postdoc pipeline be created between a USM research institution and a comprehensive to provide the postdoc with teaching experience?

- 4) *Take advantage of Maryland's research expertise, location, and political assets to pursue a high profile national lab(s).* A fourth, and potentially longer-term, strategy for making a significant change to the R&D profile of the USM would be to align with a national lab. While such a strategy might involve the need for significant political intercession at multiple levels, the state, both politically and geographically, is in many ways uniquely positioned to accomplish this. Maryland has a number of potential national institutes/laboratories within its border, such as the National Cancer Institute based at Frederick, as well as two currently operating University Affiliated Research Centers (the DOD-sponsored Applied Physics Lab at Johns Hopkins and the NSA-sponsored Center for the Advanced Study of Languages at UMCP) that could serve as models. Further, it is worth noting that the establishment of the National Cybersecurity Center of Excellence as a new FFRDC (federally funded research and development center)—administered by MITRE with USM participation, especially UMCP and UMBC—may also provide an opportunity in this emerging area.

Questions the Board and USM institutions might ask as they further explore this strategy include:

- What are the System or institutional administrative responsibilities/costs associated with such an alignment (i.e., what are the downside risks)?
- What political/legislative actions would need to be taken?

- 5) *Expand the vision for research to include opportunities for more USM institutions, greater emphasis on applied research, and more research-related learning by students.* In addition to strategies the USM research universities can use to capitalize on emerging research opportunities, the USM, in its conversations with campus leaders, also heard that the System must look at ways to broaden the number of System institutions participating in the research mission. And equally importantly, campus leaders expressed the belief the USM must look at how the research being carried out on campuses and in the classroom enhances the educational experience of students. Such experiences,

they stressed, particularly for students in STEM fields, can be as important to their ultimate success in the workplace or a graduate program, as any learning that takes place in the traditional classroom setting. For many USM comprehensives, the way in which they engage in the research mission already ranges from actively seeking to integrate research-based experiences into their undergraduate curriculum to carrying out traditional lab-based research. By getting more institutions throughout the System engaged in the research mission, however, and building cooperative mechanisms that support them in their efforts, the USM would not only expand its research capacity, particularly in areas of applied research, but also would help the comprehensive institutions carry out their primary mission: enriching the learning experience of students attending their institutions.

Questions the Board and USM institutions might ask as they further explore this strategy include:

- Can we use the research expertise available on our research campuses, along with the experience faculty at USM comprehensives have in best practices for incorporating research into their undergraduate-focused learning environments, to leverage greater involvement by faculty and students in research and research-based learning opportunities throughout the System?
- For the USM's larger comprehensives with existing applied doctorates (TU, UMES, SU), how can current areas of expertise in applied research be expanded and strengthened? Given the workload expectations for faculty at the USM comprehensives, are there policies and or reporting processes the BOR should look at that would facilitate greater faculty and faculty-led student participation in research?
- For institutions with less of the administrative infrastructure and resources needed to easily participate in going after more sponsored research (e.g., CSU), what can be done to improve their prospects for obtaining more contract and grant funding (partnering with other, more developed research campuses, developing a grants office capacity where none exists, etc.)?
- Should the USM invest some resources in smaller-scaled centers of excellence at comprehensives to build up potential growth and competitiveness in obtaining federal grants (such as the Allied Health-Care Management Training and Simulation Program)?
- How can the USM build on current institutional successes in promoting undergraduate research, including maximizing opportunities for obtaining additional federal support through such programs as NSF's Research Experiences for Undergraduates (REU)?

6) *Mitigate risk from decreased federal funding by diversifying the USM's Research portfolio.*

Finally, while Maryland remains a national leader in basic research, most of which is funded through federal agencies, it remains an underperformer in the area of applied research, most of whose support comes primarily from industry. According to the most recent NSF statistics, Maryland as a state ranked just 17th in industry R&D, compared to a 4th place rank in academic R&D. While this difference is largely an artifact of Maryland's location next to the nation's capital and the federal research agencies and the historic focus of its business community, the over emphasis given to federally-funded research, both in the State's R&D portfolio and the USM's, places the USM and Maryland at greater risk in times of slowing federal spending.

Strategies discussed earlier in this paper, such as a more coherent strategy for focusing on specific areas of research need/opportunity and involving more USM comprehensive campuses in research efforts, could help to address this risk. However, more targeted strategies designed to diversify the R&D portfolio should also be explored. One potential way where USM research campuses could encourage greater collaboration between private/corporate labs and their own research faculty would be to open up university academic research facilities to corporate laboratories. By providing the corporations with research space within USM facilities, USM institutions would not only develop relationships with private companies that could help sustain research programs during times of slowdowns in federal funding but also would give USM faculty and students a degree of access to those companies not currently available.

Questions the Board and USM institutions might ask as they further explore this strategy include:

- What would be the fall out, both from the governor’s office and Wall Street, if the USM opened up its research laboratory facilities to a public/private partnership?
- What policy changes related to technology transfer, protection of intellectual policy, and licensing would be required to make USM institutions a more attractive partner in private sector research?

III. Concluding Thoughts/Next Steps

Research and innovation carried out by USM institutions will continue to be primary components of the USM’s strategic plan to help drive Maryland’s economy. Facing an environment in which federal research funding is unlikely to grow – stability in key agency budgets may be the best near term outcome we can hope for – the USM and its institutions must explore new strategies by which they can grow and diversify their R&D portfolio. In addition, where the opportunity exists, USM institutions at all levels of mission complexity—from our most research intensive to those focused primarily on undergraduate education—should be encouraged and supported in their efforts to incorporate research-based learning experiences into their undergraduate and graduate programs. Based on ideas suggested by USM campus research leaders and national R&D experts, this paper has put forth some initial thoughts on strategies the USM could employ to boost its R&D and research-related education efforts in support of the strategic plan. They range from being more strategic in how we target and go after research opportunities to opening up academic research space to private corporations. Over the coming year, the Board and the USM campuses will engage in an extended conversation exploring these and other options as we move to “reboot” the USM research and innovation agenda.