Saturday, December 3, 2011
Council of Scientific Society Presidents

Good morning. Let me begin by thanking Marty Apple, President of the Council of Scientific Society Presidents (CSSP), for the invitation to join you today.

For almost 40 years, the Council has stood as one of the nation's premier resources for the development of science policy in the physical, mathematical, and life sciences.

At a time when the US faces unprecedented global competition for leadership in science, technology and innovation, and faces these challenges in a polarized political environment and traumatized economy, your work and your voice take on even greater importance. We simply must find innovative solutions to a variety of science education and resource problems if we are to secure a prosperous future for our nation. And, I can think of few organizations better positioned to weigh in on these crucial challenges than CSSP. So, it is a special pleasure to join you today.

Marty has asked me to talk about the research university of the future. I don't know if I've ever felt a greater gap between the importance of a topic I'm asked to address and my inability to respond with any a degree of certainty in what I say. As I considered my assignment, I recalled the immortal words of Yogi Berra: "It is difficult to make predictions, especially about the future". Those words never rang more true for me.

So, I apologize in advance to those who thought I might be in possession of some special crystal ball. I am not. I will offer some observations that I hope will spark some discussion on this topic at the end of my remarks.

By way of background, the University System of Maryland—where I serve as Chancellor—consists of 11 degree granting institutions, a specialized research center, and two regional higher education centers. We enroll over 145,000 students with roughly 8,000 faculty members and some 20,000 staff. I had the privilege of serving as President of our flagship campus—the University of Maryland College Park (UMCP)—for ten years.

To a degree none of us has witnessed in our lifetimes, our nation's research universities are in a period of both feast and famine. There is a veritable <u>feast</u> of exciting areas of research, many of which address pressing national needs that are ripe for transformative breakthroughs. I think of areas like

- stem cell research, with the potential to cure Parkinson's disease and injury-induced paralysis, maybe even Alzheimer's;
- personalized medicine, enabled by the human genome project;
- alternative sources of energy that could make the U.S. energy- independent;
- particle physics, which is on the verge of answering existential questions about the origins of the universe;
- neuroscience and its ability to understand and correct cognitive deficiencies;
- and on and on the list goes.

Across the research university landscape, this coming decade has the potential to be an unprecedented era of discovery on fundamental questions many of us thought could not be answered in our lifetimes.

On the other hand, as we are all painfully aware, we are also in a period of fiscal famine, experiencing unprecedented resource declines that threaten the ability of many, if not most of our nation's higher education institutions to carry out their core missions.

And, to an extent I once would have thought impossible, this particular fiscal trauma has impacted private research universities, albeit to a lesser extent. Nonetheless, I never thought I would see the day when our best endowed private universities would have to borrow money to meet annual operating expenses, lay off staff and close programs; nor could I have imagined public universities furloughing Nobel Prize winners and other distinguished faculty.

The breadth and depth of the fiscal carnage are both stunning and debilitating.

Another notable feature of this period of time is the dim prospects for recovery in the foreseeable future. We have, of course, experienced periods of fiscal decline in the past, one as recent as the first few years of this new century. But, this decline has a different character.

In the past, economic downturns were followed by periods of economic boom and losses were recovered relatively quickly. So we are used to a pattern where higher education "tightens its belt" for a time, waits for the storm to pass, then returns to a period of growth. I know no one who predicts that will be the case with our current fiscal decline.

In addition, I see this decline in public funding to be a symptom of a broader problem. While elected officials give rhetorical support to the importance of higher education, declining tax revenues and other sacrosanct expenditure categories have left higher education holding a severely depleted bag.

In particular, public higher education, which was once seen as a "public good" is now increasing viewed—both by policy makers and the general public—as a "private benefit." In many states, we are approaching a point at which public higher education is becoming "privatize" public higher education.

Paul Courant, James Duderstadt and Edie Goldenberg summed up the challenge in a piece for *The Chronicle of Higher Education* last year. One paragraph from that is worth quoting:

> *"Today, the state side of the partnership is failing. Public institutions of higher education are gravely threatened. State support of public universities, on a per student basis, has been declining for over two decades; it was at the lowest level in 25 years even before the current economic crisis. As the global recession has*

> *deepened, declining tax revenues have driven state after state to further reduce appropriations for higher education, with cuts ranging as high as 20% to 30%, threatening to cripple many of the nation's leading state universities and erode their world-class quality."*

As bad as this is, worse could be on the doorstep. The stimulus funding—which enabled many states to prop up higher education budgets theses past two years—has been expended. And we are seeing the impact of this in increased austerity in state budgets. As a result, across the country, university budgets, including the budgets of most of our great public universities, are being slashed at levels deemed unimaginable even a few years ago. The University of Washington and the University of California institutions have lost more than 30% of their public funding with more cuts the way. Similar cuts have occurred across the country, in Texas, Arizona, Florida, North Carolina to name just a few. Sadly, there simply is no reason to believe that these cuts will be reversed in the short-term—or even medium-term.

During these challenging times, most universities have relied on huge tuition increases to offset this loss of public funds. While this has certainly mitigated the drop in state support, can tuition at public universities continue to go up at anything like the rates of the past several years much longer? Bob Ostertag, a professor at UC Davis noted in an article just the other day that:

- Six years ago, tuition at University of California was $5,357
- Now it stands at $12,192
- And under current proposals, it will be as high as $22,068 by 2015.
- For a public university, THAT is simply unimaginable

So in this environment what are we in higher education to do?

Our dilemma—which should be our nation's dilemma really—is compounded by what we see when we look beyond the borders of the United States. Other countries, especially Asian countries, are making huge investments in building their higher education infrastructures, including impressive investments in research. In fact, the swiftness of the fall of fortunes in the U.S. has been more than matched by the speed of the rise of investments elsewhere. For decades, most of the rest of the world has been content, or at least forced, to accept U.S. dominance in science and technology research. This is no longer the case. The search for talent and knowledge has gone global at a dizzying rate. We've all read about the huge investments in higher education and research in China, Taiwan, Korea and India. I'm sure many of you have seen the results of these investments first hand.

China is a particularly dramatic example of the global pursuit of the highest possible standard of excellence and of the competition we face for research and education leadership and knowledge generation. The Chinese government now spends billions of Yuan – close to 2% of its gross domestic product on higher education annually. China has more than doubled the number of higher education institutions over the past 10 years,

from 1,022 to 2,263. Five million Chinese students enroll in degree courses now, compared to one million a decade ago.

But China isn't just after numbers. It has a specific goal of bringing its best institutions, like Tsinghua and Beijng, into the world's top 10. In a recent speech to the Royal Society in London, Rich Levin, president of Yale University, stated that China's top universities would rival Oxford, Cambridge, and the Ivy League within two decade's time. *The Financial Times*, in a front-page story last year, reported that China already leads the world in growth of scientific research and is now the second largest producer of scientific knowledge, on course to overtake the U.S. if it continues on its present trajectory.

For me, one anecdote vividly captures the global pursuit of talent now underway. It concerns Choon Fong Shih, a name that may be familiar to many of you. Dr. Shih was born in Singapore and educated at Harvard. He rose through the academic ranks at Brown University and established himself as one of the world's leading experts on fracture mechanics. In 2000, he became the Chancellor of the National University of Singapore and is widely credited with building that university into a research powerhouse of international stature. So far, this is a story that has parallels in other Asian countries, Taiwan most notably . . . brilliant Asian scientists get educated in the U.S., have distinguished academic careers, return home to lead major institutions. But, this story has a twist.

A few years ago, as I'm sure you know, King Abdullah of Saudi Arabia decided to build a world-class center of academic and research excellence called, not immodestly, the King Abdullah University of Saudi Arabia or KAUST. It opened its doors in 2009. The university was launched with a $10 billion endowment and the best facilities money can buy. Given the benefactor, no surprises here . . . But, what is striking about this story is that, in one of the world's most closed societies, the university has cast its net for talent as broadly as possible. Dr. Shih was recruited to become its president. Moreover, KAUST is open to men and women alike. Women are not required to wear veils and the religious police are not permitted on the campus. If this can happen in Saudi Arabia, can there be any doubt that the global race and competition for talent is on.

So, I return to my question, what are we in higher education to do in the face of all these challenges?

Obviously, we need to press for better support for higher education in our states and at the national level. And we must speak with a unified voice in calling for investments in federal R&D support.

Moreover, despite the nation's financial circumstances, we have several things working for us in this regard.

First is the fact that never in my lifetime has the nation been so focused on college completion. America's declining status in college completion rates has finally gotten

people's attention. Newspapers, periodicals, and television reports are increasingly noting the alarming statistics:

- Thirty years ago, the U.S. was #1 in both high school completion rates and percentage of adults with a two- or four-year degree
- Today we rank 26th in high school completion and 16th in degree attainment.

President Obama has set a national goal of recapturing leadership in college completion by 2020. In addition, the Gates, Lumina and other major foundations have made college completion a top priority, and are matching that rhetoric with substantial funding. And the National Governors Association has embraced college completion as its number one goal and it led an effort to create uniform college-ready, high school completion standards.

Second, even with the ongoing budget crunch and international competition, America's research universities remain universally recognized as the world's best. The 2011 Academic Ranking of World Universities from the Shanghai Ranking Consultancy places 17 American universities among the top 20 in the world. With a high proportion of Nobel Laureates and other international award-winners in the sciences, mathematics, and humanities . . . our research universities remain hubs of achievements and engines of discovery. So we have not lost anything…yet. What we are facing is a serious threat of losing something of extraordinary value to our nation.

Here again, this concern is held at the highest levels of government. It was Congress that asked the National Academy of Sciences to undertake the study that lead to the *Rising Above the Gathering Storm* Report. And, it is Congress that has asked the Academy for a follow-up study on the state of America's research universities. This report will be released soon and the timing could not be better, as Congress will be making some very difficult decisions on the Federal Budget and, in particular, domestic spending priorities. Funding for research may be one of the few areas where bi-partisan support is possible.

So, we need to rally the troops, raise our voices in unison and make the strongest possible case for continued significant investment in research and, I might add, Federal financial aid programs.

But, in my view, it will not do for higher education to just ask for more support. In this era, we cannot be the one enterprise in society that is unwilling to consider change – perhaps even revolutionary change in how we do our business. At a time when essentially every other area of human activity is undergoing significant reengineering in how it adjusts to the new fiscal realities, we will have little chance of recapturing higher levels of public investment if we refuse to at least consider new paradigms for teaching and learning and new strategies for investing in research activities. My point is academia must not exercise the option of simply hunkering down to wait out this economic downturn, as we have done in the past. We face challenges that MUST be met and addressed now. Too much is at stake for our nation.

How can America be the global leader in things that matter if we aren't the leader in educating our citizens and developing the next great innovations in technology?

That's why I feel so strongly that higher education must step forward and exercise leadership at this moment in time. I don't mean to sound fatalistic or overly dramatic but a lot is at stake for our nation and the well being of future generations. Much will depend on how we in higher education respond to the challenges we are facing at this moment.

So, let me offer three things that universities, and research universities in particular, need to embrace if they are to do their part in pulling America out of its educational doldrums.

First, given the economic challenges facing our nation and states, we in higher education must demonstrate a firm commitment to act as cost-conscious, cost-effective stewards of our funds and demonstrate that we are doing our part to temper growth in the costs of our operations. Some will say, what do you mean? We've been cutting our budgets like crazy. How can we do more for cost containment? Yes, budgets are being cut but those funds are being replaced, at least in part, by huge tuition increases, making college less and less affordable. This is not a sustainable model for public higher education. What most universities are not doing is making systemic changes in their business and academic operations to adjust to the new fiscal realities. We are on a collision course with public opinion and our state and federal governments. Congress started holding hearings this past week on college costs. President Obama has invited a dozen or so university leaders to the White House Monday, including me, to discuss this topic.

Now, with all due modesty, I will submit that the USM was ahead of the curve on this matter, implementing what we called our Effectiveness and Efficiency Initiative, or E&E, six or seven years ago as a result of our nation's previous recession during the first few years of this Century. Do you remember that recession? We thought it was awful back then. Today we look back on it with a sense of nostalgia. In any case, through this initiative, which is on-going, we began looking systematically at all of our academic and administrative processes to see how they can be reengineered to operate at lower cost without impacting quality.

The fiscal and academic impacts of this effort speak for themselves. Administratively, we have removed more than $250 million in direct costs from our budget, while experiencing significant additional savings through cost avoidance. We consolidated back office operations of our campuses, we began buying major commodities as a system and not as individual institutions, we limited degree programs to 120 credits, we required students to earn 12 credits outside the traditional classroom, and we required an on average 10 percent increase in faculty's student contact hours. We made sure the state and the general public new about the strong actions we were taking, and we aligned our budget requests with the state's needs in workforce development and economic growth. All these efforts not only gained compliments but greatly increased our credibility with state leaders.

The results speak for themselves. Academically, USM's four-year and six-year graduation rates are at an all-time high, average time to degree is down from 5 to 4.5 years, the rankings of our institutions have never been greater. And, importantly, the credibility we gained with the state means that we became much more of a funding priority for the state. Believe it or not, our state appropriation is higher today than at the start of the Great Recession. Because of cost containment and state support, tuition has risen a cumulative 6% since 2008. Maryland has moved from having the 6th highest tuition in the nation all the way down to 25th. I must say, it was a source of great pride when, at a press conference a few years ago, President Obama challenged colleges and universities to "follow the example of the University [System] of Maryland".

So, serious attention to cost containment by reengineering administrative and academic models should be on the agenda of every American university. Our example shows it can lead to greater support and improved academic results.

My second item concerns reform in the teaching and learning paradigm. Let me begin with and an observation: At the start of any previous decade in my lifetime, if someone had predicted that universities would operate their education and research programs at the end of the decade more or less like they operated them at the beginning of that decade, they would have been dead right. But, I am absolutely convinced that such a statement today would be proved dead wrong in 2020. We are on the cusp of huge change in the way we carry out our educational and research missions. The great advances being made in the cognitive sciences and technology will drive these changes. But the rate of change will be accelerated because of our fiscal challenges. It turns out that many of the new paradigms can actually lower costs once the initial start-up investments have been made. This is a good thing because they will force us to rethink and improve the teaching and learning process, especially in the STEM areas.

We in higher education are quick to say that the reason we have a declining production of STEM graduates is because the K-12 sector is not adequately preparing students for the rigors of STEM education at the collegiate level. While there is some truth to this assertion, the fact is that the largest loss of students with interests in STEM careers along the Pre-K to college degree continuum is in the first two years of college, even among students who come to us with high STEM aptitude. Too many universities continue to teach beginning STEM courses with the 1 in 3 approach. This is when you tell the freshman at the beginning of the semester in a STEM course, look to your left and look to your right. Only one of you will pass this course at a level to succeed in the next course. This is especially true in my discipline of mathematics.

There are some exciting developments in teaching and learning that could be a "game changer" in STEM education but universities must have the will to embrace these new strategies. As we all know, change does not come easily on a university campus.

Let me briefly describe one such strategy, which has produced impressive results. Carol Twigg launched the effort while she was Vice President at Educom (now Educause). Carol had the hypothesis that many large lecture style classes, especially in the STEM

areas, were highly inefficient, both in terms of cost and learning outcomes. In part, her hypothesis was based on the observation that the passive learning environments of these courses were out of sync with the culture and expectations of the internet-savvy, highly networked, electronic gadget-oriented generation of students coming to our colleges and universities. In controlled experiment after controlled experiment, her hypothesis has been borne out, at large public universities, small liberal arts campuses, elite privates and community colleges. Carol has created the national Center for Academic Transformation, or NCAT, to support course redesign throughout higher education.

The University System of Maryland hired Carol as a consultant for a three-year period. Under her guidance, each of our campuses developed “Twigg” models in lower division multi-section STEM courses. We found the same results as in her benchmark study. In all cases, students in the ”Twigg” sections did better on uniform finals and at the same or lower cost than the sections taught using traditional methods. We are now investing several million dollars across the USM with the goal of redesigning all of our lower division STEM course.

We are also partnering with Carnegie Mellon University on a related but even more sophisticated strategy. In this approach, developed at CMU, disciplinary experts are working with cognitive scientists to produce highly sophisticated software that is used as learning modules in lower division STEM courses. Here again, the results are dramatic improvement in student learning and retention of material and, after the initial course development, at much lower instructional costs.

Recently, I had the privilege of learning about yet another active learning model, developed by Nobel Laureate Carl Wieman, Associate Director for Science in the President's Office of Science and Technology Policy. I know that earlier this year, CSSP presented Dr. Wieman with the 2011 Award for Education Research Leadership. As you know, he uses brain scans and imaging to study the ways the brain develops “expert thinking” . . . with the goal of getting students to think like experts. Like Carol Twigg’s and CMU’s work, Carl Wieman’s approach changes the model to require active mental effort as opposed to passive listening.

My view is that the approaches I have described, and others based on the same principles, have demonstrated beyond reasonable doubt that they improve learning without substantially increasing costs, and in most instances actually lowering costs.

At the core, we are educators. As such, we have a fundamental responsibility to help the next generation master the disciplines we teach. We simply cannot ignore pedagogical strategies that improve learning, understanding, and retention. And as administrators, we cannot ignore the fact that many of these strategies lower the cost of education delivery.

Universities across the country need to invest in and commit themselves to adopting these strategies. They hold the promise of radically changing our ability to produce larger numbers of highly skilled STEM graduates.

The third and final item where I think we will see significant change in this decade is where and how we do research. The great centers of research in STEM fields will be increasingly interdisciplinary and much more widely dispersed around the globe. We already see the precursor of this phenomenon with the linear accelerator at CERN. While significant particle research will continue to exist in the U.S., many if not most of the real breakthroughs will come from teams—no doubt with U.S. membership—working in Switzerland. China already has the world's largest super computer. By 2020, we should expect to see quite a few major centers of cutting edge research elsewhere in Europe and in Asia.

I also believe we will see fewer research universities in the U.S. by 2020, and a narrower portfolio of research activities at our major research universities. While there may be a few exceptions, I don't believe universities will be able to aspire to "excellence across the board" in research. The funds simply won't be there to maintain competitive research programs in a wide swath of areas when the competition isn't just 50 or 60 other U.S. universities, but three or four times that number spread around the globe. This is not necessarily a bad thing. In my view, we have more "wanna be" research universities than we can possibly afford and we need much more focus by these campuses on moving our nation to President Obama's goal of recapturing global leadership in college completion.

Another challenge for our research universities will be attracting adequate numbers of talented graduate students. Foreign graduate students already dominate many of our best science and engineering programs. While our universities are still seen as offering the best graduate education opportunities and we have had our pick of exceptional students. This has been our salvation, since U.S. colleges and universities are not producing enough domestic science and engineering graduates to fill the need in our graduate programs. But the handwriting is on the wall. We certainly cannot count on this flow of foreign students in the coming years as strong research centers evolve in other parts of the world. That's why it is so important that we build the domestic STEM pipeline in the U.S., producing much larger numbers of well-educated and motivated domestic students in STEM areas. Otherwise, we face the prospect of a significant shortfall in graduate students, who are absolutely essential to maintaining excellent research programs.

And finally, I believe it is essential that our research universities embrace a more entrepreneurial approach and better support a culture of innovation . . . through stronger partnerships with the private sector. While basic research must remain a major focus of our great research universities, more focus needs to be placed on translational research and technology transfer, which can serve as a catalyst to boost our economy and create high paying jobs.

We are certainly trying to move in these directions in Maryland. We have recently completed a new Strategic Plan with a 2020 time horizon. It represents our best thinking as to how we need to respond to the needs and challenges of our state and nation over this decade.

At its heart, it has three goals. First, accelerating the development of the new teaching and learning paradigms in the STEM disciplines. Second, developing Maryland's highly skilled workforce for the 21st Century, with a focus on greatly expanding our production of STEM graduates degrees. And, third being the catalyst for growing Maryland's innovation economy.

As part of this effort, we are changing our promotion and tenure policies to give faculty credit toward tenure for work they do in tech transfer.

In a nutshell, our Strategic Plan aims to enhance Maryland's competitiveness in the innovation economy with specific goals including, over the decade to:

- Produce an additional 2,000 STEM degrees annually, a 40% increase
- Double Extramural Funding to $2.4 billion annually
- Generate 325 Spin Off / Start Up Companies

I think this makes a good stopping point for my comments.

I would just like to end with the observation that, while much of what I have talked about today may seem a "downer," I see real positives as well. First, the fiscal circumstances have the potential to bring out real and meaningful innovation in how we do our business and carry out our missions. Second, this inevitable global expansion of knowledge creation will almost certainly lead to significant improvements in the standard of living and the quality life around the world. And, while we may have to share more of the limelight on breakthrough research discoveries, the competition and collaboration on a broader scale will undoubtedly accelerate advances and make us better at what we do.

Thank you so much for allowing me to speak with you today. I look forward to our discussion.