Annual Report on Research, Scholarship and Creative Activity at the University of Michigan, FY1999

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Delivered to the Regents of the University, December 16, 1999

It's a great pleasure to stand before you today to celebrate with you and to brief you on the research, scholarship and creative activity generated by the faculty, staff, and students of this great academic enterprise: The University of Michigan. Just about one year ago, I assumed my position in the Office of Research, and I can honestly say it has been, in fact, a fantastic year - a year full of interesting challenges and discoveries, a year of learning about the multitudes of fields and disciplines we have across our three campuses, and a year of reflection on what research means and what the future holds for the University of Michigan.

Among all of the activity I've been involved in or witnessed, what impresses me most is the tremendous vitality that exists in our faculty and students. The zest for research and scholarship at Michigan is remarkable - unquestionably one of the most distinguishing characteristics of our institution. I have also observed that Michigan is underrated, when compared to its East Coast and West Coast peer institutions, and that's probably due to its gentle Midwestern humility. Unlike our peers, we don't boast our accomplishments as loudly nor as widely, and when we do pat ourselves on the back, we do it with perhaps too much restraint.

One of the main things I would like to do over the course of the next 30 minutes is to talk about what it means to be engaged in research and scholarship at a great public university such as ours. I will also enlist the help of a few faculty members, who will visit us by videotape in a little while. Next, I will review the statistical indicators that we track on research activity. And finally, I'd like to look ahead and share with you some of the challenges that face our University and nation, from the standpoint of the individual faculty member and the administrative leadership of the University, as well as the Congress and President who jointly set national policy affecting higher education.

The Meaning of Research and Scholarship

To really understand what research and scholarship means, we have to examine it at the level of the individuals engaged in these activities - the faculty, students and staff. What motivates them to plod along, sometimes for 20 or 30 years, to find the answer to a question, to decipher the working of some ancient alphabet; to examine the molecular structure of some complex protein; to measure the abundance of certain molecules in a distant galaxy; to develop a model based on a longitudinal study aimed at understanding the relationship between cognition and memory in people with Alzheimer's disease compared to same-aged controls; to construct integrated circuits made of new semiconductor materials that enable computers to operate at faster speeds and consume less power; to develop a genetically engineered treatment for muscular dystrophy; or any of the other myriad projects that our faculty and students pursue across our University of Michigan campuses.

I don't have easy answers to where this inspiration and energy comes from except for the obvious - the people who choose this activity as their life's work do so because they posses the built-in curiosity, a drive for discovery and, in many cases, a gift for being able to recognize significance amongst the commonplace.

One important aspect of research and scholarship is found in the relationships that form among those involved in any project. Faculty members and students, both graduate and undergraduates, come to develop very special links as they work closely on intellectual problems. Research teams so often bring together the "green" students with their unique enthusiasm and wonder with senior faculty members who have studied an area for many years and leavens the process with his or her experience. When all of the individuals gel, the outcome is wonderful and intellectually formidable. Reaching that point, of course, takes hard work, intense study, and patience.

The Stature of UM Faculty

Let me turn now to a brief discussion of the kind of intellectual resource and stature found in our faculty and research staff. In the course of any given year, literally hundreds of honors and awards are bestowed on members of the Michigan faculty, staff and students. These span from something as singular as the Nobel Prize just awarded to Professor Veltman, to election to the National Academies, from being recognized by one's professional societies to selection to a variety of national commissions that advise the federal government.

In fact, we in the Fleming Building don't hear about most of these honors, so there is no way that I can present the full scope of the recognition conferred on our faculty. And on top of these awards, there is also the 1,700-some new research and training grants our faculty members are awarded every year. This is a tremendous task, particularly when you consider that it involved the submission of about three times as many proposals, each of which had been subjected to a rigorous and highly competitive review process, in order to win those 1700 awards. To give you a fuller sense of what it takes to secure funding from external agencies and foundations, I will elaborate on the proposal submission and award process later on in this presentation.

You already know a good deal about the recognition given to Professor Veltman a few months back. And it was also reported to you at a previous meeting the election of four of our faculty to the Institute of Medicine, which, together with the National Academy of Sciences and National Academy of Engineering, represents the highest honor individuals in those fields can be elected to in this country. But let me add a postscript to that particular honor.

The Institute of Medicine currently has only 588 members nationwide. Election to this body represents membership in an extremely elite group - there are hundreds of thousands of scientists and professionals in the fields of medicine, nursing, dentistry, and public health, not just those on the faculties of the nation's medical and other health-related schools, but also those serving in all of our hospitals, national research laboratories, and other health-related institutions.

I might add that one-fourth of the membership is reserved for scholars in the social sciences, law and other disciplines outside of the life sciences and medicine. Having four of our faculty be among the 54 elected this year to this prestigious body is a special honor this University. We now have 18 members of the Institute of Medicine participating in this important national arena.

Here is another example of what we have at Michigan. Just last week, Sandy Gregerman, the director of the Undergraduate Research Opportunity Program was in Washington, DC to accept the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. The University of Michigan was one of five institutions so recognized this year for a program that

has an outstanding record of involving undergraduate students with faculty in the integration of research with the education of our students. This kind of program can only exist in this form at a place like Michigan - and this Presidential Award further justifies the pride we all have for this program and for the faculty and staff who make it so successful.

Every year, many of our faculty are recognized for their excellence by their relevant professional societies . Just one recent example is the awarding of the C.F.W. Coker Award to Francis Blouin, director of the Bentley Historical Library and a professor of history and information. Blouin and several colleagues received the Coker Award, given by the Society of American Archivists, for creating the definitive historical guide to the archives of the Vatican. This is a project that took a decade, and makes available for the first time a way for scholars to make use of one of the richest archival resources about the history of the western world.

Let me offer just one further example of how the honors given to our faculty reinforce for us the high caliber of our institution. This past year, the Institute of Electrical and Electronics Engineers (IEEE) sponsored three international symposia in the areas of microwave electronics, solid-state circuits and electron devices. Each was attended by no less than 1000 participants. One activity of these symposia is to recognize the publication of outstanding research from the year. For the first time ever, all three of the top prizes went to faculty members and graduate students from the University of Michigan.

Motivation and Curiosity

Now why do our faculty earn this kind of recognition? In overly simple terms, it is due to their intellect, their passion for what they do, and their plain hard work. By way of examples, I'd like to present to you five short video segments during which a faculty member will offer a few words about what he or she does, and why it's exciting and motivating for them to undertake their chosen area of study. Of course, there are so many fields of study that we could turn to for similar examples, that these five individuals offer just a glimpse at what is taking place over and over again on our campuses.

I'd like to begin with a young faculty member in biology and the Biophysics Research Division, Jim Bardwell. He did his Ph.D. work at the University of Wisconsin and was a post-doctoral fellow at Harvard Medical School. For the last half dozen years, Professor Bardwell has been engaged in studies of protein folding and how this occurs inside of cells. He was also the youngest member of the Life Sciences Commission appointed this past year by President Bollinger.

In this video clip, he will talk about some work being done to understand "heat shock proteins," which are proteins that organisms synthesize whenever they encounter dangerously high temperatures, either in the environment or, in the case of higher organisms, due to a fever. These heat shock proteins gather around other proteins in the cell and prevent the heat from unraveling their three-dimensional structure. Now, let's hear more from Jim.

James Bardwell

When I was a graduate student, I sequenced four genes in four years; one gene a year. Now there was a machine about the size of this microwave that can sequence a hundred a day. So that's like more than a 10,000-fold increase in speed.

So you can do a huge amount of experiments very quickly and you can find new things very fast.

Well, we're working on a particular set of proteins that are made at high amounts under heat shock conditions; when you have a fever or when you're exposed to some toxic chemical. What we are particularly trying to do is figure out exactly how these proteins work to protect you from the toxic effects of these treatments.

How do we do that? We essentially use three kinds of methods. One is genetic method. So we look to see what the gene does for the protein in the cell. So we destroy the gene and we see what the effect of destroying the gene is on the whole organism. And the organism we work with is a bacteria, a gut bacteria called E. coli.

The other set of techniques we use are biochemical techniques. In other words, we make the protein, we purify it so we only have that protein in solution. And then we look at it in a test tube to see how it works. And the third type of technique works if you get a protein pure and you can build a crystal of it, like a salt crystal. Then you fire an x-ray through it, so you an get a snapshot-essentially an enlargement of the protein.

So there's never been a better time to discover new things. And we're explorers. That's what we're doing. We're trying to find out new little pieces that fit into the puzzle. When you find a new little piece, the beauty of it is not only to see that it fits, but usually you see that it actually opens up a whole new vision, a whole new window on life, on the world.

Next, I'd like to introduce Professor Arlene Saxonhouse of our political science department. Professor Saxonhouse is an eminent scholar, a former chair of her department, the 1997 recipient of the Distinguished Faculty Achievement Award, and a member of the American Academy of Arts and Sciences. Her research focuses on ancient political thought and its relevance for modern political systems.

Arlene Saxonhouse

When I go back to the ancient Greeks, and particularly to the ancient Athenians, I'm going back to a period when democracy was in fact created. It's the first democracy and really the major democratic regime until we get to the 19th and 20th Centuries. And there are all sorts of qualities of that ancient Athenian democracy that are of interest, particularly every office was chosen by lot. You didn't have individuals chosen by election and therefore you included the entire community in all activities of the government. There was no

senate or house of representatives. There was no such thing as representation. Everyone was elected.

One of the things that I think emerges from the study of ancient democracies is a questioning of what does it mean when we go about electing? What are we losing when we go about electing? What would it mean, what would it be like if we were to have a lottery system for offices? Obviously that's not something that we can institute at this point. But it raises some issue about the degree to which we want democratic regimes to be more open and incorporate a larger percentage of the population into the activities of self-rule.

What I try to do then is think of, "Okay, these are issues that people doing political theory are concerned with." How do the texts that I read-Plato, Aristotle, Thucidides-give us insights into these questions. What's so exciting about reading these works, the ancient Greek texts, is that there's always something new in them. I mean if you get an author like Plato, and I assume this is true of Shakespeare too, every time you read one of his dialogues there are new insights and new ways of thinking about the issues that he's raising.

Now we'll hear from Professor Tom Gladwin. Tom did his graduate work at Michigan, earning both an MBA and a Ph.D. with a combined focus on environmental issues and the globalization of the economy. After graduation, he went to Geneva as a Rockefeller Foundation post-doctoral fellow. He then became director of the Global Environmental Program at the Stern School of Business at New York University. We are very fortunate to have been able to lure him back to Michigan about a year and half ago to become the Max McGraw Professor of Sustainable Enterprise with appointments in both our business School and the School of Natural Resources and Environment. In addition, Tom directs the Frederick A. and Barbara M. Erb Environmental Management Institute and the Corporate Environmental Management Institute, which he will tell us more about.

Thomas Gladwin

About four years ago, the Erb Environmental Management Institute was established as a joint initiative of the School of Natural Resources and Environment and the School of Business here. Its mission is to promote, on an all-University basis, environmentally sustainable commerce, enterprise and entrepreneurship that gets business into harmony with nature. We're trying to bring about business that will serve the needs of the present without jeopardizing the needs of future generations.

The Erb Institute has an explicit mission of catalyzing and orchestrating interdisciplinary research. It is our belief that the major problems of our time, whether it's biodiversity loss or climate change or megacity growth, or toxic pollution,

are all challenges that can't be solved by any one discipline working alone.

At our Erb Institute, we're largely looking at themes of natural capitalism, that is advanced resource productivity in our use of energy and materials and renewable resources. We're looking in a very exciting way at what can we learn from 3.9 billion years of evolution about how nature manufactures and distributes and heats itself and so on. That's called biomimicry - understanding natural systems and then imitating them in your search for new manufacturing processes, technologies and so on.

We also have an educational program that's called the Corporate Environmental Management Program, just rated number one in the nation by the World Resource Institute and the Aspen Institute. That's creating the next generation of leaders, of environmentally responsible leaders.

Industry has finally accepted that this challenge of sustainability, sustainable economy, sustainable energy, sustainable materials, sustainable commerce. It's probably the number one megatrend reshaping business. So they really need wisdom, knowledge, new technologies, ideas, tools and metrics and it's a great partnership, a very rich partnership for the future.

Next, you'll hear from Brian Athey, a biophysicist by training who is currently an assistant professor of anatomy and cell biology in the Medical School. Brian came to the University a few years ago from ERIM, the Ann Arbor-based Environmental Research Institute of Michigan. He's here now in large part because of his expertise in creating and analyzing complex images. What he will talk about is something called the Visible Human Project, a multi-million-dollar effort funded by the National Library of Medicine to make available detailed digital images of human anatomy via the internet.

Brian Athey

We've been working with the Visible Human Project since its inception in the early part of the decade and what it involves is basically a new way to teach human anatomy-for all kinds of people, medical students, dental students, nursing students, K through 12 students. It's a way to make anatomy accessible through the internet basically.

So the Visible Human becomes basically a big what we call a database locator that allows us to not only navigate through the gross anatomical form, but to dip into the language and look and see connections; to dip into other databasing resources that we have, and so it provides a basis for something which we call a visual bioinformatics.

For example, if we wanted to fly through the esophagus and look around and see what was available. Go down into the lungs and see the branching of the structures in the lungs. Look at the pelvis and see some abnormalities say with the femur, something that might be involved with a hip replacement or something like that. All these things are possible by using the computational capabilities available to us today to synthesize views.

The thing about the Visible Human and a computer representation is that they are synthetic methods and you can try things over and over. If you want to cut through a vein and look and see, you can cut it and it's not destroyed because you can bring it back together on the computer. So this offers us capabilities to extend into the realm of surgery, using virtual reality and using 3-D computation.

All these things are beginning to be possible because we have the data sets available to us from the Visible Human, and we're developing the computational and infrastructural capabilities as well as the broad range of other intellectual capabilities brought to bear on the problem to make these very difficult and complex problems solvable.

Last, I want to introduce Linda Abriola, a professor in the Department of Civil and Environmental Engineering and Director of our Environmental and Water Resources Engineering Program, ranked among the best of such programs anywhere. Professor Abriola received a Presidential Young Investigator Award in 1985, the College of Engineering Research Excellence Award in 1994, and the Outstanding Educator Award from the Association for Women Geoscientists Foundation in 1996, among many other honors.

The work Professor Abriola will discuss is a very interesting project that has involved computer modeling, laboratory experimentation, and now an actual field trial of cleaning the subsoil of toxic organic pollutants. Currently there is really no satisfactory method to clean up many of the organic spills, but Dr. Abriola and her lab colleagues have developed a method that they think will be quite successful in removing such contaminants.

Linda Abriola

Chemical contaminants have contaminated many, many sites in the U.S. The costs for cleanup are estimated at approaching a trillion dollars over the next twenty years. There are particular sites that I'm interested in that are very recalcitrant to remediation. And these are sites that are contaminated by organic liquids, particularly chlorinated solvents is my interest. Those are degreasers, dry cleaning fluids.

And what we're doing is using surfactants, which are detergents basically. Just like a detergent would take the oil

off of your clothes; the dirt off of your clothes, this can increase the solubility of these organics and sort of wash the soil, so to speak. We test out surfactants in the laboratory in little beakers, and we look to see which ones are the good solubilizers. Then what we do is test it out in soil columns and we see whether we can clean the soil columns. And we always to very well there. We write equations to describe the movement of these contaminants and their chemistry, and we put it all into a computer simulator and we predict what happens.

And we're at the point now where we're pretty happy with what we have. And the Michigan Department of Environmental Quality is funding us to go out to a site in Oscoda, Michigan that is right on Lake Huron. There's a big contaminant plume going right out to the lake and polluting the lake. It's a perchloroethylene spill and it was a dry cleaner. Now it's a Speedy Printing Company who has the property now.

If all goes well, we're going to try to clean up a pilot test, a clean-up of a very small portion of the spill. We've done coring and we've observed where this contamination is, and we've even gone in the building and seen staining in the joists where the stuff has leaked down. So the State is real interested in this technology because it can help speed clean up and reduce costs. But we have to demonstrate, of course, that it's going to work.

One of the problems in this field is that there hasn't... it's a very new field. It's maybe 20 years old. And there are a lot of people out there working in it who don't have the knowledge at all and can't solve the problems. And here at Michigan we have a wonderful group of people here who can give people the expertise they need to go out and tackle these. So you have the sense that you're doing something important.

This kind of devotion to inquiry, to students, and to understanding the unknown is found across the many disciplines, centers, institutes and research projects we have at the University of Michigan. I'm probably not telling you anything you don't already suspect, but I think it's important for us to be reminded about the remarkable cadre of people we have on our campuses.

Resources in Support of Research and Scholarship

Of course, these people cannot work without resources. So now I'd like to review some of the financial highlights of Michigan's research enterprise.

For FY1999, research expenditures totaled $499.7 million, an increase of 1.6 percent over FY1998. This increase continues a steady rise in research expenditures since FY1990 although

when inflation is taken into account, the aggregate purchasing power of our FY99 expenditures actually declined by about 1.5 percent compared to the previous fiscal year. In short, we experienced a flattening of the expenditures curve compared to earlier in the 1990s.

There have been no dramatic changes in the composition of our research expenditures by source or use of funds. Funds from Federal sources did increase by $23 million, from 65 percent last year to 68.5 percent of the total in FY1999. Relatively small decreases occurred in the categories "state and local governments" (grants from state agencies and other non-federal units of government declined by $2.5 million), and "trade and professional associations" (grants from organizations such as the American Chemical Society dropped about $4 million). University funds allocated to research expenditures remained about the same as last year.

If we look at expenditures by fields of study, life sciences remain the largest fraction overall, now accounting for 47 percent of total research spending. Expenditures in the categories of engineering, social sciences, and physical sciences also increased over last year. The one category that declined in overall proportion was "all other fields," which includes projects in the Schools of Business, Education, and Law.

The only comparison we have of research expenditures by peer institutions is based on data published by the National Science Foundation. Available figures compare research expenditures for only FY1997 and earlier years. Using these data, the University of Michigan ranks first in the nation in research expenditures. We expect comparative data for FY1998 to become available in the next few months. When it is published, I will share it with the Board of Regents.

It is worth spending a few minutes to provide some additional perspective on the scope of the research and scholarship enterprise that our faculty, students and staff are engaged in. A conservative estimate suggests that nearly 24,000 members of the University community take part in some direct way in scholarly work of some kind. Sponsored projects active in FY1999 surpassed 4,600, of which 4,300 were supported by external funds, with the balance funded internally.

And if you consider University expenditures in total (not including those for the Hospitals and Health Centers), research expenditures comprise 31 percent of the total spending by the University.

Of course, not all research and scholarly activity is supported by specific external or internal funds. Access to computing resources and libraries may be all that's required to carry out some projects. Nonetheless, measures of research expenditures is a useful indicator of research activity and productivity. In order to obtain a grant, a faculty member must submit a detailed proposal and demonstrate to a review panel of experts that he or she is highly qualified to conduct the proposed work, that the necessary facilities are indeed available and equipped with the requisite instrumentation, that institutional policies are compliant with Federal regulations, and that the academic environment is supportive of research inquiry. Let me talk a bit about the proposal process.

Approximately 70 percent of proposals submitted by the University of Michigan come from individual faculty members or a team of two faculty members working jointly. The remaining 30 percent are team proposals involving three or more faculty researchers. In some cases, as

many as 20 or more faculty might be involved in putting together major proposals, such as for large centers or training grants.

To write a credible research proposal for submission to a Federal agency or a funding foundation, it will take a faculty member anywhere from one week to many weeks of full-time work. And if it's a larger team proposal, the total effort may be measured in terms of months of full-time work. To be successful, these proposals are expected to present original ideas, approaches, or techniques that the project will undertake. In addition, the proposal must demonstrate that the University has the facilities and support services that will be needed to see the project to completion. Proposals are subjected to an elaborate, peer-review process involving experts from other institutions as well as panels of judges. In most Federally funded programs, the fraction of proposals selected for funding is less than 20 percent, and in some competitions, only 5 out a hundred are successful. So the fact that Michigan has seen steady growth in such peer-reviewed funding attests to the excellence of our faculty members and the work that they do.

Whereas research expenditure is a useful surrogate indicator of research productivity, it does not necessarily measure the impact of a body of work on other researchers active in the same field, and by extension, on society at large. Here, we are always looking for nonmonetary indicators by which we can gauge not only the quantity, but also the quality, of our research output. One such indicator is "scientific impact."

Last fall, the Institute for Scientific Information ranked the University of Michigan fifth in the nation in terms of "scientific impact." This organization analyzes citations of scholarly papers and determined that overall, papers by Michigan faculty were cited in relatively great numbers. In particular, papers in the fields of education, psychology and psychiatry, astrophysics, computer science, immunology, pharmacology, and law ranked very high nationally.

Challenges

Finally, I'd like to talk about the challenges we face, both from the standpoint of individual faculty and from that of an administration interested in making sure that the institution is positioned to continue to succeed and contribute in the areas of research and scholarship.

As we close out the century, we have the perspective of time to recognize the changing pressures that our faculty have had to adapt to. If we look back at the 1960s, most of our faculty are likely to recall those as the golden age of sponsored research. Budgets for federal agencies were growing, and, frankly, competition for those funds were not as keen as today because many fewer universities were as involved in seeking sponsorship for research and scholarship as are today.

Federal agencies had many programs that funded new initiatives with few constraints - and Congress was more trusting of agencies to fund projects appropriately. The success rates then were much higher, as well - often 50% to 60% of proposals received funding. Today, the funding rate is more like 20%, and in some areas, as few as 1 out of 10 proposals receives funds. One aside - the reviewers rate a much higher percentage of proposals as worthy of funding, but the agencies don't have enough money to fund all of those projects.

In the 1970s, many faculty members found they needed to adopt another role - that of team member. More and more sponsors were urging researchers to come forward with proposals that involved a group of people collaborating on a project. There is nothing wrong with that

approach - it's one we continue to encourage in our faculty. The salient point is that this was a new behavior that the faculty scholar and researcher needed to add to his or her repertoire.

As the size of research groups grew, the complexity of managing these groups added a new demand on the faculty. So, in the 1980s, I characterize the challenge as one of learning to become managers and accountants. This is no small task, and it, too, remains among the demands faculty still must satisfy today.

For a variety of reasons, in the '90s, the new "hat" our faculty needed to be fitted for was one of lawyer. The amount of rules and regulations that accompany each grant has grown in a major way over the last decade. Not just accounting for how funds are spent, but certifying compliance of a whole range of requirements in the care and use of human subjects and animals, radioactive materials, OSHA workplace rules, and financial conflict of interest. Again, I don't necessarily want to imply that all of this is entirely bad, but it certainly adds to the work burden of our faculty.

What's next? Well, it already appears that in the new millennium our faculty must master the "occupation" of entrepreneur. As agencies such as the National Science Foundation want to support major interdisciplinary centers of research, they also want to see these centers describe up front how they plan to develop their discoveries into economically viable products or processes. Technology transfer has become an important consideration in the review of research proposals, and so our faculty must respond accordingly by thinking more and more like entrepreneurs with an eye toward commercialization of their work, and possibly even making plans to start their own companies to accomplish this.

Even with all of these new demands being placed on our faculty, they have not only prevailed, but thrived. As I pointed out earlier, we continue to be among the leading universities in several measures of research excellence.

But for our faculty to continue to succeed, the institution must also adapt and support the faculty at several levels. Foremost is making sure that they have the resources they require, including: administrative support; seed funding to help new areas of work get started; top-flight facilities; and cost-sharing for projects when sponsors require it. Laboratory and office space is forever scarce, and this is a major concern for faculty, deans, and the central administration.

The institution also faces constant pressure to maintain the high quality of our faculty, so recruitment and retention are something we pay constant attention to.

In the Office of Research, we are especially aware of the challenges the University administration faces in supporting and enhancing the scholarly enterprise. This encompasses everything from our vigilance in efficiently administering the proposal submission and grant administration process, to nurturing emerging areas of research that might become major strengths at Michigan with the right mixture of resources and encouragement. For instance, in recent months, our office has been working with several of the deans to give a boost to our research capacity and expertise in the geosciences, materials sciences, and geographic information systems and spatial analysis. Like these examples, most of the areas that we target for attention involve a great deal of interdisciplinary activity.

Another important function that my office is involved in is the broad area of compliance. The number of rules and regulations that our institution must adhere to is enormous and growing,

spanning areas such as proper use of humans and animals in research, conflict of interest issues (particularly when the research involves technology transfer), and safe use of hazardous or radioactive materials, to name a few. We also endeavor to do more than serve as conduct watchdogs through our "research responsibility training program" -- a series of presentations and workshops that expose students, post-doctoral scholars and faculty members to the intricacies of regulations as well as the ethical challenges that they can encounter.

Reviewing and monitoring the use of humans and of animals in research are two large areas of activity. The University has five panels to review the use of human subjects, comprised of more than 60 faculty scientists and non-scientists, as well as community representatives, which must approve and then annually review some 4000 projects for safety and appropriateness. Likewise, all uses of animals in research or education must obtain approval from a scientific committee. At any one time, nearly 900 different projects are running that utilize animals, and each year more than 150,000 animals, mostly mice, are used for research or educational purposes.

As you well know, the Federal government is increasingly interested in seeing that the outcomes of sponsored research include technology transfer and economic benefit to the nation. Through our Technology Management Office and in cooperation with several of the deans, we have an active program in licensing technologies and, more recently, in facilitating the creation of start-up companies built around some University of Michigan technology. So in the last year or two, the University has been involved with the commercialization of new laser technology with applications in both eye surgery as well as manufacturing, or "micromachining." We've also licensed many software packages, such as a series of programs useful for ergonomic analysis and planning in the workplace. Currently, we're exploring the possibilities for the novel DNA laboratory-on-a-chip that has been developed at the University of Michigan.

Along with our success at obtaining external funding comes greater interdependence with government, both at the State and Federal levels. In order to be in a position to understand and anticipate national trends, especially those emanating as national policy from Congress and the President, we have a Federal Relations Officer in the University's Washington Office devoted exclusively to research issues. We are involved in developing and maintaining relationships with members of Congress and other bodies that develop or advise about national policy. My office is also deeply involved with others at the University and with our peer institutions in articulating the Michigan's positions or concerns about new legislation and regulations that affect the research enterprise.

For example, we have been active in the efforts to let the federal government understand the problems our faculty would face if changes in the Freedom of Information Act are instituted in particular ways so as to call for us to disclose raw data to almost anyone who requests it. This requirement would not only be costly in terms of the time it would take to assemble and make available such data, but more importantly it poses serious conflicts when research projects obtain data under a pledge of confidentiality.

Of course, one of the ongoing issues we face in Washington is lobbying Congress and the Administration to maintain increases in funding for basic research at a level no less than on par with the rate of inflation. This is a constant educational effort to help our representatives understand the importance of basic research to national goals of education, innovation, and economic growth. Many members of the faculty and administration testify before

Congressional committees on both specific and general topics related to funding of research and scholarship of all kinds.

Let me say a little about one threat to stable federal research funding that this University speaks against-a political practice called "earmarking" that is infiltrating higher education at a rapid pace. This occurs when Congress specifies by legislation, usually in the appropriations bills for the various agencies, that particular research projects at specific institutions be funded. Twenty years ago, Congress allocated perhaps $10 million dollars in this way. In this past fiscal year, that figure has climbed to $800 million. So large are these earmarks, that federal agencies are often forced to make significant cuts in their other peer-reviewed funding programs.

Let me give you an example of this. In a recent issue of *Science*, an article on the subject of earmarking -- better known colloquially as "academic pork" -- described how Western Kentucky University will receive $2 million to fund an ambitious astronomy project. This project did not undergo any peer review for scientific merit, nor is Western Kentucky University particularly noted for its astronomy program. Rather, Senator Mitch McConnell from Kentucky saw to it that the NASA appropriation bill included funds for this specific program. McConnell has argued that an earmark such as this one is the only way for a small university to obtain any significant research support, and he has a point. Unfortunately, as this article points out, it's not clear that Western Kentucky is fully capable of carrying out the project it has been funded to undertake.

Nonetheless, a growing number of institutions have decided that earmarking is here and so they lobby their representatives for such research funds. Michigan has taken the position that this is not the wisest way to distribute research funding. We strongly support the integrity of the peer review process which is supposed to evaluate proposals on the basis of merit, not the committee assignments of a state's Congressional delegation. We support this position because it has proven to be the best method for seeing to the most productive use of federal funds. In addition, it hurts all of the university research community by reducing the total funding available to those who can put forward sound research proposals that pass rigorous intellectual review.

Conclusion

I want to close with a few comments -- one on the Life Sciences Initiative and the other on the balance between teaching and research.

All of the attention we have devoted to the Life Sciences in the last year has already done much to generate a sense of excitement and pride to be part of Michigan. Further, the Initiative has demonstrated in a concrete way the commitment of President Bollinger and the rest of the central administration for the University of Michigan to remain among the very top institutions in the country. When I think about the proposed Institute, it reminds me of just how special this institution is. Through the addition of some 30 faculty and associated support staff and facilities -- an increase in the size of the faculty of one percent -- we are setting in motion a host of new avenues of research in the life sciences. But because of the great diversity of expertise found at the University, including disciplines beyond the life sciences, we are surely going to see many as-yet unforeseen synergies develop. It is going to be an exciting era at Michigan.

Now, one last item. Recently I had a conversation with a department chair. I asked him about the typical work load of his faculty. He replied that faculty members in his department

probably average a work week of 60 hours, with a number devoting an excess of 80 hours a week. I doubt it's any surprise that we have a dedicated faculty. But what I want to do is juxtapose this observation with the University's experience in selecting its Thurnau Professors. The faculty members who are named Thurnau Professors are receiving our highest honor in recognition of excellence in undergraduate teaching. What is not known about this group of faculty is that most of them also qualify as among our most creative and productive in terms of research and scholarship. They are our best affirmation that excellent teaching and research are not only compatible, but complementary.

Without a doubt, the University of Michigan is a great institution populated by intelligent, creative people whose work creates a vibrancy that is found in only a very few universities around the world. I salute our faculty, staff and students for their collective contributions to knowledge, the arts, and the social good in all its varied forms.