Research and Scholarly Activities, FY 1998

A Presentation to the Regents by Frederick C. Neidhardt, Vice President for Research, on November 19, 1998

INTRODUCTION

As surely as November brings roast turkey and pumpkin pie, OVPR brings its annual report to the Regents on the research and scholarly activities of the University during the prior fiscal year.

Attention is always given to the volume of research as measured by the dollars expended on sponsored projects. This metric, though simple, easily determined, and comparable from year to year, fails to display the value of the University's research, to capture the excitement of the activities of our faculty and students, or to herald their contributions to scientific knowledge, to the world of ideas, and to the artistic expression of the human spirit.

The financial numbers are important, however, because the dollars are necessary to support research and scholarly activity. Moreover, they do provide some measure of quality, not just quantity. External support of research is acquired by our faculty through competitive grants and contracts, won in national, peer-reviewed competition. That $2 out of every $100 the federal government spends on basic, non-military research comes to Ann Arbor is an achievement of which we can all be proud.

But our reports to you have traditionally highlighted key issues hiding behind the numbers, and today's is no exception. In the past I have identified for you three prominent themes in the administration of UM research: (i) the contribution to undergraduate education, (ii) technology transfer, and (iii) interdisciplinary / multidisciplinary research. Today I focus on the last of these themes.

Research at the Intersections

Let me reveal a secret. The UM is number one in research volume because its faculty derive strength, inspiration, ideas, and assistance from one another. Our university is a great place for scholars to work because they can interact with top-flight individuals outside their own discipline. One in every eight funded research proposals involves the collaboration of faculty members from different disciplines, and one-third of our research dollars are awarded to us for interdisciplinary and multidisciplinary research.

Work at the intersections of disciplines is extraordinarily exciting and frequently leads to unpredictable outcomes. That's why some of the most creative scholars are those that seek out collaborators from alien traditions. Furthermore, all the problems that afflict the human condition are complex, defying solution by any one discipline. That's why federal agencies and national foundations insist on multidisciplinary projects.

These two facts explain why so much of the activity of our faculty occurs in spite of the organizational structure of the University. Many of our faculty are engaged in research that transcends their discipline and that occurs in spite of the barriers that are inherent in an organization planned to foster disciplinary strength.

Before showing any numbers about FY 1998, I want to treat you to a description of two projects that came to fruition this past year and that occurred at disciplinary intersections.

DNA Laboratory on a Chip

A few years ago Prof. David Burke of the Department of Human Genetics in the Medical School had a bold idea, but not one that he could act upon alone.

HereÕs the background. As a geneticist interested in humans, Dr. Burke is blessed in working in an era in which the genetic component of human disease is directly accessible in a way never dreamed of a few short years ago. DNA is information encoded in molecular form and accessed by an organism to perform specific tasks during its development and life. DNA analysis (sequencing, genotyping) involves biochemically learning that information directly. This information has predictive medical value; it is not destiny, but it is the predictive probability of the outcome of future events affecting that organism in concert with its interactions with the environment.

Within medicine, DNA analysis is important clinically for

- individual identification: parent-child, forensics, military, disasters
- organ transplantation and bone marrow matching
- bacterial and viral diagnosis, and tracking of epidemics
- genetic predisposition to disease
- genetic based drug or therapy interactions

Outside medicine, DNA analysis has scores of uses, such as

- comparative genomics and other basic biological studies
- crop and animal breeding for disease resistance, high yield, etc.
- new crop development for marginal agricultural areas
- tracking and breeding of endangered species

Recognizing that DNA analysis has become a cornerstone of biology, Prof. Burke envisioned the enormous value of simplifying the process -- simplifying it to bypass reliance on elaborately equipped laboratories and specially trained technicians, to conserve expensive materials, and to permit DNA analysis rapidly and under field conditions. He knew that he could never achieve such a technical advance himself, but had faith that the project was feasible. With encouragement from the Chair of his department and some seed money from the Medical School and from OVPR, Dr. Burke approached the College of Engineering, which had both the specialized disciplines and the specialized facilities to address the challenge. In fact, it was the existence of such technical expertise that had originally attracted Prof. Burke to join the University of Michigan faculty.

The success of Prof. Burke and his colleagues, Prof. Mark A. Burns (Dept. of Chemical Engineering), Prof. Carlos. H. Mastrangelo (Dept. of Electrical Engineering and Computer Sciences), and their postdoctoral fellows and students, was heralded in the October 16, 1998 issue of Science magazine. The article, "An Integrated Nanoliter DNA Analysis Device," described what quickly became known as the DNA lab-on-a chip.

The functions of a complete DNA lab are performed on a silica chip containing microchannels, mixing chambers, air jets, incubators, electrophoresis gels, detectors, and data analyzing devices [exhibit 11 -- samples handed to Regents]. A minute quantity of sample (120 nanoliters, which is roughly one-tenth the amount of liquid that can bead up on the period at the end of a sentence) is taken up at an entry port, moved along a micro channel, and mixed with a similar sized drop of reagents. The mixture is blown by fine air jets into a microchamber with controlled temperature, and the products of a reaction are separated by electrophoresis and detected by fluorescence. The data are analyzed by a microcomputer and the results displayed.

This miniature laboratory operates with a minimum of expensive reagents on very tiny amounts of sample, and without any human intervention. It can readily be operated as a completely contained, battery-operated, hand-held device. Because the entire device can be produced by photolithography (photocopying on a silica chip), the cost of a single DNA lab-on-a-chip can eventually be below $10!

Seven Enigmas

If the DNA lab-on-a-chip illustrates the creative accomplishment that can result from individuals of multiple disciplines bringing their various contributions to bear on a well-defined task, **Seven Enigmas** represents a more unusual collaboration. This project, a work of seven dances, had its very nature defined by the creative interaction of disparate disciplines addressing the issue of how humans approach the enigmatic and become affected by it. It is a celebration of "some of the many possible responses [of humans] in the face of incomprehensible mysteries and unreachable knowledge."

The video and the brochure from the September 1997, Power Center performance of **Seven Enigmas** relates how this artistic process was created using the varied talents of a dancer and choreographer (Prof. Peter Sparling); a creative painter and set designer (Prof. Jim Cogswell); a video artist and film maker (Robert Anderson); a space physics scientist (Dr. John Clarke); a neurobiologist, morphometrician, and mapper of the human brain (Dr. Fred Bookstein); a keyboard synthesizer musician (Daniel Roumain); and a host of other talented faculty, staff and graduate students. Biological landmarks of the human brain, images of distant galaxies, gyrating morphs, and striking sculptural forms combine with the dancerÕs movements to convey glimpses of the process of inquiry.

In this instance, space physics, mathematics, neuroscience, the visual arts, music, electronics, video and dance all contributed ideas and expressions to a project that was truly at disciplinary intersections.

Expenditures in Support of Research

The numbers for FY 1998 look superb. The details are presented in OVPR Report to the Regents, 1998.

As in all recent years, the UM faculty continued to increase its volume of research measured by research expenditures (Report, page 2). Now approaching the 0.5 billion dollar mark, the annual rate of expenditure has been climbing for many years, and, as demonstrated in the charts and slides, has almost doubled in the past decade. The increase in expenditures over FY 1997 was 7%, probably sufficient to assure our retention of the number one position in the nation.

Federal agencies continue to provide the lionÕs share of the support, accounting for 65.0% of the total (Report, pages 3 and 4).

The profile of subject areas supported by research expenditures shows little change over the past decade, with the life sciences continuing as the most prominent sector (45.5%) (Report, pages 8 and 12). With a projected 15% in the budget of the National Institutes of Health or FY 1999, and the continuing eagerness of the American populace to support health research, there is little reason to expect a downturn in this area.

Never in recent memory has there been so much verbal support of basic research in Congress. We should take advantage of this momentum and should throw full support behind the proposed federal science policy plan of Representative Vernon Ehlers. One must keep in mind that Congress has not faced the difficult issue of the growth of the entitlement programs within the federal budget. As a result, the current level of support of research has an uncertain fiscal base, and the University would do well to continue to cultivate other sources of research funding.