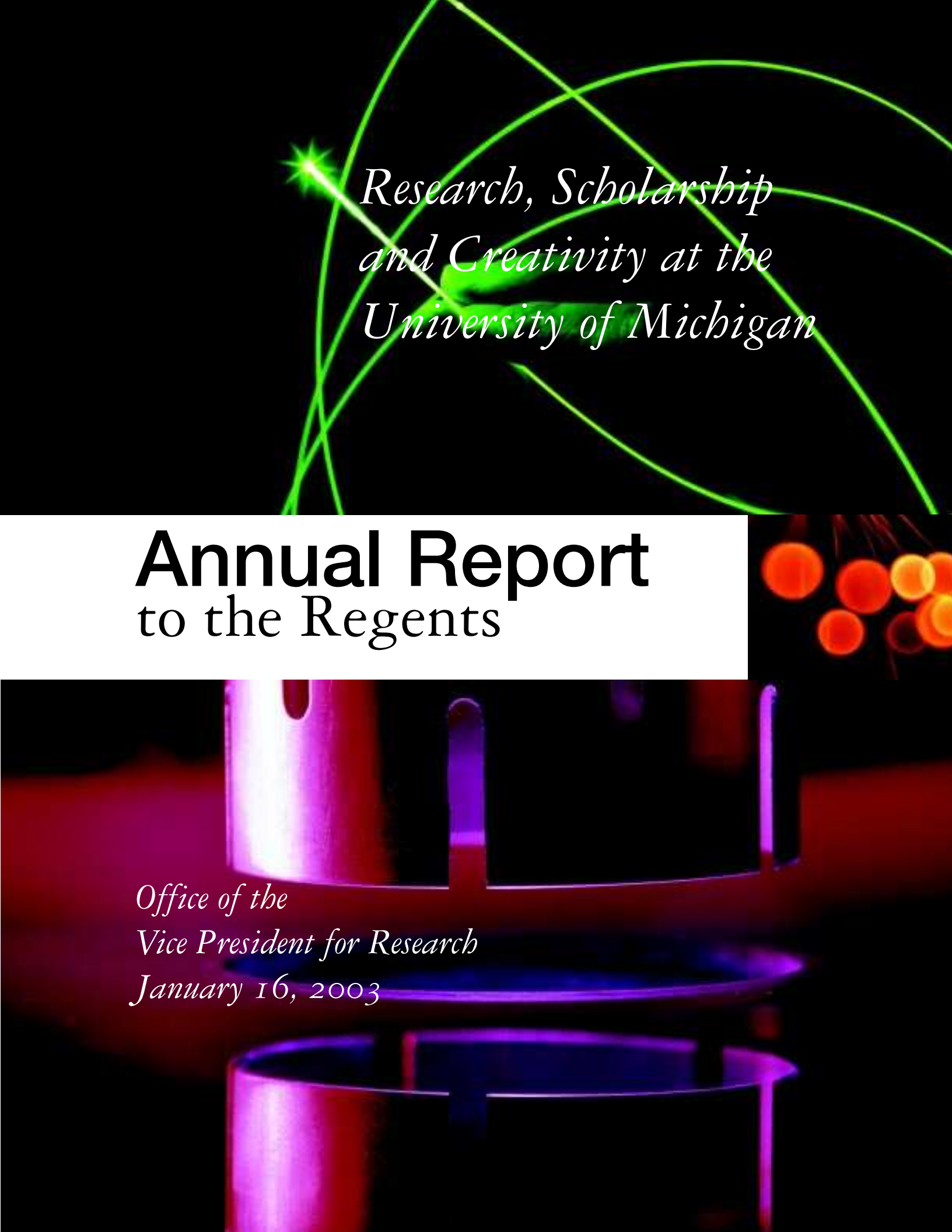


Research, Scholarship and Creativity at the University of Michigan

Annual Report
to the Regents

Office of the
Vice President for Research
January 16, 2003

Dear Colleague:

We are delighted to present the Annual Report to the Regents on Research, Scholarship, and Creativity at the University of Michigan for FY2002.

There is much good news to share about creative research and scholarship by our faculty and students. Last year, the University's research expenditures rose for the twentieth straight year. Almost $656 million was spent on research that will help to carry out the University's mission to serve the people of Michigan and the world.

In addition, there is a new vision for the Office of Technology Transfer that already is winning accolades for "exemplary success" in commercializing technology and promoting entrepreneurship in the state of Michigan.

We are certain you will find this information of great interest. Please contact either of us with your questions or comments.

Thank you.

Best regards,



Mary Sue Coleman
President



Fawwaz T. Ulaby
Vice President for Research

Contents

Executive Summary 1

Part I

Profile of Research Funding, FY2002 2

Federal Research Funding Outpaces Federal Budget's Growth 3

Invigorating Research: The School of Natural Resources and Environment . . 4

Vision and Creative Growth: The School of Nursing 5

The Research and Scholarship Continuum 6

Part II

The University of Michigan Office of Technology Transfer: A Transformation in Progress 7

The Past 8

The Transition 8

The Transformation 10

OTT Changes Since 1996 10

Arbor Networks: The Sweet Flow of Success. 13

HandyLab: Getting a Sense of the Future 14

IntraLase: An Eye for Perfection 15

The Future 16

Executive Summary



What spells "success" at a large research university? Without a doubt, it is the number and volume of research grants that provide important research opportunities for faculty, researchers, graduate students, and undergraduates. Success is also determined by the range and scope of the research—and its usefulness to society.

FY2002 was an award-winning year for University of Michigan research. The Institute for Scientific Information ranked UM No. 9 in a report examining the impact of research at the nation's top 100 federally funded U.S. universities in 21 fields, as measured by the citation impact of research papers. In addition, the Michigan Economic Development Corporation (MEDC) honored the Office of Technology Transfer for "Exemplary Success in Commercializing Technology and Promoting Entrepreneurship in Michigan."

The MEDC award is especially gratifying. For several years, it has been apparent that alumni, the business community, State of Michigan officials, and the press have been disappointed in the University of Michigan's showing in the area of technology transfer. Yet the UM Office of Technology Transfer was the only university technology program to receive the award. Right now, Technology Transfer is in the middle of a ten-year transformation that includes a new staff mandate, new resources, new energy—and a new technology transfer vision worthy of the University of Michigan. MEDC recognized the changes that already have taken place and has confidence that our plan for vitality will come to fruition.

In these uncertain economic times, all of our sponsors—federal, state, and local government; industry; individuals; and foundations—continue to have faith in us. In fact, this year marks the 20th straight year of research increases at the University. Research expenditures increased by 10.8%, bringing the total to nearly $656 million. Led by a 17% boost in funding from the Department of Health and Human Services (which includes the National Institutes of Health), the percentage increase is the largest in more than ten years, and resulted from growth in nearly all major areas of research. We also have faith in ourselves: The University allocated more than $100 million for research, a 6% increase from the previous year.

Our success is evident from the smallest units to the largest. Featured in this report are the School of Nursing and the School of Natural Resources. We will share a brief analysis of why research activity for each is doing so well.

The awards and the research expenditures demonstrate the foundation we have laid, the impact we are making, and the good story we have to tell. Part 1 of this report elaborates on how well the University of Michigan educates students and conducts valuable research; this section includes important financial information. Part 2 shares OVPR's perspective on technology transfer's past and present—and the brilliant future we have planned.

Important research culminates in something that is useful to society. Vital technology transfer demonstrates how a research university fulfills its obligation to society in important economic ways.

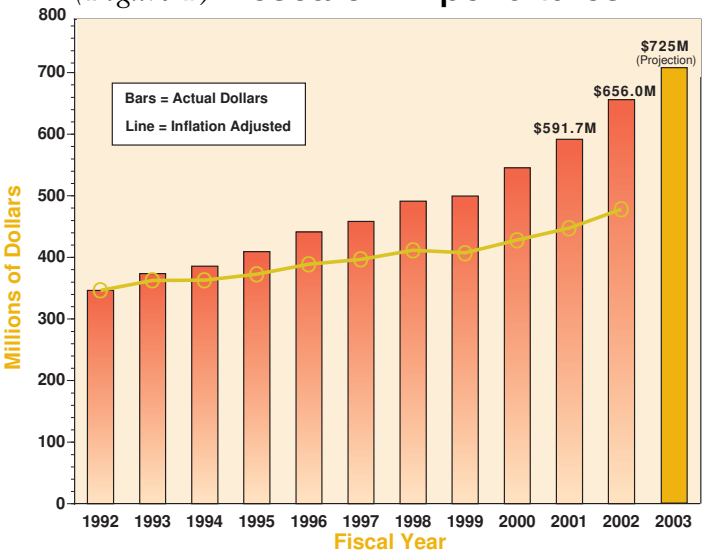
By all counts, University of Michigan research is alive—and thriving!

Part I:

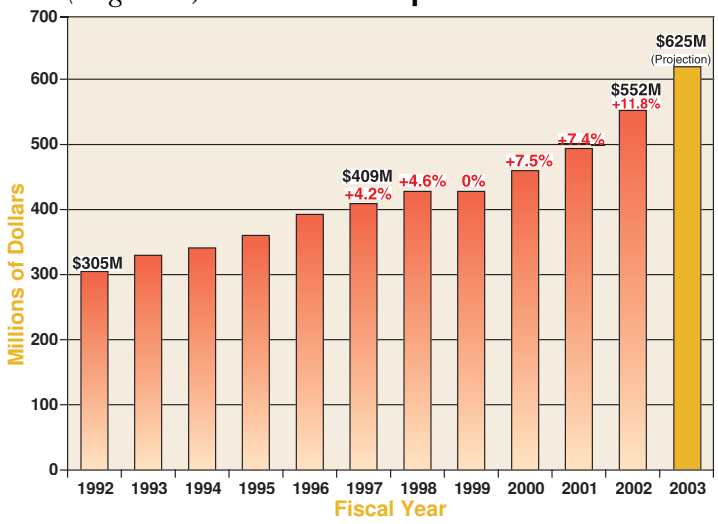
Profile of Research Funding, FY2002

There is much good news to share about University of Michigan research. Despite weak economic times, all of the UM's sponsors have valued the research proposals of the faculty and seen to it that Michigan received research funding that will help sustain its vitality. Once again, federal, state, and local government; industry; and foundation sponsors outpaced their grants and awards from previous years. For the tenth straight year, the UM's research expenditures have risen, with FY2002's $656 million in research expenditures almost double that of ten years ago (Figure 1). The same is true for research expenditures from external sources (Figure 2). And the value of research awards jumped to $741 million, about $50 million over last year's total, and more than double the value of awards received ten years ago (Figure 3).

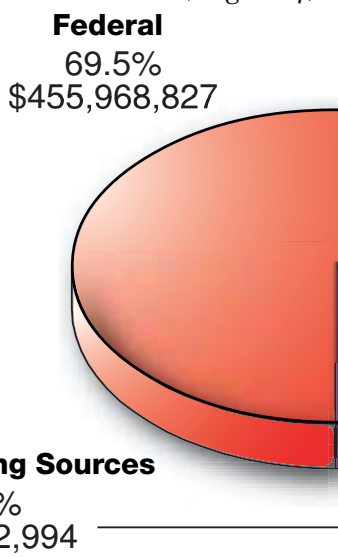
(Figure 1) **Research Expenditures**



(Figure 2) **External Expenditures**



(Figure 4)

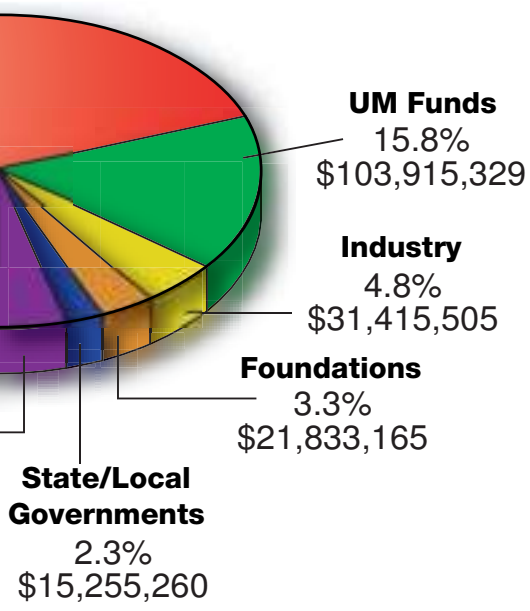


Federal Research Funding Outpaces Federal Budget's Growth

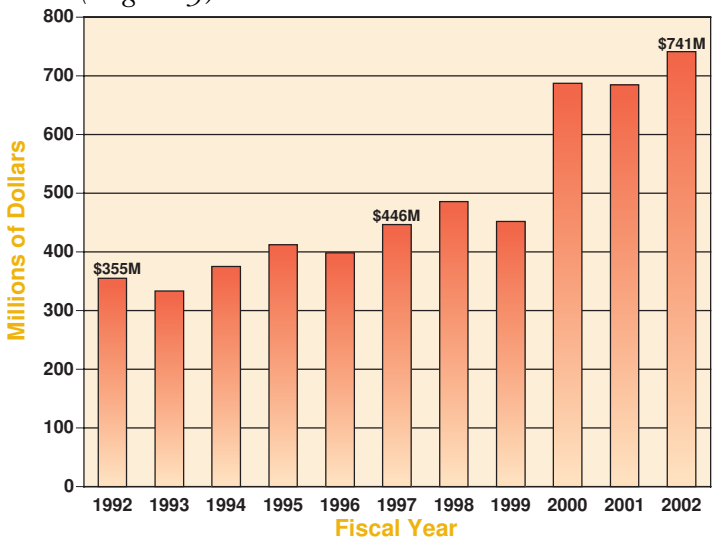
The federal government's confidence in UM research continues. More than two-thirds of our annual research expenditures stem from federal agencies (Figure 4). And for the sixth straight year, the University has captured an ever larger share of federal research dollars as demonstrated by larger growth rates (Figure 5). Outstripping the federal research and development budget's growth by 24.5% between 1996 and 2002, the University continues to grow at a rate two times faster than total federal R&D expenditures.

The University is also involved in some very important research funded by the State of Michigan—specifically, the research funded by the Michigan Life Sciences Corridor (MLSC) initiative. In FY2002, UM faculty conducted some $9 million in research activity with MLSC funding, including serving as the home for two core technology sites focusing on proteomics and bioinformatics. These research areas show great promise, both scientifically and in the prospects for developing valuable technologies that the private sector will be able to put to use for the benefit of society.

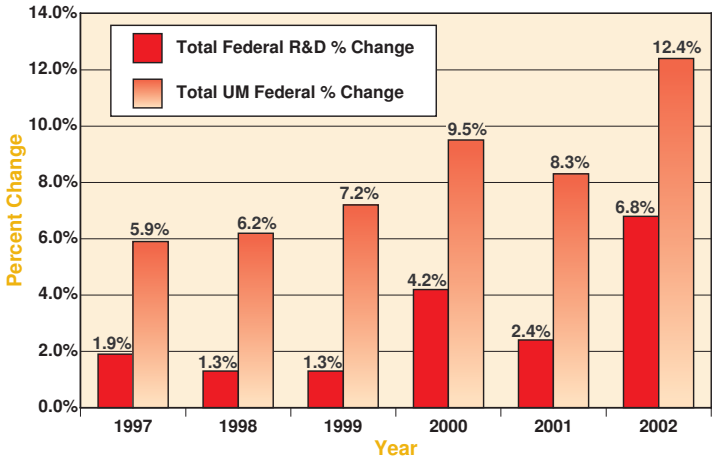
Expenditures by Sponsor



(Figure 3) **Research Awards**



(Figure 5) **UM vs. Federal Growth**



School and College Highlights

The 2001 Report to the Regents included information about research growth in our largest units: the Medical School, the College of Engineering, and the College of Literature, Science and the Arts. We also provided data on three "rising stars": the Institute of Social Research, the School of Public Health, and the School of Education, which experienced exceptional growth during the last several years. To date, these units continue to thrive and grow at a rate similar to what was reported last year.

This year, we feature two smaller units whose research is equally vital to society: the School of Nursing and the School of Natural Resources and Environment. They are making excellent strides in growing their research activity, and each unit shares its interpretation of why its research area is doing so well. The charts (Figures 6 and 7) show their research expenditures from external sources.

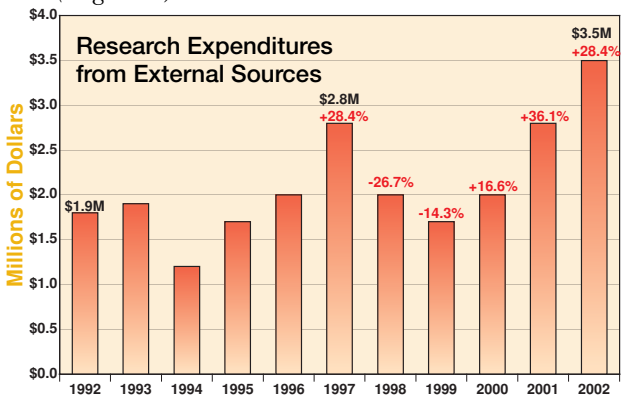
Invigorating Research
The School of Natural Resources and Environment

Research growth in the School of Natural Resources and Environment (SNRE) is the result of four major stimulants: the recruiting of a dynamic dean in the person of Rosina Bierbaum; the hiring of new faculty, including endowed faculty appointments; multi-faculty initiatives; and new research theme areas.

SNRE has been extremely successful in making new faculty hires in the last few years. A number of these individuals have been hired into senior endowed faculty positions—either through external searches or by promoting current senior faculty members—and these individuals have been extraordinarily successful in generating new research funding. In particular, those working in the area of Sustainable Systems and Ecosystem Management have attracted many successful projects. Similarly, newly hired junior and senior faculty have brought into being a number of new research programs and funding very soon after taking up residence at Michigan. The promising area of Spatial Analysis has grown dramatically and is generating some exceptional externally funded programs.

Multi-faculty initiatives, in areas such as Environmental Justice, have also obtained phenomenal external research sponsorship. At the same time, SNRE is extremely pleased to report that "traditional" faculty grants with single principal investigators also expanded in number and in funding level.

(Figure 6) **School of Natural Resources**



In September 2002, the School completed a reorganization of research concentrations into interdisciplinary theme areas: Great Lakes, Global Change, Sustainable Production

and Consumption, and Ecosystem Management and Conservation Biology. Seminars, symposia, and research grants will be the logical outcomes of this refocusing. The change has already borne fruit, as faculty groups interested in several of these themes have generated promising proposals. The Great Lakes theme also will be enhanced by the recent shift of the Michigan Sea Grant program and the Cooperative Institute for Limnology and Ecosystems Research (CILER) to SNRE, establishing in the School a critical mass of research in this area.



Vision and Creative Growth
The School of Nursing

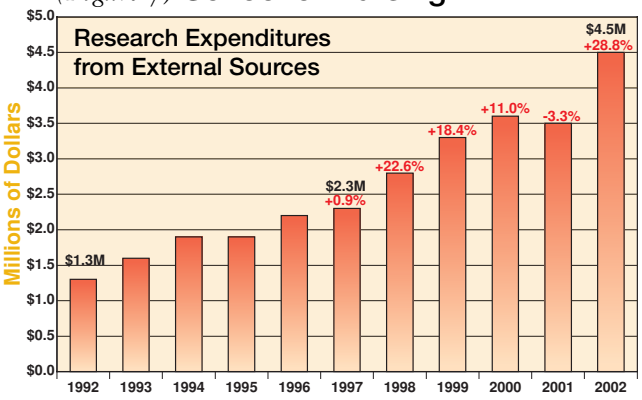
For the last few years, Nursing's leadership put in place a superb infrastructure that is, in essence, very research and grant "friendly."

The Nursing School's Grants and Research Office team coordinates the proposal-planning process, ensuring that the mechanics of proposal submission function smoothly. This enables the Principal Investigator to focus on the science or the training mission.

Now, the School is developing a parallel process to ensure that junior scientists benefit from senior investigator expertise. As a junior faculty member's first major extramural proposal is developed, four or five principal investigators and the School's proposal writer form a "science team" for the proposal. The team holds meetings that focus on the specific aims of the proposal and how they will be achieved. The science team also does a mock review with the junior scientist, using National Institutes of Health study section protocol. Should the proposal not be "funded" in the first mock review cycle, the science team meets with the Principal Investigator to hold a "remodeling party" to strategize about appropriate revisions.

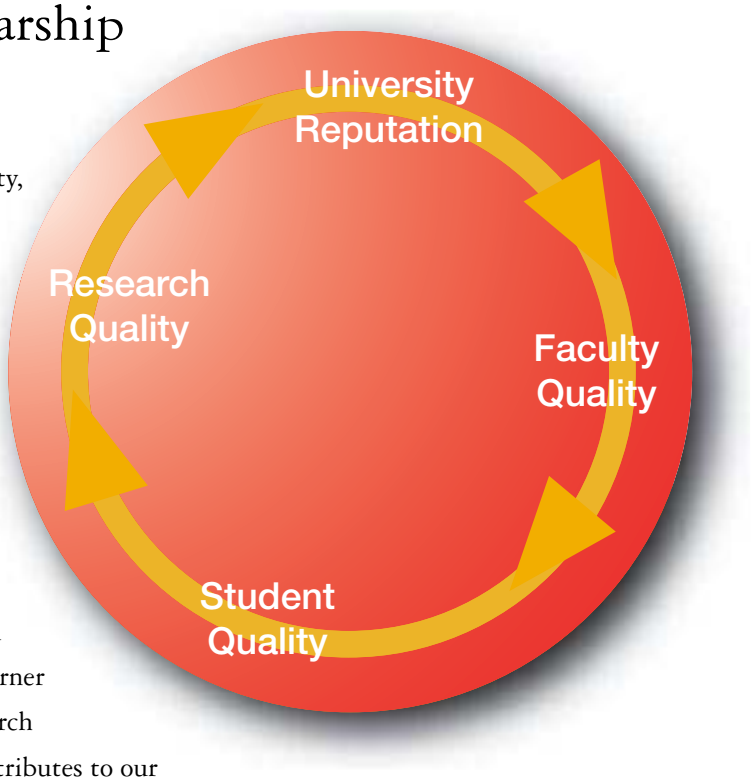
At the federal level, the current emphasis on addressing health disparities—fueled even more by the recent Institute of Medicine report about the disproportionate morbidity and mortality burden borne by underrepresented ethnic/racial groups—fits well with the research interests of the School of Nursing faculty. The School is well positioned to respond to recent Requests for Applications, and has submitted successful proposals for an Exploratory Center focused on health disparities and for an interdisciplinary program aimed at understanding women's health disparities.

(Figure 7) **School of Nursing**



Finally, the School's three Centers of Excellence—Cognitive Function, Frail and Vulnerable Elderly, and Health Promotion—provide a rich environment for the incubation of research and training innovations.

The Research and Scholarship Continuum



Reputation. Mention "The University of Michigan," and the name signifies quality, purpose, and excellence. Part of that reputation lies in the integral relationships of the people who make up the university—and the work we do here.

At Michigan, the relationships are a continuum. Our national reputation attracts superb faculty and excellent undergraduate students. The top-notch faculty, in turn, attract stellar graduate students. Faculty, graduate students, and even undergraduate students, working together, garner research grants and awards, and conduct research that is both worthy of our reputation and contributes to our society's quality of life.

One indicator of the UM's success in keeping all of these factors spiraling ever upward appeared in a recent report from ISI (Institute for Scientific Information), which placed the University as the ninth-ranked U.S. university in terms of "research impact." ISI made this determination based on the large number of scientific papers by UM faculty which appeared in the top journals in 21 different fields of study between 1997 and 2001.

Juxtapose this indicator with the growth in research expenditures and it's no surprise that the University enjoys an exceptional reputation. It all fits together. And it's all at Michigan.

Highest Impact U.S. Universities, 1997-2001

(Ranked by frequency of Top Ten appearances in 21 fields)

Rank	University	Top Ten Appearances
1	Harvard University	15
2	Stanford University	11
3	MIT	9
4	UC-San Diego	9
5	Yale University	8
6	UC-Berkeley	8
7	Columbia University	8
8	Caltech	7
9	**University of Michigan**	**7**
10	Duke University	6

Source: Science Watch, Vol. 13, No. 5-6, 2002

Part II:

University of Michigan Office of Technology Transfer
A Transformation in Progress

Around the world, emerging technologies are becoming the drivers for the creation of new wealth. More and more, the United States relies on the fruits of academic research for its own new technologies that, in turn, help create the country's new wealth.

With the passage of the Bayh-Dole Act in 1980, universities became active participants in the process of commercializing inventions. This new source of economic development propelled universities into the commercialization marketplace. Although commercialization of university discoveries was slow at first, over the last 10 years, the national pace has quickened—since 1991, faculty disclosures of inventions have grown 65%, licensing agreements have increased by 135%, and royalty levels are more than 250% larger.

Why is technology transfer important? Briefly, with new technology developing at exponential rates, technology transfer is the lifeblood of new economic activity. This allows us to accomplish our core mission: to transfer University technologies to the market to generate benefits for the University, the community and the general public. However, success in the technology transfer arena cannot happen overnight. Such achievements take time, patience, and contributions from local and regional business partners.



The results of technology transfer—greater societal good, improvement of the quality of life, and economic development—contribute to the University of Michigan's own core missions of education, research, and service.

Today, the University is committed to raising its technology transfer standing so that it is among the top five programs in the nation by 2006. This section of the report explains how we will get there—and what we have done to prepare for the future.

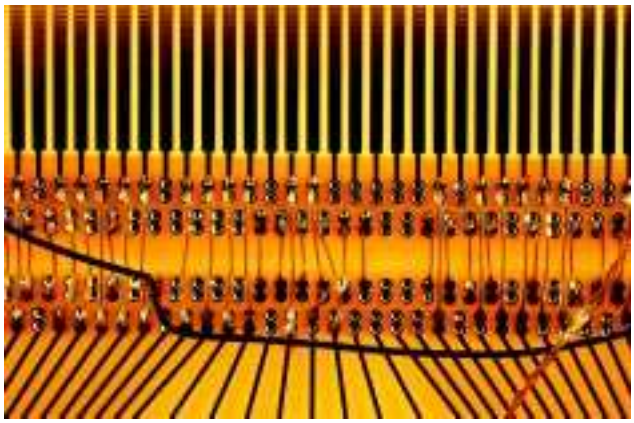
TT Timeline | **1980** Bayh-Dole Act passed | **1983** First UM tech transfer (TT) office | **1983** Regents' Policy on Intellectual Property

The Past

Until recently, technology transfer at the UM has been relatively undistinguished. In 1983, the University established a technology transfer office, but relative to peer research institutions like the Massachusetts Institute of Technology and Stanford University, the UM had a small budget and few staff people. Because of this, some people thought that the University didn't place a high priority on technology transfer. Many faculty felt discouraged about participating, and technology transfer staff morale was low.

Ann Arbor's distance from the concentrated centers of banking on the east and west coasts—and its relative lack of entrepreneurship and venture capital—also discouraged an entrepreneurial approach to research and technology development.

The Transition *1996-2001*



During the past five years, the UM's technology transfer efforts have undergone a transformation that was the result of a variety of forces, including increasing faculty expectations and growing interest by the State of Michigan in the role of universities in economic development.

In 1996, with the support of Vice President Homer Neal, the University established a new Regents' policy. Despite the fact that technology transfer had been perceived as peripheral at the UM for many years, the policy deemed this activity to be an important University mission. The policy:

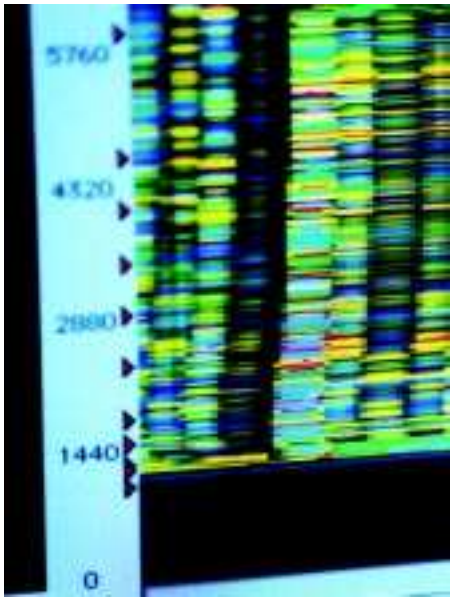
- urged Schools and Colleges to support their faculty's technology transfer efforts, and
- paved the way for increased focus on start-up companies by allowing faculty to continue to work in research areas in which they might have a commercial interest, as long as there was strict oversight and conflict-of-interest management.



Marvin G. Parnes, Associate Vice President for Research, was assigned the task of addressing the deficits in the University's technology transfer program. Armed with the new policy, Parnes advocated for additional resources and practices designed to reduce technology transfer barriers. In addition, he supported initiatives to reach out to the national and regional business communities, and to knit together efforts from two major units, Medicine and Engineering, to identify their priorities for technology transfer. In an effort to reposition and redesign the program, he became Interim Director of the Office of Technology Transfer (OTT) in fall 1997 and served through January 2001.

During this period, the Medical School appointed a faculty committee to review technology transfer issues. A joint planning activity with the Office of Technology Transfer and the Office for the Vice President of Research resulted. The Medical School established the Office for Technology Transfer and Corporate Research, which reported jointly to the Dean's Office and the Interim Director of Technology Transfer, with Elaine Brock as Director.

In 1999, when Fawwaz Ulaby stepped into his role as Vice President for Research, he quickly determined that there was a need to develop a coherent University-wide stance on the role of technology transfer and the kind of institutional commitment required to achieve its potential at the UM. This led to an unprecedented day-long technology transfer retreat that included key executive officers and deans, as well as several consultants from highly successful peer institutions. Three major outcomes resulted:



- a consensus that the UM is seriously committed to technology transfer and would act in a unified fashion to promote a technology transfer program commensurate with Michigan's excellence in research.
- the assertion that a strong technology transfer program promotes the public benefit of research results, supports the professional development of participating faculty and students, and fulfills the University's responsibility as a public institution to contribute actively to the economic development of the state and the nation.
- the commitment both by the Provost and the Vice President for Research to provide improved resources and coordination across the campus and recognition that resources were critical for success in technology transfer.

Soon after, College of Engineering Dean Stephen Director appointed a faculty committee to review related issues. This led to the creation of a satellite Technology Transfer office in the College, reporting to the Dean's Office and the Interim Director of Technology Transfer, with Tim Faley as Director.

Legal services also were reviewed, and Vice President and General Counsel Marvin Krislov made it a priority to provide high-quality legal services for technology transfer. OTT legal staff was incorporated into the Office of the General Counsel, and new arrangements were forged with outside counsel.

TT Timeline

1996 Regents declare TT a UM mission | **1997** Marvin Parnes, OTT Interim Director | **1998** Medical School/OTT satellite TT office | **1999** UM Leadership TT Retreat

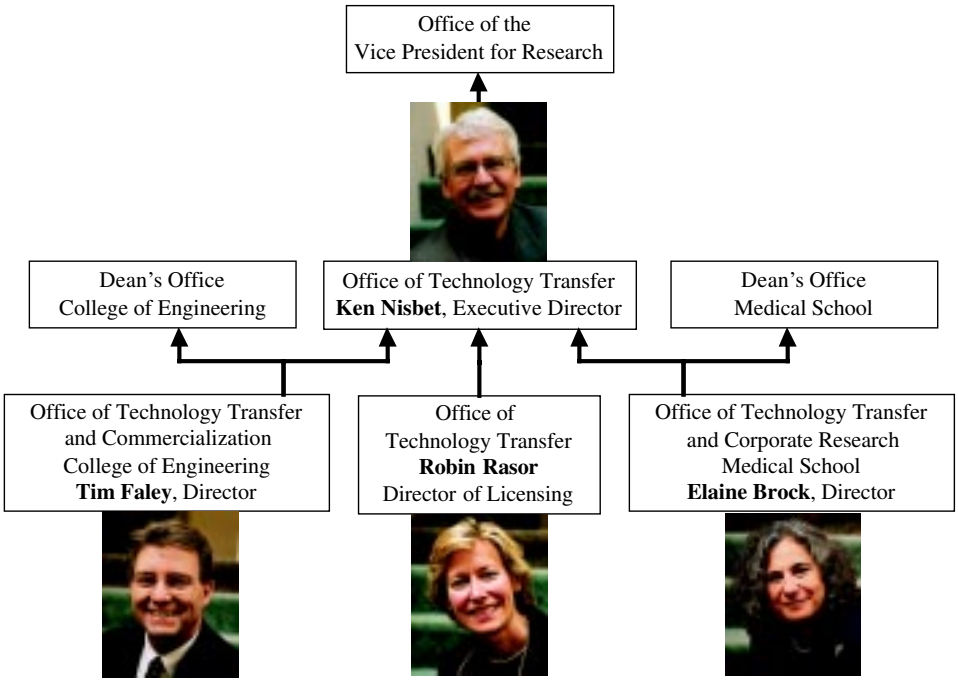
The Transformation

In January 2001, Vice President Ulaby appointed Ken Nisbet as Executive Director of the Office of Technology Transfer and the two satellite offices in the Medical School and College of Engineering (see below). Previously, Nisbet served as Director of New Business Development. Perceived locally and nationally as a leader in university-based economic development and a champion of faculty participation in technology transfer, Nisbet continued the makeover of UM tech transfer. He hired and transformed the staff, and built stronger ties with the business community. Working with Vice President Ulaby, he also organized a National Advisory Board composed of business leaders from around the country.

Office of Technology Transfer
Changes Since 1996

Resources and Staffing: The number of OTT staff increased markedly since 1996. There are now twice as many licensing specialists and professionals in start-up business creation. The new staff possesses a range of experience in business as well as academe. The budget for protecting intellectual property and engaging expert consultants grew fourfold, and as a result of matching funds from the state, OTT is leveraging University funds to expand the capacity to move research along the path to commercialization. Morale and energy is high. The staff is committed to providing professional service and seeing as much technology as possible get out the door of the laboratory or studio and into the marketplace.

Technology Transfer Organization



Structure: The two satellite offices in Medicine and Engineering coordinate closely with the Office of Technology Transfer to ensure that faculty are well served in their disciplines and that the special issues associated with technology and research in different fields are well understood. Faculty committees actively participate in making decisions about resource investments in technology. Strong links exist with the Business School and the Zell-Lurie Institute for Entrepreneurship; collaborations on class projects, student internships, and technology events take place frequently. Two intellectual property attorneys from the Office of General Counsel reside in OTT, providing legal assistance and responsive service.



University and Community Perspectives: The faculty and the business community view UM technology transfer in a vastly different—and positive—way. UM is seen as a leader in state economic development efforts and also is drawing interest from venture capitalists on both coasts. The local business community sees UM as open and welcoming of their interest and involvement, and the community is now a partner in the academic commercialization process.

Through the OTT TechStart Internship Program, now in its third year, students from the Business School, School of Information, College of Engineering, Medical School, and Law School have meaningful educational experiences as they lend their energies and expertise to UM technology transfer projects.

A clear expression of this change can be seen at the annual Inventors' Reception, which honors more than 500 inventors who have participated in the technology transfer process. The Reception celebrates invention by featuring technology exhibits, speakers, awards, and participation by campus and community leaders. The spirit and sense of engagement is palpable, and the new spirit of collaboration is evident among the Office of Technology Transfer, the individual units, and the community.

TT Timeline

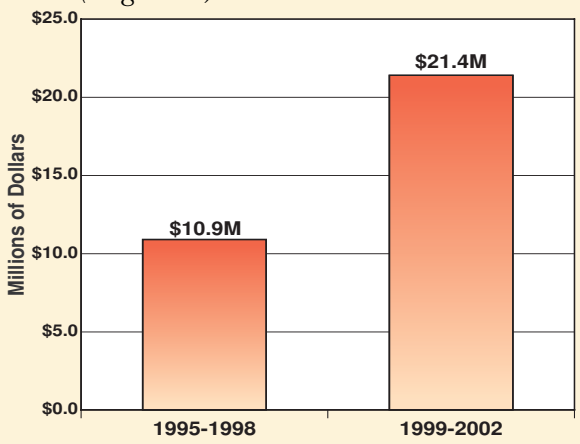
1999 College of Engineering/OTT satellite TT office

2001 Ken Nisbet, OTT Executive Director

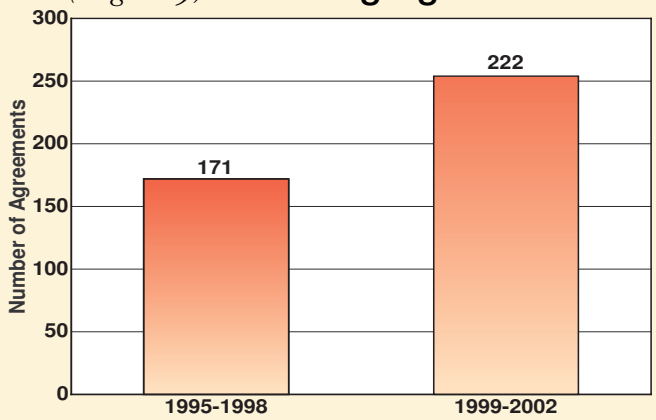
2002 OTT National Advisory Board

Tech Transfer: Indicators of Progress

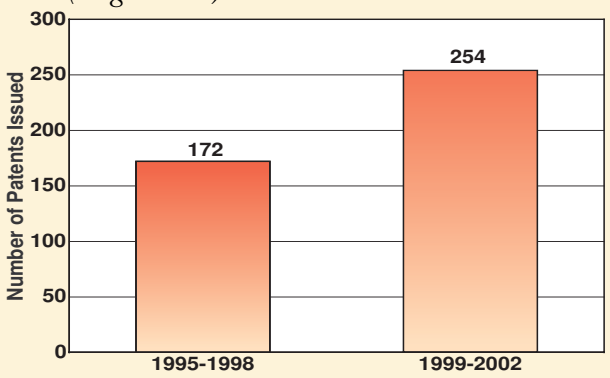
(Figure 8) **Revenues**



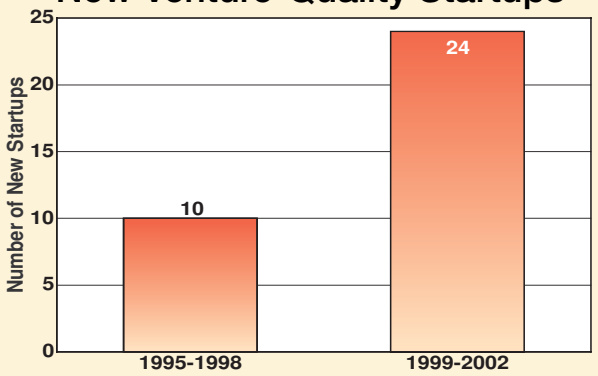
(Figure 9) **Licensing Agreements**



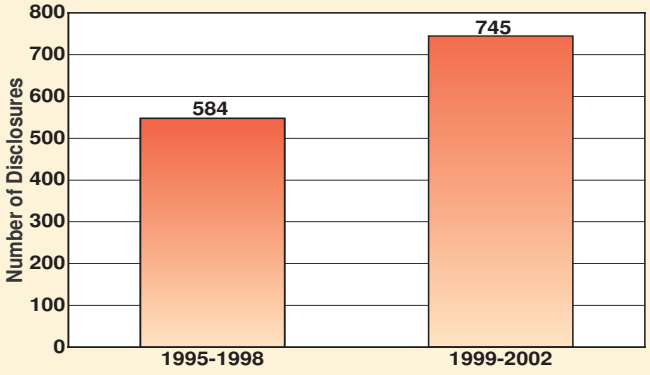
(Figure 10) **U.S. Patents Issued**



(Figure 11)
New Venture-Quality Startups



(Figure 12) **Disclosures**



Metrics: The traditional indicators of technology transfer success are moving toward the levels the UM is aiming for. A series of five charts compare the time periods 1995-1998 to 1999-2002, and show growth in revenues (Figure 8), license agreements (Figure 9), patents issued (Figure 10), "venture-quality" start-ups—new companies that attract significant outside investment (Figure 11), and faculty disclosures (Figure 12). By all of these measures, the University tech transfer operation is improving.

As a capstone to the growing awareness of positive changes in the UM's program, the Michigan Economic Development Corporation (MEDC) honored the Office of Technology Transfer for Exemplary Success in Commercializing Technology and Promoting Entrepreneurship in Michigan in 2001. OTT is the only university technology transfer program to receive such recognition.

And in December, 2002, the MEDC honored 12 Michigan-based start-up companies on the basis of innovation, success in the marketplace, and contributions to Michigan's economy. Three of the celebrated start-ups—Velcura Therapeutics, Quantum Signal, and Nephros Therapeutics—were launched with important assistance from the Office of Technology Transfer.

Success Stories

Behind the statistics and awards that show the growing successes of the UM technology transfer efforts are the real successes—the new technologies that have found their way to the market. What follows are short descriptions of three start-ups created based on discoveries made by Michigan faculty and students.

Arbor Networks
The Sweet Flow of Success



In the world of computer networks, firewalls and intrusion detection systems are not enough anymore. Network worms, denial of service attacks, and attacks on the computer infrastructure itself make security a top concern.

A solution came from the UM research lab of Dr. Farnam Jahanian, professor of electrical engineering and computer science, and the thesis work of Jahanian's then-graduate student, Dr. G. Robert Malan. Today, Jahanian (on left) and Malan are the co-founders of the extremely successful startup company, Arbor Networks, named by *UPSIDE Magazine* as a Hot 100 Private Company, and by both RedHerring.com (a web publication) and *Network World* as one of Ten Start-Ups to Watch.

Jahanian and Malan are quick to acknowledge the early contributions made by the Office of Technology Transfer. Jahanian says, "I credit Tech Transfer with helping us move through the start-up

process judiciously and get our technology to market quickly. It would have taken us an additional six months otherwise, and we would have missed important opportunities to raise money and capture emerging markets."

The past year was filled with milestones. At 64 employees, the company will soon outgrow its Ann Arbor and Lexington, Massachusetts, offices. In August 2002, Arbor announced that it raised $22 million in Series B financing from top-tier venture capital firms and strategic investors. Most of the new funding is earmarked for new product development.

HandyLab
Getting a Sense of the Future

In a birthing suite, a woman goes into labor. The nurse on duty quickly takes a vaginal swab, places it in a syringe containing a small amount of buffer solution, and injects the liquid into a port on a hand-held instrument. Then, by pressing a single button, the nurse triggers a fully automated DNA analysis. In less than 30 minutes, she'll know whether or not the baby has been exposed to Grade B Streptococcus, a potentially fatal pathogen carried by about one-fifth of new mothers, but treatable if detected early.



Thanks to a start-up company known as HandyLab—and the breakthrough findings of University of Michigan researchers—this scenario is being repeated in pre-clinical trials at the UM Medical Center and Baylor University. Within the next three to five years, the same on-site technology may be widely used for diagnosing a whole range of infectious and genetically-based diseases, and for detecting airborne pathogens such as anthrax and smallpox.

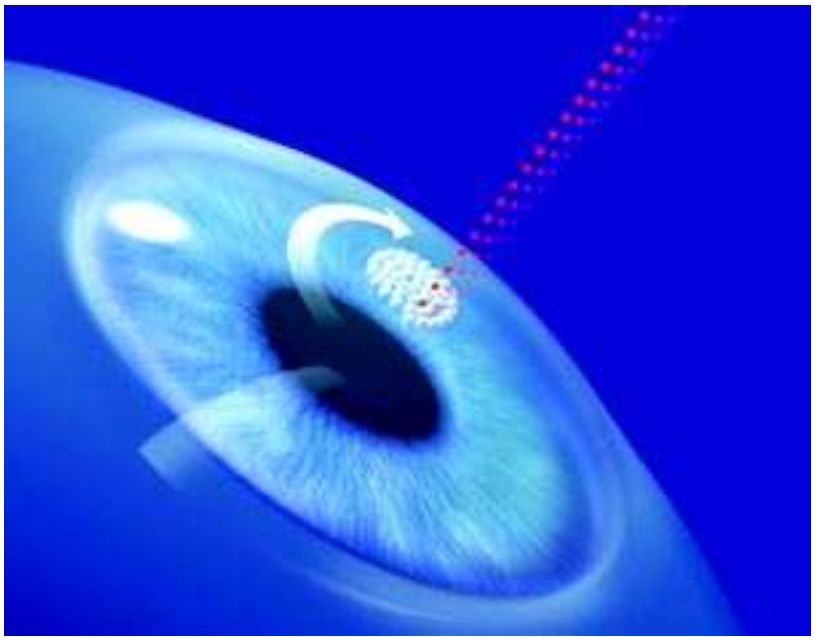
The research that drives these remarkable "nano-devices" was conducted over a seven-year period by chemical engineering Ph.D. students Kalyan Handique and Sundaresh Brahmasandra, Handylab's founders, and their faculty advisors Dr. Mark Burns (Chemical Engineering) and Dr. David Burke (Human Genetics). In 1998, their hand-held analysis systems earned a place on *Science Magazine's* list of Top Inventions of the Year. By June of 2000, the two scientists launched HandyLab to develop a growing number of portable and easy-to-use diagnostic test systems.

IntraLase
An Eye for Perfection

Every year, more than one million LASIK eye procedures are performed in the United States. For many patients, LASIK surgery provides freedom from glasses or contact lenses. Patients and surgeons alike are concerned that the surgery be performed perfectly and painlessly. Thanks to a collaboration at the UM Kellogg Eye Center and the Center for Ultrafast Optical Sciences (CUOS), that surgical goal is within reach.

In 1997, Kellogg's Dr. Ronald Kurtz, who conducts laser surgery research, saw the potential of harnessing femtosecond laser technology, developed by CUOS Director and College of Engineering Professor Gerard Mourou, for laser eye surgeries. Kurtz contacted the Office of Technology Transfer, which helped formulate a concept and introduce researchers to commercialization partners.

Within a year, a local venture capital firm, EDF Ventures, forged a plan to use the UM technology, and leverage the expertise and infrastructure of an earlier laser company, Escalan (including the talents of Escalan researcher Tibor Juhasz) to produce a next-generation laser eye surgery system. The technology was licensed from OTT, EDF Ventures supplied the initial funding, and Kurtz and Juhasz founded IntraLase together.



IntraLase's ultrafast, minimally invasive lasers are used in next-generation eye surgeries, including vision correction, corneal transplants, and glaucoma. With IntraLase's products—which have received approval for medical use from the Food and Drug Administration—surgeons may avoid the complications related to the current "metal blade" system in common use for making corneal incisions. Compared with the laser that is traditionally used in LASIK surgery, the IntraLase laser uses a rapidly fired, very short pulse laser with minimal surface contact. With IntraLase's software, surgeons may design very precise, computer-controlled incisions at any depth within the cornea without the risk of damaging the surrounding tissue.

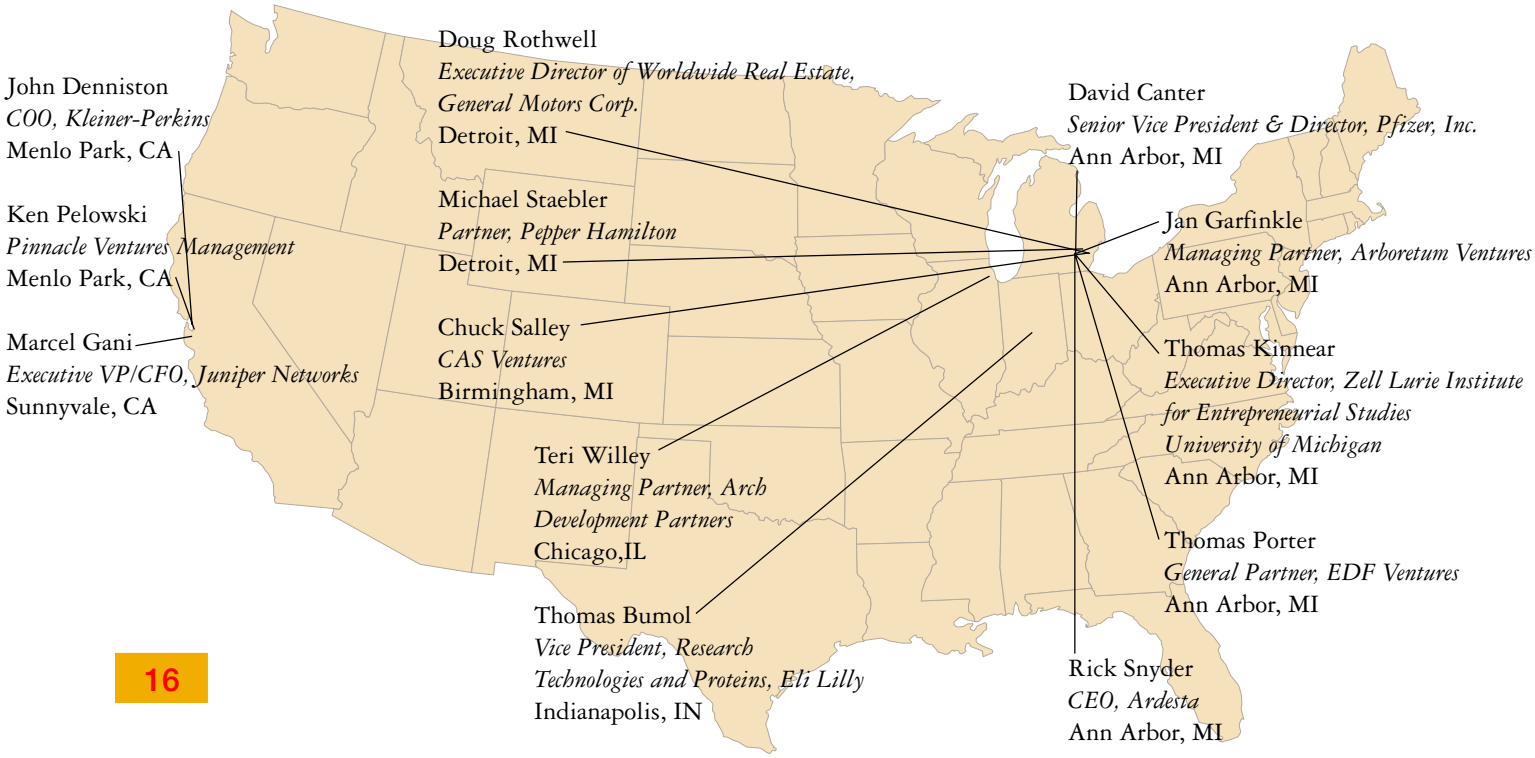
The Future
Goals for 2006

The University of Michigan is one of the top-rated public research universities in the nation and requires a technology transfer program that reflects this standing. The University is committed to raising its technology transfer ranking to be among the top five programs in the nation by 2006. We expect that the new National Advisory Board (below) will assist us in the process, providing feedback and guidance as well as practical assistance. At its inaugural meeting, the Board recommended that the University invest in more "gap funding" to make sure that the distance is narrowed between promising research in the laboratory and the development required to attract investors.

The University's program has come a long way in closing the gap, but many challenges remain. And the rewards from tech transfer investments often require years to realize. (DNA cloning was invented in 1973 at Stanford, but significant revenues were not realized until 1993!) But with the staff's talent, team spirit, and attitude; the increased excitement and engagement of our superb faculty; and the support of the regional business community and national networks, Michigan is poised to realize its potential as a source of valuable technologies in the many fields of research in which it is a leader.

With the full commitment and endorsement of the University, our technology transfer activities will fulfill the mission of providing the benefits of our research to the University, the community and the nation.

University of Michigan
Technology Transfer National Advisory Board



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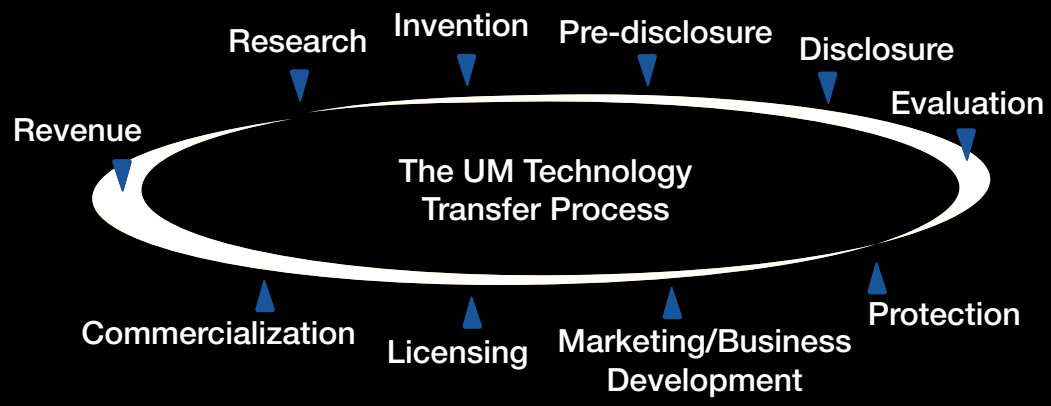
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