

**ECONOMIC IMPACT OF UPMC
STRATEGIC PLAN
PHASE II EXPANDS INITIAL IMPACT OF
PROJECT**

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October, 2000



*Research to drive informed decisions.
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ECONOMIC IMPACT OF URMIC STRATEGIC PLAN PHASE II EXPANDS INITIAL IMPACT OF PROJECT

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ECONOMIC IMPACT OF UPMC STRATEGIC PLAN

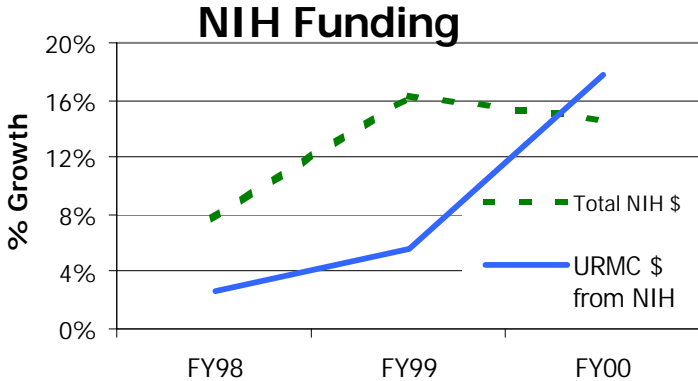
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SUMMARY

NIH Funding Growth Confirms Impact of Vision

In 1997, the University of Rochester Medical Center (URMC) engaged CGR to measure the economic impact of the Medical Center on the Rochester area and to forecast the effect on the region of a planned expansion in physical facilities and research activities. Subsequent to the issuance of that report, UPMC has been diligently pursuing the goals it set for itself in its *Strategic Plan*, filling nearly all of the projected 50 faculty positions with highly qualified individuals.



Figures released in early October 2000 demonstrate that the plan has substantially enhanced the research capacity of the Medical Center, as measured by funding from the National Institutes of Health (NIH). While total UPMC funding from NIH continued to grow during the period of intense faculty recruitment, the rates of growth

in 1998 and 1999 still lagged total growth in NIH funding. In 2000, however, UPMC grant funding from NIH increased at triple the rate of 1999, pushing the total to nearly \$90 million. While this represents only a single year, the statistic appears to confirm the expectation that the investment in new researchers and facilities will expand not just the University, but the community as well.

Confident in its vision, the Medical Center has launched a second phase that involves the construction of an additional building of 143,000 square feet and the recruitment of 35 new faculty. This report is intended to forecast the community economic impact of the second phase.

The Role of the University Medical Center in the Rochester Economy

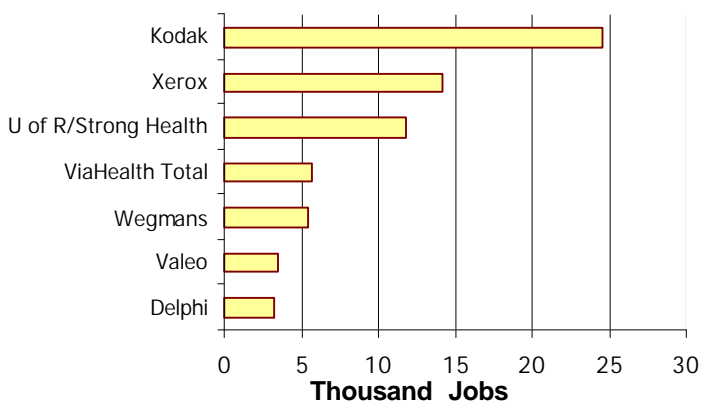
The Rochester economy is still viewed by many in the nation as a dependent of the Eastman Kodak Company. Kodak still plays an important role in the local economy and leaves a lasting legacy in the many institutions established by George Eastman and generously supported by the company since his death—including the University of Rochester School of Medicine and Dentistry. The community has grown beyond Kodak, however. As the world economy moves into the Information Age, the higher education sector has taken over from manufacturing as the linchpin of economic success.

Degrees Conferred (Bachelor's and Higher) 1996-97	
Field of Study & Rank (of 60 largest metros)	
All Fields	7
Biological & Life Sciences	3
Physical Sciences	3
Mathematics	3
Engineering & Related Degrees	5
Computer & Info Sciences	12
Visual & Performing Arts	1

Source: Atlanta Regional Consortium for Higher Education

The University of Rochester, along with the Rochester Institute of Technology, leads Rochester's seventeen colleges and universities. During the 1996-97 academic year, the Rochester MSA granted nearly 10,000 college & university degrees—many in key areas of technology such as mathematics, engineering, the physical sciences, the biological sciences and computer and information systems. On a per capita basis, Rochester ranks near the top of the 60 largest metropolitan areas in granting degrees in many critical fields, as summarized in the adjacent table.

Rochester's Largest Employers 2000



Source: Rochester Business Journal

The University of Rochester is now the metropolitan area's third largest employer, providing nearly 12,000 full time and an additional 2,500 part time jobs. Full time employment at the University increased 13% between the time of the first study in 1997 and the present.

The University Medical Center exemplifies the role played by higher education institutions in the New Economy. Rochester's growing biotech/pharmaceutical industry is anchored by URMC. As explored more fully in CGR's *Economic Impact of Vaccine Biology Initiative*, URMC's investments will stimulate innovation, which will spur job growth in the community. This is exemplified by the stellar contribution of the Haemophilus influenzae type b vaccine. Licensed to Wyeth Lederle Vaccines and Pediatrics (the former Praxis Biologics), this vaccine has contributed \$XX million in royalty income to the inventor and the University since 1993. In its 1997 report, CGR estimated that the annual contribution of Wyeth Lederle to the local economy of \$20 million.

At the time of the 1997 study, the University Medical Center was the fifth largest "export" employer in the metropolitan area, defined in terms of the amount of income drawn into the community from outside the metropolitan area. Continued growth at the medical center (much of it stimulated by the *Strategic Plan*), when combined with some shrinkage among Rochester's manufacturers, has propelled URMC into the third position. Only Xerox and Kodak exceed URMC's contribution to the metro economy.

Findings of 1997 Study

- ❖ Implementation of Phase I of the *Strategic Plan* will attract highly-skilled professionals to the Rochester area, adding **\$52 million** in **annual output** by 2000/01 and **\$75 million** by 2005/06.
- ❖ The **construction phase alone** will employ the equivalent of about **1,300 person-years** of labor and generate over **\$40 million** in employee compensation.
- ❖ **New, permanent employment**, both on-site and off-site, will total **585-615** by 2000/01 and **1,005-1,045** by 2005/06.
- ❖ **New annual employee compensation** by 2005/06 will total **\$31-33 million**, almost one third of the capital investment.
- ❖ URMC's investment in expanded research capacity will **spawn additional licensable technologies**, stimulating new jobs at the University and through spin-offs. An effort of this magnitude should stimulate **50 "invention disclosures"** per year. Perhaps **one-quarter of these will be licensed** to private firms—occasionally local start-ups—for further research and product

Total Project Impact			
	Phase I	Phase II	Total
Construction Phase			
Employment	1,300	370	1,670
Output	\$93m	\$40m	\$133m
Employee Compensation	\$41m	\$14m	\$55m
On-going Impacts			
Employment	1,025	220	1,245
Output	\$75m	\$15m	\$90m
Employee Compensation	\$32m	\$9m	\$41m

development. On average, each licensed technology will return **about \$90,000** in royalties to the University. New license revenue may eventually total one million dollars per year. In this manner, new discoveries will translate into additional research jobs at the University and, in some cases, research and/or

manufacturing jobs in local business firms.

- ❖ Phase II of the expansion, when fully implemented, will have an ongoing impact on the Rochester economy of over \$14 million.
- ❖ Direct and indirect compensation to individuals working on-site plus those working off-site will be \$8.4 million.
- ❖ Aggregate employment, both on site and off site, will total nearly 220.
- ❖ The construction phase alone will employ the equivalent of 370 person years and generate employee compensation of nearly \$11 million.

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ACKNOWLEDGMENTS

Staff Team

INTRODUCTION

The size of Rochester's economy is determined by its residents' ability to sell goods and services to individuals and firms outside the region and to efficiently meet the needs of residents through internal resources. The popular understanding of this fact focuses on firms that export products outside the region, particularly manufacturing firms. We intuitively recognize that when film, sunglasses, or photocopiers are shipped to Belgium, Japan or North Carolina in exchange for money, the local economy expands. Yet the essential characteristic of an export is the flow of funds, not the physical movement of a product. Economic activities that bring income into the region are vital to the economic base of a region. Firms that sell only to residents of the region are important, but don't increase the size of the regional economy and are not considered "basic" industries.

The University of Rochester Medical Center (URMC) does not sell a physical product. Yet URMC provides services and—through research—creates knowledge. This knowledge, while not shipped in a boxcar or in a semi-trailer truck, still represents the exchange of a product for compensation from outside the region. Similarly, services provided to individuals living outside the region constitute an export as they bring income into the region from another part of the state or nation. In the most important sense, then, URMC is a significant part of the economic base of the Rochester region.

The distinctive quality of the emerging Information Economy is that the share of value in the economy that is attributable to knowledge is rapidly increasing, relative to the share of value attributable to physical manufacturing. This new economy is often referred to as the "weightless" economy, as so much value is now derived from non-physical goods. The Industrial Revolution and the manufacturing firms that it spawned defined America's economy from the later part of the 19th century through most of the 20th century. The economy of the 21st century will be defined by information—and at the center of the Information Revolution is the university.

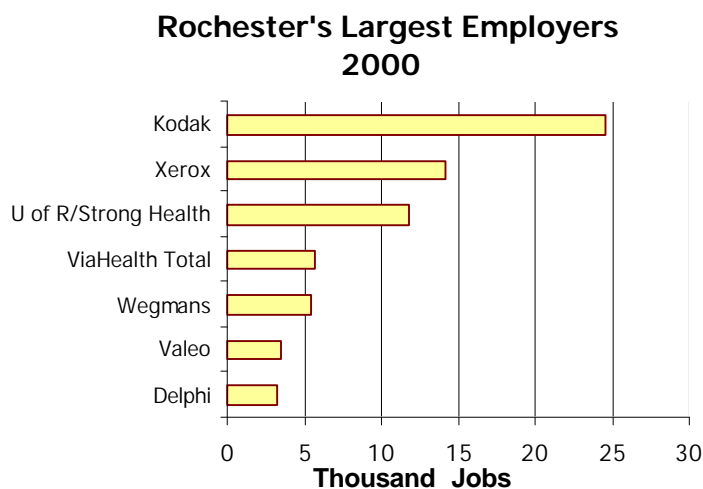
Just as the Eastman Kodak Company has defined Rochester for the nation in the 20th century, the University of Rochester and its fellow institutions of higher learning will define Rochester in the 21st. Kodak still plays an important role in the local economy and leaves a lasting legacy in the many institutions established by George Eastman and generously supported by the company since his death—including the University of Rochester School of Medicine and Dentistry. The higher education sector is positioned to assume the leadership of the Rochester economy in coming decades, however.

Degrees Conferred (Bachelor's and Higher) 1996-97	
Field of Study & Rank (of 60 largest metros)	
All Fields	7
Biological & Life Sciences	3
Physical Sciences	3
Mathematics	3
Engineering & Related Degrees	5
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Source: Atlanta Regional Consortium for Higher Education

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The University of Rochester is now the metropolitan area's third largest employer, providing nearly 12,000 full time and an additional 2,500 part time jobs. Full time employment at the University increased 13% between the time of the first study in 1997 and the present.



Source: Rochester Business Journal

The University Medical Center exemplifies the role played by higher education institutions in the New Economy. Rochester's growing biotechnology/pharmaceutical industry is anchored by URM. As explored more fully in CGR's *Economic Impact of Vaccine Biology Initiative*, URM's investments will stimulate innovation, which will spur job growth in the community. This is exemplified by the stellar contribution of the Haemophilus influenzae type b vaccine. Licensed to

Wyeth Lederle Vaccines and Pediatrics (the former Praxis Biologics), this vaccine has contributed \$XX million in royalty income to the inventor and the University since 1993. In its 1997 report, CGR estimated that the annual contribution of Wyeth Lederle to the local economy of \$20 million.

Nationwide Economic Importance of Academic Medical Centers

The economic impact of academic medicine on the economy is widely acknowledged. A study conducted for the Association of American Medical Colleges (AAMC) by Tripp, Umbach and Associates reported a combined economic impact of AAMC members of \$186 billion annually.¹ The consultancy notes that the direct impact of these institutions (reported as \$79 billion) exceeds the total value of shipments of most U.S. industries, including aircraft manufacturing (\$63 billion), steel (\$42.2 billion) and communication equipment (\$40 billion).

University of Rochester Medical Center

Strong Memorial and Highland Hospitals

Strong Memorial Hospital delivered \$464 million in patient care services between June 1999 and June 2000, employing over 7,400 people (both full and part time) with a budgeted 2001 payroll of over \$268 million. Although much of the service value provided to Monroe County residents would probably be provided by another hospital if Strong and Highland did not exist, less than two-thirds of patient service revenue to Strong Memorial comes from individuals living in Monroe County. Almost ten percent comes from individuals living well outside the Rochester metropolitan area.²

Thus, of Strong's total payroll of \$212 million, at least \$21 million can be considered an "export" of the Rochester area, increasing the size of our local economy and the diversity of employment opportunities in the area. This estimate is conservative for two reasons: (1)The services delivered to out-of-region and out-of-state patients are more sophisticated, likely requiring a higher skill level (and pay level) than the average level of services provided to local residents; and (2)Monroe County residents have local access

¹Tripp, Umbach and Associates, "The Economic Impact of AAMC Member Institutions," The Association of American Medical Colleges, November 1996.

² Strong Memorial Hospital, net revenue percentage by area June 1999 to June 2000.

to services that residents of other parts of the state and other states travel to receive, thus reducing the “leakage” of health dollars to other regions.

School of Medicine and Dentistry/School of Nursing

Full-time faculty and staff at the medical school and school of nursing number about 3,665 (plus nearly 700 part time), making these two schools the region’s sixth largest private employer and third largest “export” employer, slightly ahead of Valeo and behind Eastman Kodak and Xerox.

With 407 medical students, 307 Ph.D. students and 106 masters students, the School of Medicine and Dentistry and School of Nursing provide a wide variety of careers for its students ranging from laboratory and clinical research to professional practice in primary and specialized fields. The vast majority of medical students come to the University of Rochester from outside the local area. Fully 60 percent come to Rochester from outside New York. As these students come to campus, they bring tuition (\$19.2 million in 2000) that pays salaries on campus, and purchasing power (estimated at over \$10,000 per student) to buy goods and services throughout Monroe County.

The School of Medicine and Dentistry (SMD) also supervises medical residents who are placed in hospitals across the region, providing a highly skilled, inexpensive labor pool for these hospitals. While salaries are modest (by the standards of physicians), payroll to SMD’s 659 residents totals about \$22 million. Over a third of these residents are married and bring a family’s total consumption to the community. While a complex question to answer with confidence, the loss of these residents could drive up health care costs in the region as hospitals replace low-paid residents with physicians earning market rate salaries. A study conducted by a student from the University of Rochester’s public policy program estimated the benefit to the community at more than \$100 million.³

³Gretchen Guess, *Limited Cost/Benefit Analysis on Graduate Medical Education in Rochester, NY*. University of Rochester Public Policy Analysis Program, March 1996.

URMC Research

The School of Medicine and Dentistry provides more than just clinical training. A substantial number of SMD faculty are engaged in world-class research on topics ranging from clinical trials of drugs targeting diseases such as leukemia or Parkinson's disease to research into the fundamentals of human biology. Support for the research mission of the medical center comes from the National Institutes of Health, private foundations and corporations. These external sources also bring new money into the Rochester community from outside and pay the salaries of principal researchers, post-doctoral fellows, technicians and research assistants, the vast majority of whom live in the community and spend much of their income on housing, food and other items here in Rochester.

Research funding across all sources totaled about \$132 million in 2000. While substantial support comes to the University to support clinical drug trials; the majority of the funding comes from the National Institutes of Health.

Economic Impact of University of Rochester Medical Center: Third in Rochester MSA

The lifeblood of any economy is the core of firms and institutions that draw income from outside the region. Only by increasing this "outside" income can we boost the average income of our residents. Popular belief is that manufacturing firms are the only source of "basic" or "exporting" employment. Newspaper headlines focus tremendous attention on the loss of 50 or 60 manufacturing jobs. Yet, *any* institution that brings money from outside spurs local employment.

While the University of Rochester is clearly the third largest employer in the community, much of the University's total employment is at Strong Memorial and Highland hospitals and serves a local clientele. The Medical Center, considered as a separate economic unit, qualifies as part of the "core" economy to the extent that it draws income from *outside* the region, rather than just providing services to those who already live here. URMC does this in three respects: First, it draws patient service revenue from individuals who reside outside the Rochester metropolitan area. Second, it attracts students from outside the region to the School of Medicine and Dentistry. Third, it brings research dollars into the community from the National Institutes of Health, foundations, pharmaceutical companies and other funders.

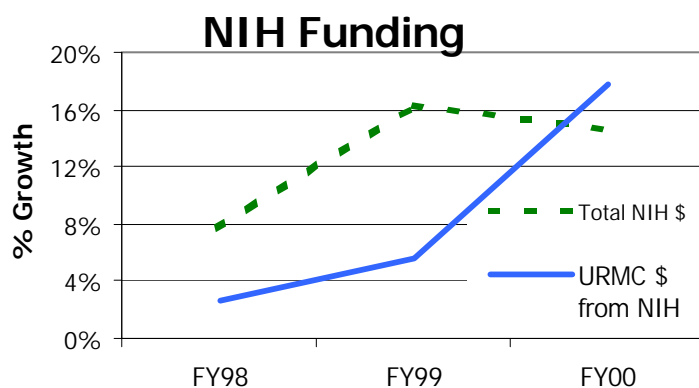
With the expansion of the Medical Center's research mission, CGR estimates that its contribution to the Rochester economy—independent of the rest of the University—is **third** behind Kodak and Xerox. The Medical Center adds more to the Rochester economy than Valeo, Delphi Energy Management Systems or Bausch & Lomb. Adding to its importance, the University of Rochester Medical Center is a particularly stable part of the economy, relatively insulated from seasonal and cyclical changes in economic conditions.

Economic Impact of Expanded Research Mission: URMC Strategic Plan

The URMC Strategic Plan was intended to increase the importance of the Medical Center within the medical research community, as measured by funding received from the National Institutes of Health (NIH). Although URMC funding from NIH has increased steadily over the years, its *share* of the total fell from 1988 to 1999. Given the competitive nature of academic research, this trend was disturbing and could force a downsizing of the URMC research facilities. Just like any other “basic” or “exporting” industry, a loss in high income direct employment at URMC would have a multiplied effect in the community due to the significant number of jobs supported by the spending of the URMC researchers.

NIH Grant Share Increases in 2000

The Medical Center has been diligently pursuing the goals it set for itself in the *Strategic Plan*, filling nearly all of the projected 50 faculty positions with highly qualified scientists. And the investment has begun to pay off: Figures released in early October, 2000 demonstrate that the plan has enhanced the research capacity of the Medical Center, as measured by URMC's



share of total NIH grant funding. In 2000, URMC grant funding from NIH increased at *triple* the rate of 1999, pushing the total to nearly \$90 million. While this represents only a single year, the statistic appears to confirm the expectation that the investment in new researchers and facilities will expand not just the University, but the community as well.

Construction Phases I and II: Economic Impact of New Facilities

The creation of a “state of the art” research facility through new construction, renovations, and new equipment expenditures of nearly \$113 million in the first phase and \$36 million in the second phase will have a substantial impact on the Rochester economy and is essential to the task of attracting top scientists to Rochester. The direct effects of these expenditures will lead to the creation of 1,300 jobs in the first phase and an additional 370 in the second, with a total compensation of \$40 million.

Operation Phase: Annual Economic Impact of Expanded Research

The addition of new, high-caliber researchers to the already strong base at the URMC will result in an increase in the size and number of grants and contracts received from the NIH and other sources. While this funding will further promote important research activities, it will also attract a more talented group of fellows and students to continue the growth of the Medical Center.

Phase I

Assuming that the goals set by the Medical Center are achieved, total employment stimulated—both direct and indirect—by the new research initiative will exceed 600 and personal income in the region will have grown by about \$20 million. By the year 2006, the Strategic Plan will be directly responsible for adding 645 jobs with total salary compensation of about \$24 million. As these researchers spend for personal consumption, research materials, and the maintenance of their labs, CGR estimates that \$75 million in total output will be generated, resulting in almost 400 additional jobs with nearly \$9 million in employee compensation.

Phase II

The second phase of the project involves construction of an additional 143,000 square foot building and the hiring of an additional 35 faculty and nearly 120 additional staff, mostly

	Total Project Impact		
	Phase I	Phase II	Total
Employment	1,025	220	1,245
Output	\$75m	\$15m	\$90m
Employee Compensation	\$32m	\$9m	\$41m

technicians and post doctoral fellows. The aggregate employment impact is expected to be about 220, adding \$15.2 million to total output and \$9 million to employee compensation.

The Phase II building will also have 25,000 square feet of additional space for future expansion. If populated with the same configuration of faculty and support staff, the annual budget will grow approximately \$2 million when the building is fully used.

Economic Impact of Royalty Income & Innovation Start-ups

The economic impact of this additional component will likely exceed \$2.5 million.

Support for government funding of basic research is desirable because private firms, unsure of being able to earn a reasonable return on investment from a general increase in knowledge, are believed to “underinvest” in basic research. Taxpayers must finance the kind of fundamental exploration that is unlikely to directly yield marketable products. Policymakers believed that all knowledge gleaned from taxpayer-supported research should be placed in the public domain.

Unfortunately, getting from the “invention” phase to a marketable product is time-consuming and expensive. If all knowledge acquired with federal support is released to the public domain, then private firms have little incentive to make the substantial investment required to turn a discovery into a product. While it may seem just that this knowledge belong to all, society is more likely to benefit from the knowledge gained if someone is assigned the right to profit from developing the idea into something with tangible—and marketable—benefits. In 1980, senators Birch Bayh and Bob Dole co-sponsored legislation (PL 96-517, called the Bayh-Dole Act) recognizing this practical economic reality and permitted universities to patent innovations funded by federal dollars. In intervening years universities have become increasingly adept at capturing the benefits of licensable technology. In its survey of 159 U.S. and Canadian universities, hospitals and research institutions, the Association of University Technology Managers reported that gross royalties received by surveyed institutions in 1994 totaled \$422 million.

The *Strategic Plan*, by dramatically increasing the level of research effort at the University, will surely stimulate the development of new licensable technology. The scale and value of licensable technology that will be stimulated by this investment is difficult to estimate, but is still a real and important “spill-over” benefit of the plan.

In a paper published in the *American Economic Review* in 1989⁴, Jaffe reports the results of a regression analysis of the relationship between university research and corporate patent activity at the state level. Jaffe found a strong correlation between the two—particularly for drug research—and infers from his data that it is university research that is stimulating industrial R&D, rather than the reverse. As much of Jaffe’s period of study (1972-86) preceeds the Bayh-Dole Act, it is reasonable to assume that the stimulative effect of university research is much stronger today.

*Haemophilus
Influenzae type b:
Wyeth Lederle
Vaccines and Pediatrics*

The *Haemophilus influenzae* type b (Hib) vaccine is the first approved for infants since the polio vaccine and is believed to have reduced incidence of bacterial meningitis in children by over 90%. David Smith, a former chairman of URMC’s pediatrics department, started Praxis Biologics in 1983 to commercialize a discovery made in his laboratory. More than \$43 million in royalty income has been generated by the license by 2000—almost all since 1991. Although the original patent expires just after the turn of the century, additional discoveries extend its life for an additional decade, ensuring a continued flow of royalty revenue for many years.

The success of the Hib vaccine is highly unusual. It would be unwise to suggest that another success of this magnitude is likely in the near future. *Technology Access Report*⁵ reported in 1996 that the royalty revenue from the Hib vaccine was among the 15 highest ever received by a university. At its present rate, it will enter the top ten within a few years. While a rare event, this case demonstrates the potential of technology transfer and the importance for the University of Rochester and the community of a continued focus on research and the successful transfer of technology to the private sector.

Of the \$43 million received from Wyeth Lederle, half has gone to the inventor and the remaining funds have been apportioned

⁴Adam Jaffe, “Real Effects of Academic Research.” *American Economic Review*, December 1989.

⁵Michael Odza, “Big Winners in University Tech Transfer.” *Technology Access Report*, April 1996.

across the University. Most of the University's share of the royalties has been reinvested in the research mission, paying the salaries of new researchers and stimulating more innovations.

More important to the community is the impact of the start-up company formed to bring the invention to market. Established in 1983, Praxis Biologics was sold in 1989 to American Cyanamid for \$220 million. Attached to American Cyanamid's Lederle division, Lederle-Praxis Biologicals continued to expand in the Rochester area, building an 85,000 square foot research and development facility in Henrietta in 1993. The company was sold again in 1994 as American Cyanamid was acquired by American Home Products. The company is now named Wyeth Lederle Vaccines and Pediatrics.

Wyeth Lederle's Henrietta facility employs 150-160 researchers and technicians.⁶ CGR estimates that the total budget of the facility is over \$25 million with at least \$10 million in payroll.⁷ Not only has the region attracted or retained over 150 skilled scientists and technicians, but their spending and that of the company has stimulated additional employment among the greater community.

Wyeth Lederle continues to maintain close ties with the University of Rochester, particularly the departments of Pediatrics and Infectious Diseases. Consulting fees and research agreements feed profits from the firm back into the University, increasing again the ability of the University to develop new innovations. Proximity to the University is prized by the company both for these intellectual ties and for the access to skilled, inexpensive labor drawn from University of Rochester and Rochester Institute of Technology students and graduates. Eager to develop new products from new innovations, Wyeth Lederle will provide a local R&D site for the knowledge "manufactured" in Rochester's new research facility.

⁶James Sciandra, Wyeth Lederle Vaccines and Pediatrics, personal communication, February 1997.

⁷Based on spending per R&D worker reported in U.S. National Science Foundation, *Research and Development in Industry*. Cited in *Statistical Abstract of the United States*, 1996, table 979. Adjusted for inflation by CGR.

*Massachusetts
Institute of
Technology: Economic
Impact of Product
Development*

Licensed technology adds employment and income outside the University even before a product is brought to market and begins to earn royalties. A 1995 study at the Massachusetts Institute of Technology⁸ estimates that licensing of university inventions adds more than \$20 billion and 150,000 jobs to the national economy every year. MIT focused its attention on the R&D spending of companies before a product is ready for market. By surveying firms with active licenses with MIT, the study reports spending per license per year to prepare a product for market.

MIT divided the sample into two parts, physical science and biotech. For the purposes of our study we are focusing our attention on the biotech results. We will report data acquired from start-ups and what MIT calls “small entities,” firms employing fewer than 500 workers (unfortunately, large firms in the biotech industry were unwilling to cooperate with the researchers). Averaged over 16 biotech licenses, firms reported spending \$1.92 million per year per license. The average age of the sample licenses was 4.5 years, slightly over half the 8 years generally required to bring a product to market.

The MIT data highlight the fact that start-ups are responsible for a disproportionate share of investment and job creation from university licensing. Investment by start-ups was over \$3 million per year per license, compared to about \$600,000 for other firms. Using the figure released by the National Science Foundation on total spending per worker in R&D industries (cited above), we estimate that the average start-up firm in the sample employs about 17 workers.

The Rochester community, while lacking Boston’s scale and diversity, is unique among cities of its size in the number of highly educated and skilled people working in high technology fields and in the presence of two world class research universities. Rochester is much more likely to become the site of new R&D facilities—either begun as start-ups or as branches of major firms—than many competitive metropolitan areas. The community already is

⁸Lori Pressman, *et. al.* Pre-Production Investment and Jobs Induced by MIT Exclusive Patent Licenses. Massachusetts Institute of Technology Technology Licensing Office, March 1995.

home to MDT Biologics, Medeva Pharmaceuticals (formerly Fisons) and Wyeth Lederle. As reported by Wyeth Lederle staff, Rochester's research universities continue to attract additional people to the community with training and interest in biotechnology. When the skilled work force is combined with support for new firms, particularly that provided in incubator space under construction on Bailey Road, Rochester has the ability to stimulate and support University of Rochester scientists who wish to follow in the late David Smith's footsteps and start their own firms.

There is a strong incentive for a technology licensee to maintain strong ties to the scientists involved in the original discovery. A study by Zucker and Darby⁹ asserts that the most productive bioscientists "play a key role in regional and national economic growth,...for those science-based technologies where knowledge is tacit and requires hands-on experience." The authors suggest that "star" scientists tend to form start-up companies rather than partnerships with existing firms. Their research indicates that the key factor in determining the location of new biotechnology enterprises is the proximity of these "star" scientists. When a successful initiative to attract scientific stars to Rochester's new facility is combined with the existence of an established research infrastructure, it is reasonable to expect some spin-off business formation. We cannot predict the *value* of future spin-offs or of R&D research occurring locally because of URMC innovation, but these will occur and will create new opportunities for residents of the region.

Forecasting Innovation and Its Benefits

Invention is, by its very nature, serendipitous. Nonetheless, universities report data on invention disclosures in relation to the amount of money spent on research, permitting some understanding of the expected number of discoveries for a given research investment. *Technology Access Report* summarized the ratio of invention disclosures to total research funding by university for

⁹Lynne Zucker and Michael Darby, "Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry." *Proceedings of the National Academy of Sciences* Vol 93, pp 12709-12716, November 1996.

1994¹⁰. The ratio ranges from one disclosure per \$500,000 to one disclosure for every \$5 million. The median for all institutions is one invention for every \$2.3 million in research investment. Rochester's experience is comparable to the university-wide median: In 1996, the University of Rochester reported 65 invention disclosures on a research budget of \$160 million, roughly one disclosure for every \$2.5 million in research spending. Institutions with a medical school reported one invention for every \$1.75 million in research investment. This is not surprising as biotechnology is known to be a more productive area for patentable research. Variation among institutions can be explained by the type of research under way at the facility, the institution's effort to identify inventions by researchers and the university's skill at finding appropriate private sector partners to develop the inventions.

What level of innovation and payback can be reasonably expected for the new research facility at URM? We already know that universities with medical schools have a higher *average* rate of invention. The new research facility at the University will be wholly in the medical school. Furthermore, the investment will be disproportionately weighted toward three research areas that are not only particularly strong research emphases of the medical center, but are also known to be particularly productive areas for invention. Immunology and Vaccine Biology has unusual promise as a source of new invention, particularly given the demonstration value of the Hib vaccine and the continued contact between Wyeth Lederle and researchers at the University. Based on all these considerations, we believe that a reasonable estimate of the rate of invention disclosures would be one invention per million dollars of new investment. Thus the roughly \$64 million in new investment can be expected to generate about 64 new invention disclosures annually.

The University's Office of Research and Project Administration, indicates that roughly half of all invention disclosures become the subject of patent applications with approximately half of those resulting in a license to a company. About 15% of licensed

¹⁰Michael Odza, "Ratio, Invention Disclosures to Total Research Funding. *Technology Access Report* July 1996.

technologies eventually yield a product with royalty payments. The 1994 AUTM study reveals that the average royalty per license (both those that do and do not pay royalties) for all U.S. universities was \$32,000. Licenses with U.S. hospitals and research institutions pay an average of \$85,000. Roughly consistent with this number, the MIT study reported that the average biotech license (*minus* outliers paying more than \$1 million in lifetime revenue) earned \$93,000 for MIT.

Thus 64 annual disclosures can be expected to yield 32 patent applications and 16 licenses, each with a value of approximately \$90,000. Based on these averages, we believe that royalty income from the increase in URM C research should eventually reach about \$1.4 million annually. There is, of course, a long “lead time” involved in bringing technology to market. The Office of Research and Project Administration reports that the average period between licensing and marketing of a product is 5 to 8 years.

CONCLUSIONS

CGR’s study of the University of Rochester Medical Center’s *Strategic Plan* has addressed the economic impact of this initiative on the Rochester metropolitan area (defined as Monroe County and its five adjacent counties). The *Strategic Plan* sets a course for the Medical Center to follow if it is to regain its position as one of the top fifteen research institutions among academic medical centers. Our task was to place the economic role of URM C in its current context, then estimate the effect on the local economy of the kind of endeavor set forth in the plan.

On-Going Economic Impact of Completed Project

We find that implementation of the *Strategic Plan* will have a substantial, lasting impact on the regional economy. Building on the significant, ongoing contribution already made by the medical center, we estimate that that the new research facility will ultimately add over 1,200 new jobs to the economy with total compensation of about \$41 million. State and local tax revenue is expected to be about six percent of this total of nearly \$2.5 million annually (Tax Foundation estimates for NYS).

Total Project Impact			
	Phase I	Phase II	Total
Construction Phase			
Employment	1,300	370	1,670
Output	\$93m	\$40m	\$133m
Employee Compensation	\$41m	\$14m	\$55m
On-going Impacts			
Employment	1,025	220	1,245
Output	\$75m	\$15m	\$90m
Employee Compensation	\$32m	\$9m	\$41m

The Phase II building will have 25,000 square feet of additional space for future expansion. If populated with the same configuration of faculty and support staff, the annual budget will grow approximately \$2 million when the building is fully used. The economic impact of this additional component will likely exceed \$2.5 million.

Construction Period

As the community's largest current construction project, the new medical facility has already has a significant impact on the Rochester economy. In 1997 CGR forecasted an aggregate one-time impact on the economy of \$93 million in output and \$41 million in employee compensation.

Phase II of the project will add an estimated cost of \$30 million in building construction plus nearly \$9 million in furnishings and first-year supplies and materials for new faculty. CGR estimates that this expenditure will generate about \$14 million in employee compensation.

Spin-off Job Creation from Tech Transfer

These figures do *not* include any jobs resulting from the transfer of technology from the University to the private sector. Our research suggests that tech transfer stimulated by the *Strategic Plan* will eventually increase annual license revenue to the Medical Center by about \$1.4 million per year, divided between academic departments and the inventor. We expect that these royalties will be reinvested in new discovery, expanding our knowledge of biological processes and yielding more commercial products.

It is likely that discoveries at URM's new facility will stimulate the formation of additional technology business ventures in the community, although the chances of repeating the phenomenal commercial success of Praxis Biologics and the Hib vaccine are

small. The size and impact of these ventures on the community are impossible to forecast.

APPENDIX

Methodology

The analysis in this report was done using the IMPLAN input-output economic modeling system. IMPLAN is a regional input-output model originally developed in the 1970s for the U.S. Forest Service in response to federal legislation requiring economic impact assessments of forest development projects. Originally programmed in FORTRAN on a mainframe computer, the IMPLAN model was ported to microcomputers for 1991 release. The program was developed jointly by the U.S. Forest Service and the University of Minnesota.

IMPLAN includes 528 intermediate sectors (which convert to 3 or 4 digit standard industrial classification levels of detail), 12 final demand sectors and 6 primary demand sectors. National data are based on the National Income and Product Accounts published by the Bureau of Economic Analysis of the U.S. Department of Commerce and the 1992 Input-Output model of the U.S. economy. County and state data come from a variety of sources, with particular dependence on the U.S. Department of Labor's ES202 series, County Business Patterns and the Bureau of Economic Analysis Regional Economic Information System payroll and employment data. The relationships used by CGR are based on regional income and product flows for 1997.

Acknowledged as one of the best models of economic activity on the market, IMPLAN estimates the direct, indirect and induced impacts of economic change through the use of Type I (direct & indirect) and Type III (direct, indirect and induced) multipliers. Additional technical information about IMPLAN can be provided upon request.

CGR estimated the direct, indirect and induced impacts of URMC expenditures, as reported by URMC administrative departments. IMPLAN was used to estimate both the current impact of the URMC and the expected impact of the successful implementation of the Strategic Plan. IMPLAN-generated multipliers estimated the additional economic activity stimulated by URMC-derived expenditures in the community.

By using IMPLAN, CGR's analysis applies a slightly different multiplier to each sector. Dairy products, for example, are produced locally. The model reflects this by applying a higher multiplier to spending on dairy products than to commodities that are produced elsewhere. The principal indirect and induced impact of URMC is driven by the spending of faculty, staff, students and visitors. The distribution of URMC faculty, staff and student spending is based on U.S. Department of Commerce Consumer Expenditure Surveys for low, medium and high income ranges.

Multipliers are at the heart of economic impact analysis. A multiplier takes into consideration the initial effect of a change in final demand (triggered by new money received from outside the region) and the multiplied impact of that change as the income cascades through the economy. This is best illustrated with an example. When an employee of URMC purchases food from Wegmans or Tops, this spending supports the employment of a clerk, warehouse workers, transportation workers, etc. Retail margins are generally very small, however. Much of the purchase price flows through to the food supplier, which is generally a firm from out of the region. A purchase from the Bon-Ton or WalMart has a similar impact. A portion is devoted to local payroll, but the bulk of the purchase leaks from the region in payment for the product purchased. The income received by the employees of local firms is re-spent in the economy, but is subject to the same leakage. The cycle of spending and re-spending continues until all of the spending leaks out of the region.

The spending of the institution is also subject to substantial leakage, partly because the specialized needs of a medical and research facility are unavailable locally. We have assumed that twenty percent of the institution's spending is sourced locally (i.e. that eighty percent of purchases are initiated with an out-of-region supplier).

The economic impacts forecast in this study are subject to substantial variation, depending on the sourcing decisions of individuals and the medical center, and the strength of linkages between local retail and wholesale firms and their suppliers. For example, the extent that Wegmans purchases vegetables and other

produce locally affects the regional impact of a local purchase at the retail level. The character of the local labor supply pool will also affect the outcome of our forecast. We have assumed that the local economy has relatively few skilled workers to meet the increased demand for researchers and technicians at the new facility. Our model assumes that most of these workers will be drawn from outside the region (although we did not make this assumption for construction impacts). A downturn in the local economy that creates a relative surplus of skilled technicians would reduce the forecasted increase in aggregate demand, although it would cushion the impact of the conditions creating the surplus.