

REPORT

OF THE GOVERNOR'S

COMMISSION ON

SCIENCE AND

TECHNOLOGY



New Jersey State Library

FOR THE STATE OF NEW JERSEY

EDWARD E. BARR, CHAIRMAN
THOMAS H. KEAN, GOVERNOR

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REPORT

OF THE GOVERNOR'S

COMMISSION ON



SCIENCE AND

TECHNOLOGY

FOR THE STATE OF NEW JERSEY
DECEMBER 1983

New Jersey State Library

EDWARD E. BARR, CHAIRMAN
THOMAS H. KEAN, GOVERNOR



Thomas H. Kean, Governor



The Honorable Thomas H. Kean
Governor
State House
Trenton, New Jersey 08625

Dear Governor Kean:

I am pleased to transmit to you the Report of your Commission on Science and Technology. The report, which has the unanimous support of the bipartisan Commission, presents a bold vision of the future opportunities for economic growth and job development in New Jersey. It is firmly based on a long term and closely interrelated partnership among academia, business, labor, and government.

As you recognized in appointing the Commission, the State has a pivotal role as the leadership catalyst in ensuring a successful partnership. Implementation of the Commission's program will require a long term investment of State funds and the establishment of a successor body located within State government to oversee the future progress of this program.

I have enjoyed the opportunity to chair a Commission composed of outstanding and dedicated members who gave enormously of their time and abilities on behalf of our state. We were also fortunate to be able to reach out to many individuals and groups throughout New Jersey whose knowledge and experience helped to shape our recommendations. Together we present to you a strategy which will reinvigorate New Jersey's historic technological leadership as the underpinning for a prosperous economic future for our state.

Finally, I want to thank you for your strong support of the Commission and to personally thank you for the opportunity to serve our state in this important role.

Sincerely,

Edward E. Barr
Chairman

THE WORK OF THE GOVERNOR'S COMMISSION ON SCIENCE AND TECHNOLOGY

This bipartisan Commission held its first meeting in September 1982 and will end its activities in June 1984. This report summarizes the Commission's findings and recommendations to date.

To develop its plan for the state, the Commission sought broad public participation in its deliberations. The Commission carefully studied the composition of the New Jersey economy to direct its policies to build on New Jersey's strengths. It also attempted to build on work done at the national level and in other states. Of particular importance was the experience of states with substantial technology-based employment. Valuable insight was also gained through public hearings. The Commission focused its work on four areas:

- ☐ Academic-Industrial Innovation Centers
- ☐ Capital for New Technologies
- ☐ Technology-Trained Manpower
- ☐ Improving the Economic and Regulatory Climate

A task force chaired by a Commission member was appointed to address each of the four areas. Additional members with specific expertise in each area were recruited. The Task Force on Academic-Industrial Innovation Centers subdivided a portion of its work into four broad fields of technology (Integrated Manufacturing, Biotechnology, Telecommunications, and Future Fields). Working groups carefully evaluated each of these areas. The working groups and task forces prepared full reports for the Commission's review. These reports, along with others prepared especially for the Commission, are listed in the Annotated Bibliography in the back of this document. The membership of all task forces, working groups, and other special groups are also listed in the back of this report.

The task forces, as well as the Commission, have reviewed and considered a number of reports recently prepared at the national level. For example, several major studies have urged fundamental reforms in our educational and training institutions to help the United States secure its future in the world marketplace. Among the more significant studies have been the reports of the Business-Higher Education Forum, the National Commission on Excellence in Education, and the National Task Force on Education for Economic Growth. A full list of such studies is contained in the Annotated Bibliography.

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EXECUTIVE SUMMARY

Strategy for Action

Technology has been transforming people's lives since the invention of the first tools. Today, the magnitude and speed of technological change are affecting our lives more than ever before. The availability of new products and processes which result from technological innovation, and the uses to which we put these products and processes, can improve the quality of our lives, expand economic development, and provide sources of new employment while assisting existing industries to remain competitive.

The Governor's Commission on Science and Technology was established in recognition of the vital role New Jersey has played and must continue to play in this technological revolution. New Jersey is a center of technological innovation. No other state has more scientists and engineers per capita than New Jersey. In such fields as pharmaceuticals and electronics, expenditures for research and development in this state are the highest in the nation. In addition, New Jersey's system of colleges and universities constitutes a valuable resource, possessing enormous diversity and a multitude of strengths. However, the role of these academic institutions as a vehicle for economic development has not yet been fully realized.

The Commission has identified the components of a technology development strategy that builds on New Jersey's industrial and academic strengths. ***The strategy requires that we make investments in ideas, enterprise, and people. It also requires coordinated efforts by both public and private sectors. Finally, it requires a long-term commitment; results will not be immediate.***

The Commission recognizes that it has set an ambitious agenda for State action. But we are convinced that the challenge confronting New Jersey is great and cannot be met by half measures. We do not have the luxury of time; the situation is serious enough to demand immediate action. We have the resources — financial and human — to achieve national leadership. We must now demonstrate that we have the will.

Implementation

A crucial recommendation of the Commission is to ensure that the technology development strategy it has outlined is implemented. ***To achieve this, the Commission recommends that an oversight group be established to implement and evaluate the outcomes of the Commission's recommendations and to formulate long-range plans and programs for science and technology in New Jersey.***

This agency should be a semi-autonomous body within the Department of Commerce and Economic Development, governed by a board of overseers representing business, labor, academia, and State government. Its responsibilities would be to continue the Commission's work of identifying and supporting research opportunities at New Jersey's higher education institutions; assisting entrepreneurs and inventors to promote economic development; and stimulating an increased level of positive interaction among industry, academia, and government.

Investing in Ideas

The Commission believes that government in New Jersey must be more active in fostering the conditions necessary for industries dependent on the new technologies to evolve and grow. Higher education institutions also should play a key role in the growth of major technology-based industrial centers. Universities train the personnel and sponsor the research that provide the raw material for economic development. Government must stimulate academic-industrial collaboration and create an environment that will draw more top academic people to the state's universities.

To begin, New Jersey must build on those areas where it has strengths and where the opportunity for economic development is the greatest. The Commission focused much of its effort on identifying those technological fields where the most potential exists for income and job growth in New Jersey. The five fields to receive priority support in the coming decade are as follows:

1. Biotechnology

Biotechnology, the application of scientific and engineering principles to the processing of materials by biological agents to produce goods and services, is the basis for

many of the largest industries in the state, including pharmaceuticals, health care, chemicals, and food processing. New Jersey, long a giant in this field, must capitalize on this strength to take advantage of the explosive expansion of science and technology applications anticipated in the decades ahead.

Recommended Actions:

- ☐ Establish a world class Advanced Technology Center in biotechnology on the adjoining campuses of Rutgers University and the University of Medicine and Dentistry of New Jersey (UMDNJ) in Piscataway.
- ☐ Provide grants for industry-supported research at the state's higher education institutions.
- ☐ Provide low-cost incubation facilities to new firms in the biotechnology field.

2. Hazardous and Toxic Substance Management

The safe disposal of hazardous and toxic substances is of enormous current concern; if the problem is not solved, it will severely limit industrial growth. New Jersey's academic institutions are developing strengths in technologies basic to waste disposal. Support of a significantly expanded research program would improve the state's image, help resolve the problems which presently inhibit industrial activity and growth, and lay the foundation for the technological breakthroughs upon which a major industry could arise.

Recommended Action:

- ☐ Establish an Advanced Technology Center in Newark in hazardous and toxic substance management. The Center should be operated by a consortium of higher education institutions led by the New Jersey Institute of Technology, and including Stevens Institute of Technology, the University of Medicine and Dentistry of New Jersey, and Rutgers University.

3. Materials Science

Materials science, the processing, design, and use of advanced materials, is essential to most successful manufacturing today. New Jersey has a concentration of small firms in both the ceramics and polymer (plastics) industries, as well as a federally funded and industry supported ceramics

research center. Support of additional research activity in ceramics, polymers, and surface modification technology will both encourage the growth of new firms and assist existing firms to develop new products and remain competitive.

Recommended Actions:

- ☐ Establish a multidisciplinary Advanced Technology Center in ceramics at Rutgers University.
- ☐ Provide grants to support research in surface modification technology at the New Jersey Institute of Technology, Stevens Institute of Technology, and Rutgers University.
- ☐ Provide low-cost incubation facilities to new firms working in ceramics.
- ☐ Provide Technology Extension Services to small- and medium-sized businesses engaged in polymer processing through Stevens Institute of Technology and the New Jersey Institute of Technology.

4. Food Technology

Food technology, encompassing the study of the chemical, biological, and engineering aspects of food and food processing, packaging, and storing, is basic to the nation's economic health. By enhancing its role as a major food processing and distribution center, New Jersey can increase employment and gain benefits from new business opportunities.

Recommended Action:

- ☐ Establish an interdisciplinary Advanced Technology Center in food technology at Cook College of Rutgers University in New Brunswick.

5. Telematics

Telematics, the convergence of computer and communications technologies, is at the center of the current technological revolution. New Jersey has major industrial strengths in computer and information sciences. By developing the existing resources in higher education, the State can promote significant forms of academic-industrial collaboration. The Commission's peer review panel in Telematics will focus its recommendations on how to create concentrations of academic resources by examining the use of all possible support mechanisms, including Innovation Partnership research grants.

Investing in Enterprise

During the next decade, a substantial share of job growth will depend on the development of new products and services. These products and services will come from new, as well as existing, firms. The Commission believes the State has an important role in facilitating the growth of business.

Access to capital is necessary at each stage of business birth and growth. Companies at the cutting edge of new technologies need regular infusions of capital to turn their ideas and energies into new products and businesses. Existing enterprises need both equity and long-term debt capital to fuel their expansion and growth. Firms in mature industries require increasing amounts of capital to modernize their plants and equipment.

Although New Jersey inventors receive more patents than inventors in all but two states, California and New York, many of the viable business ventures that could be developed here based on these patents go unfunded. Venture capital tends to be attracted to a few glamorous growth centers and to a limited range of technologies. Many of the state's growing small- and medium-sized firms experience difficulty in securing conventional bank financing. These factors inhibit job-producing growth in New Jersey.

The Commission determined that New Jersey must undertake several complementary steps to increase the availability of capital to the state's businesses and to promote economic development. Highlights from our proposals are as follows:

Recommended Actions:

- ☐ Establish the New Jersey Venture Capital Partnership to make equity investments for start up and early-stage financing in new technology-based companies in New Jersey.
- ☐ Establish the New Jersey Direct Placement Fund to make intermediate and long-term loans for plants, equipment, and working capital to established technology-based companies in New Jersey.
- ☐ Change the State tax laws to allow businesses to carry forward losses from prior years.

Investing in People

The Commission believes that investments in education are as important to economic growth as are investments in plants and machinery. Technological change and the rapid specialization in economic activity have escalated dramatically the demand for highly educated and skilled workers. Unfortunately, both in New Jersey and the United States, there is a widening gap between the quality of public education and the requirements of the marketplace.

As a result, the availability of skilled technical workers is sorely limited and may soon become a deterrent to industrial investment in New Jersey, particularly by technology-based companies. Without swift action by both government and business to improve the education and technical and professional skills of our workforce, New Jersey's economy faces a perilous decline.

The needed changes must be directed at all students, beginning in the earliest grades and proceeding through a lifelong educational continuum. Recent employment trends argue strongly for a broadly based, rigorous educational system which provides its students with a strong academic foundation.

New Jersey recognizes these needs and is making a concerted effort to address them. A number of major initiatives already have begun. In September 1983, Governor Kean announced his blueprint for educational reform in New Jersey. The Commission supports the direction of the Governor's efforts, which clearly reflect the new national consciousness as enunciated by the National Commission on Excellence in Education. We also believe that additional initiatives are called for, in accord with the many recent national reports on education. Highlights from our proposals are as follows:

Recommended Actions:

- ☐ Undertake initiatives designed to provide an excellent education for every primary and secondary student in New Jersey's public schools, including the following:
 - Develop mechanisms to ensure that school time is used effectively, with maximum attention paid to rigorous academic subjects, including three years of science and mathematics and the

equivalent of one-half year of computer science for all high school graduates.

- Strengthen curricula to prepare students fully for the challenges of a rapidly changing world, including emphases on improved verbal and math skills and problem solving capabilities.
- Create a statewide program for academically gifted high school students in science, mathematics, and other fields. The program should include new specialized schools to serve the entire state, new local and regional programs within existing schools, and financial incentives for superior programs already in place.

- Improve the quality of education in New Jersey's higher education institutions, including the following:
 - Provide enriched funding for a limited number of carefully selected *undergraduate* programs in order to retain more of the state's top high school students.
 - Support all *undergraduate* engineering and applied science programs in New Jersey's higher education institutions through a targeted funding program which includes financial assistance to talented faculty for research, differential salary scales competitive with industry, and faculty exchange programs with industry.
 - Increase the size, broaden the scope, and improve the overall quality of *graduate* education in applied science, engineering, computer science, biotechnology, and related technical fields. Specific actions should include the awarding of merit-based fellowships and the establishment of professorial chairs.
- Develop new, and enlarge upon existing, systems for training and retraining the state's workforce.
 - Promote new forms of apprenticeship training.
 - Create a clearinghouse that maintains an up-to-date inventory of continuing technical education courses and industrial training needs.

New Jersey State Library

Academy of Applied Science

To provide technical assistance and expert advice to the Commission's successor and to others in State government, we urge the creation of a New Jersey Academy of Applied Science. The primary function of the Academy would be to provide, on request, advice on scientific issues to the executive, legislative, and judicial branches. It would help make the resources of the state's extraordinarily gifted and diverse scientific community available to decision makers in State government.

Fiscal Implications

The Commission estimated operating and capital cost implications for its recommendations in the five priority fields for investment, future fields to be designated, and the successor agency. It is projected that the State portion of operating costs for the first full year of operation (FY 1985) would be \$9.3 million, some of which will serve to leverage federal and private sector matching contributions. The Commission strongly recommends that the major capital improvements be funded through an \$80 million State general obligation bond issue, approval for which should be presented to the voters on the November 1984 ballot.



There is no single action that in itself will remove the barriers and encourage the development and expansion of new technology-based businesses. The Commission has reviewed the state's strengths and weaknesses and designed a set of policies to work together to reaffirm New Jersey as a technological leader and expand the rate of job and income growth. Taken together, the policies and programs outlined in this report constitute a broad and effective approach to bringing economic opportunities to the state's residents.

The Commission understands that it is asking for a considerable commitment of public and private funds. We believe, however, that the long-term cost of not moving ahead with these programs is likely to be far greater than the cost of their implementation.

1 NEW JERSEY IN A CHANGING ● WORLD:

**SCIENCE,
TECHNOLOGY,
AND ECONOMIC
DEVELOPMENT**



New Jersey has more scientists and engineers per capita than any other state.

New Jersey has earned its reputation as the laboratory of the nation.

New Jersey is a center of technological innovation. It has more scientists and engineers per capita than any other state. Industrial expenditures for research and development in fields such as pharmaceuticals and electronics are the highest in the nation. The state's higher education institutions possess a multitude of strengths reinforcing our industrial technological advantages. This report outlines strategies for channeling New Jersey's unique advantages in the technological revolution to continue improving economic opportunities for the state's residents.

Technological change promises many benefits. New inventions and innovations will generate new jobs, products, and enterprises. New production processes will restore lagging productivity growth and lead to increases in national and personal income. Medical discoveries promise further advances in health and life expectancy. Expanded engineering capabilities will help to reconcile our economic objectives with environmental constraints. Scientific and engineering developments can significantly contribute to improving the nation's and New Jersey's economy and generate economic opportunities for our workforce. For those prepared to seize the opportunities, technology offers open-ended possibilities for economic growth.

However, these benefits will not be achieved without some cost. Many traditional economic activities, and much plant and equipment are becoming obsolete. Skills patiently acquired over many years of productive employment can no longer be applied to new machines and new methods of work. To remain competitive, companies must reexamine their organizations and processes to employ the most efficient way of manufacturing goods. Products and services that provided gainful employment in the past may no longer be able to compete with new developments at home or with rapidly growing competition overseas. The industrial dominance once enjoyed by the United States has increasingly waned in the face of fierce international competition, and we no longer have the luxury of time to adapt.

New Jersey's tradition of innovation has played a crucial role in the success of our national economy. From the many inventions of Thomas Edison to the advanced research conducted by our pharmaceutical corporations, New Jersey has earned its reputation as the laboratory of the nation. The state has the traditions, the institutions, the industries, and the human resources to lead the nation in the technological revolution.

But the state's economy is not without weaknesses. The economic contributions of New Jersey's growth industries have been offset by a decline in employment in traditional manufacturing industries. Many of the inventions developed in New Jersey are commercialized elsewhere. The state's share of the nation's high technology employment fell during the last decade. New Jersey must fight to regain its position of

THE INFORMATION ECONOMY

THE OPEN ECONOMY

entrepreneurial leadership within the United States. Failure will lead to fewer jobs, shrinking paychecks, plant closings, and fiscal weakness.

The challenge that confronted the Commission was to provide a blueprint for development that builds on the state's strengths, reaffirms New Jersey's technological leadership, and expands the rate of growth of jobs and income. There is no single action that in itself removes barriers and encourages the development and expansion of new technologies. The Commission, therefore, reviewed many State policies and practices to develop a comprehensive New Jersey technology development strategy. The Commission identified the targets of opportunity created by technological progress, assessed the strengths and weaknesses of New Jersey's economy, and designed a set of policies to build upon the state's assets.

The United States economy is being transformed from one in which growth is based upon an increased capacity to produce and process materials to one in which growth is based on the processing and communication of information. The authors of the challenging study of technology, *Global Stakes*, concluded:

"We are moving from a capital intensive, physical-resource based economy of the first half of this century to a knowledge-intensive human resource based economy in the last half. The formulas, policies, economic theories, and conventional wisdom that facilitated the earlier transition from an agrarian to an industrial society are no longer applicable to the transition now in progress from an industrial society to an information society."

An increasing number of jobs involve the collection, processing, or communication of information. As a result, skills required of our workforce are changing dramatically and constantly. More workers will need to be computer literate. Greater interpersonal communications skills also will be needed as the complexity of data management systems increases. The restructuring of our economy and society thus will require a concomitant restructuring of programs and goals by our educational institutions.

During the first two post-war decades, the United States was effectively a closed economy. Imports and exports provided employment to only a small proportion of New Jersey's workforce. Today, international trade is a much more significant aspect of the state's economy. The dramatic growth of Japan and other nations on the Pacific rim, the integration of the European economies, the easy transfer of modern technologies among nations, and the rising mobility of capital, are all stimulating the integration of the world economy. While the

THE ENTREPRE- NEURIAL ECONOMY

THE NEW JERSEY ECONOMY

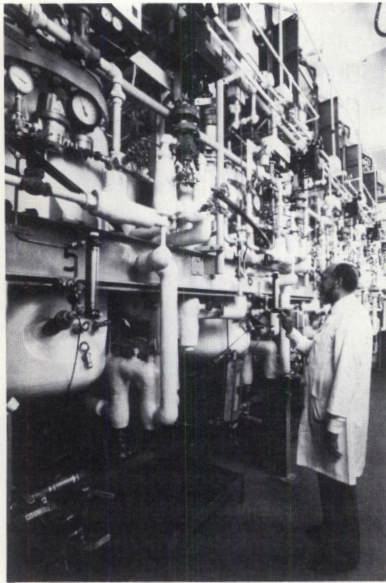
United States retains a strong export surplus in advanced manufacturing and in agriculture, it has lost its comparative advantage in such "second tier" manufacturing activities as textiles, apparel, steel, and consumer durables. The steady growth of public and private investment in research and development among our trade competitors also has posed a serious challenge to the nation's traditional lead in the most advanced technology-based industries.

Expanded trade, in the long run, benefits all trading nations. But the transition is not easy. The inevitable decline of traditional industries imposes extraordinary costs on workers and their communities. Communities hit by plant closings and individuals unable to find work in industries that have long provided them with well paid careers bear a disproportionate share of the cost of increased trade. The challenge is to capture the benefits of economic transformation while mitigating the harmful effects and sharing the burdens more equally.

Economic growth will depend heavily on the birth and expansion of new enterprises. While large corporations have been extraordinarily effective in managing large scale production and marketing, recent history shows that small and new businesses are responsible for a large share of innovations and inventions. During the last decade, approximately half of the new jobs in the economy were created by young, small, and independent companies.

Any program to support new enterprise development poses a challenge to traditional economic policy. In the past, the public sector response to economic transformation has frequently been to support the preservation of existing industries and activities. Little or no encouragement was consciously provided to emerging growth industries. An effective new technology strategy must break with this tradition and nurture the new as well as help transform the old.

The evolution and growth of technology-based industry is a complex process shaped by numerous factors. Many are beyond the control of the State: the changes in world trade patterns; the vitality of the national economy; and the progress of science. State government actions alone cannot restore economic health even to the local economy. Expanding economic opportunities in New Jersey requires a *cooperative* effort that harnesses the resources of the business community, public and private educational institutions, and State government.



An effective new technology strategy must nurture the new as well as help transform the old.

A strategy to further technology-based development demands action on many fronts. It requires increased investments in research and development by established firms as well as by government. It requires vigorous development of new enterprises to commercialize new products and processes. It requires a well-educated population. It requires more direct collaboration between academic and business groups for the purposes of applied research. It requires a skilled workforce trained in the use of modern equipment and techniques. It requires an academic community with the capacity to solve the scientific and engineering problems that confront businesses. It requires investors willing to take risks and supply long-term capital to support the development and marketing of new products. It requires entrepreneurs willing to invest their own time and resources converting scientific advances into viable business opportunities. Finally, it requires a commitment from the executive and legislative branches of State government to a bold and long-term sustained policy to promote technological development.

The Commission has reviewed the economic and educational variables that shape New Jersey's potential for industrial growth and found that the state has many advantages in its struggle for technology-based growth:

- ☐ The state has a strong base of firms engaged in research and development, not only in pharmaceuticals and telecommunications, but also in such diverse fields as food technology and materials science.
- ☐ There are more than 700 research and development laboratories in New Jersey.
- ☐ Expenditures for research and development in pharmaceuticals and in electronics in New Jersey exceed expenditures in any other state.
- ☐ No other state has more scientists and engineers per capita than New Jersey, and our workforce includes 105,000 people engaged in research and development.
- ☐ New Jersey firms invest billions of dollars in basic and applied research, the productivity of which can be assessed by the high rate at which patents are issued to New Jersey based firms.
- ☐ New Jersey ranks third among states, behind California and New York, in the number of patents issued — second in the number of patents issued per capita.
- ☐ New Jersey is a leading employer in what can be categorized as high technology industries — ranking seventh in the nation in high technology manufacturing jobs.

...technological progress must shape the activities of all sectors and all firms in the state by improving their productivity and providing new products.

A successful science and technology strategy requires a workforce with a strong educational foundation.

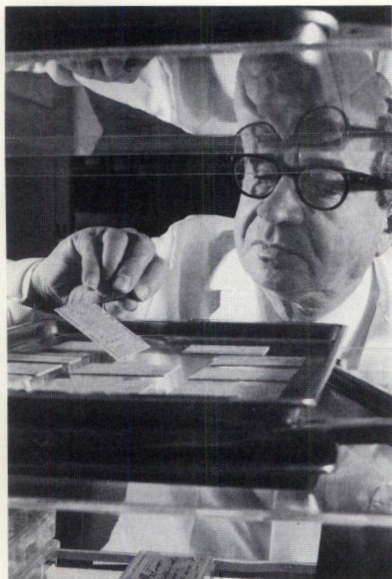
However, despite these encouraging facts, we cannot be complacent. New Jersey's relative position as a high technology employer declined between 1975 and 1980, with the state's share of national employment in high technology fields falling from 4.6 percent to 4.2 percent. High technology employment grew nationally in this period by 26 percent but by only 16 percent in New Jersey.

A central element in our science and technology strategy, therefore, must be to encourage increased research and development spending, built upon our present strengths. In addition, we believe technological progress must shape the activities of all sectors and all firms in the state by improving their productivity and providing new products. Unless firms and industries adapt to the new products and processes that advances in engineering and science make possible, they will not remain competitive with industries in other states and in other nations. A state science and technology strategy, therefore, is not a policy that favors a few new firms at the expense of traditional employers. It is a strategy that will have a broad-based impact throughout the entire economy.

We also find that, although small and new firms are responsible for a disproportionately large share of commercial innovations, New Jersey has experienced a low birthrate of new businesses and a high failure rate of small enterprises. This has contributed to its slow employment growth and the low rate at which locally developed patents are commercialized within the state. The ability of the state to provide economic opportunities for its residents, as well as to capture a larger share of the technology-based sector, depends in part upon its ability to increase the birthrate of new enterprises. At the same time, however, a healthy new business sector relies upon the vitality of major corporations as suppliers of jobs, materials, markets, and inventions.

We are aware that new businesses are risky enterprises. To succeed, they require not only entrepreneurs willing to devote their energy and resources, but also investors willing to finance new endeavors. Venture capital has not been readily available in New Jersey. Long-term debt capital also has been difficult to secure for young and growth oriented firms. A successful science and technology strategy must include initiatives to make capital more readily available to technology-based enterprises.

A successful science and technology strategy also requires a workforce with a strong educational foundation. The findings of the National Commission on Excellence in Education have brought into sharp focus the decline in the quality of education in our primary and secondary schools. In New Jersey, for example, between 1972 and 1982, the average verbal and math Scholastic Aptitude Test (SAT) scores declined by 30 and 19 points, respectively. In 1982, two-thirds of the



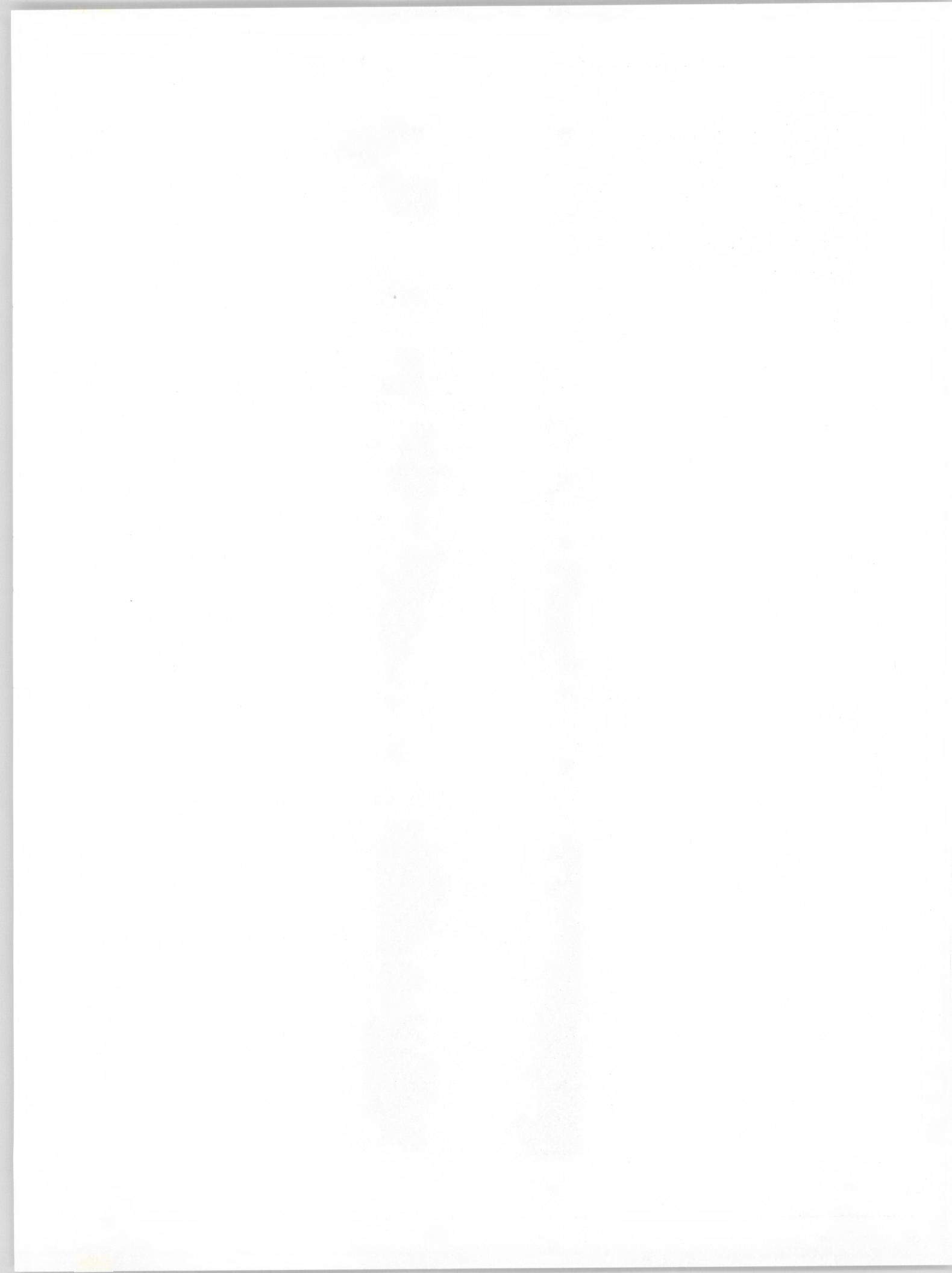
Without extensive reforms in education, we cannot hope to be a viable competitor in the technology race.

state's college freshmen tested in basic computational and verbal skills were not fully proficient in either area. Enrollments in math and science courses in New Jersey's high schools also are low. Just over half of the state's 1982 graduating high school seniors had completed less than two years of algebra, and one third had not completed one year of geometry.

At the collegiate level, New Jersey is the largest net exporter of college students in the United States. Many leave to attend schools for which New Jersey has no counterparts, but a significant proportion also leave because of student perceptions of poor academic quality at the state's colleges and universities. Additional problems confronting these academic institutions include severe equipment and faculty shortages in the rapidly expanding fields of engineering and computer science.

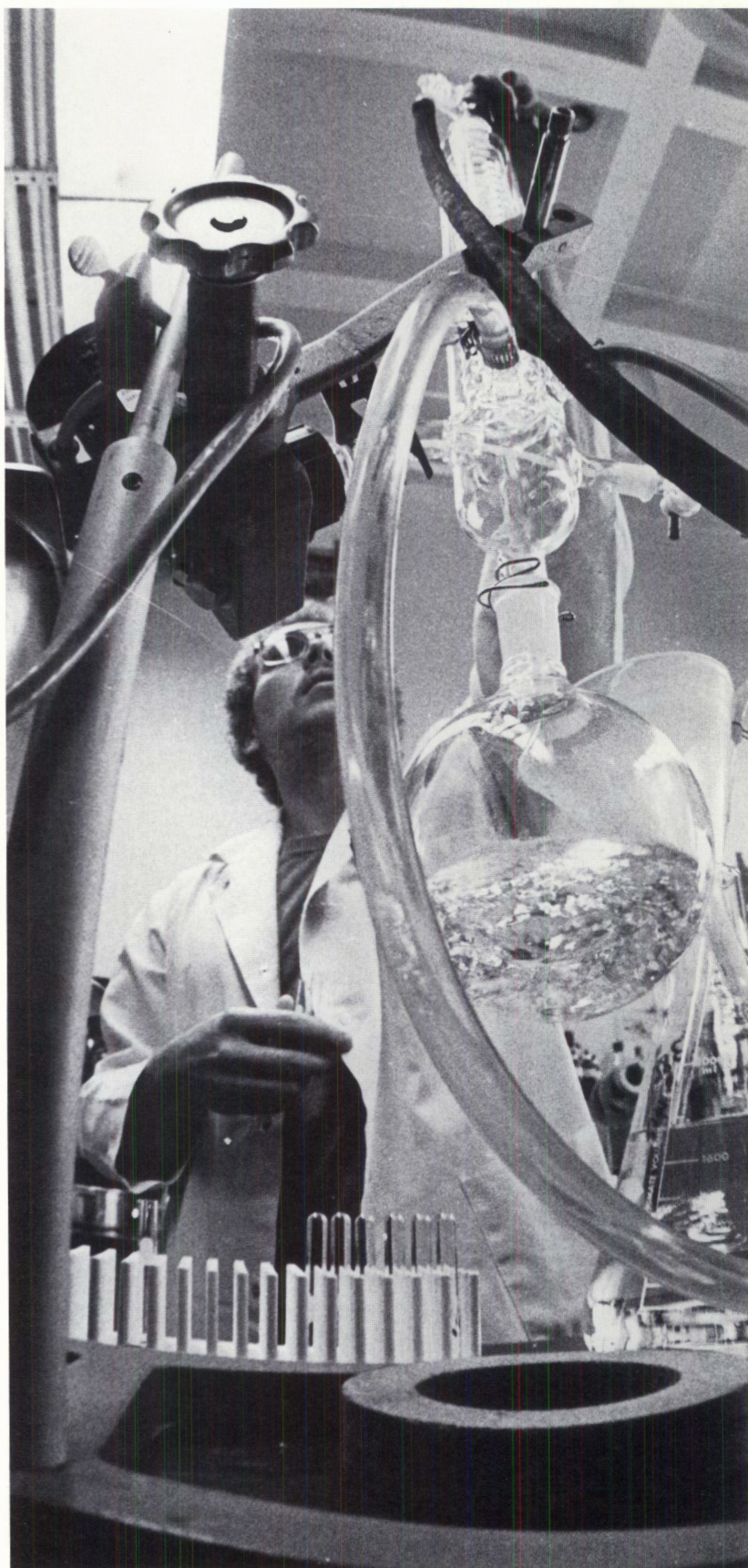
The availability of technically trained workers also is a major factor in the location decisions of technology-based firms. Yet, vocationally oriented technical training lacks a systematic focus in New Jersey. Institutions have a mixed record of responsiveness to industries' needs, limited market information is available, and there is often duplication among programs.

Without extensive reforms in education, reforms that both improve the overall quality of education and deepen our investment in the physical sciences and engineering, we cannot hope to be a viable competitor in the technology race. States from Maine to California have undertaken scores of programs designed to foster the expansion of science- and technology-based industries. Initiatives have been launched that range from increased funding for basic research and targeted education programs to the provision of incubator space and seed money for new businesses. Most of these programs were begun in the last three years. Interstate competition for talent essential to advanced technology firms will be as fierce during the next decade as the rivalry to attract "smokestack" industries was during the last decade.



2 COMMISSION RECOMMEN- • DATIONS:

**INVESTING
IN NEW JERSEY'S
FUTURE**



What enterprises have in common is the willingness to invest, innovate, and take risks.

...the complex process of technological development can not be singularly aided by any individual measure...

The key to sustained economic progress and the expansion of employment opportunities in New Jersey is the continued development of new enterprises and the strengthening of existing firms. To provide jobs for its citizens, New Jersey needs businesses that innovate and use the new products and processes made possible through advances in technology.

The range of enterprises is as broad and diverse as the state's economy. It includes small, young firms that pioneer in areas of state-of-the-art technology, as well as established corporations that invest tens of millions of dollars in the development of new products to compete in world markets. It includes food processing firms seeking new ways to satisfy expanded consumer demands; research-intensive pharmaceutical companies developing new diagnostic tools and medications; chemical and petroleum companies using advanced scientific methods to produce new products; small machine shops adopting computer assisted manufacturing techniques to improve the quality of their products; and banks and insurance companies developing new ways to meet the demands for financial services in a rapidly changing environment.

What all these enterprises have in common is the willingness to invest, innovate, and take risks. The State cannot, itself, create this entrepreneurial spirit — but it can promote the conditions that allow it to flourish by removing the barriers that now inhibit growth and development. These barriers may be shortages of skilled and trained labor, or lack of equity or debt capital. Or they may be more subtle factors — the disincentives to investment or risk-taking contained in the tax code or in the structure of State regulatory policies. Firms attempting to push forward and exploit new technologies often must bear a disproportionate share of the cost created by these barriers. Yet, New Jersey's economic future depends heavily on their success. We cannot afford to discourage new entrepreneurs or to frustrate the commercial applications of new technologies.

The Commission has reviewed many aspects of New Jersey's policies — including programs that rely on direct government spending, those that operate through the tax code, and those that use the State's regulatory powers — to develop a comprehensive strategy. We do not believe that the complex process of technological development can be singularly aided by any individual measure, such as a new research center or a special tax incentive. None of the recommendations, considered individually, will unleash a sudden burst of economic growth. But, taken together, they comprise a broad and effective approach that will lower the barriers confronting new enterprises and that will, ultimately, be reflected in a healthier state economy which will bring economic opportunities to the state's residents.

Because the Commission's recommendations are designed to work together to further technology development



...public investment in technology should occur through a partnership with the private sector.

in the state, we cannot predict the effect of each of the recommendations on the level or rate of growth of economic activity within the state. If New Jersey expanded technology-based employment at a rate equal to the national average, thousands of additional new jobs would be created during the coming decade, and many jobs which otherwise would disappear would be maintained.

We recognize that New Jersey faces fiscal constraints, and we applaud efforts to contain State spending and hold tax increases to a minimum. For this reason, it must be recognized that the recommendations made below should not be regarded simply as current expenditures. Indeed, a number of the Commission's recommendations require a commitment to long-term capital expenditures. They are investments that will yield high rates of return in the future — including increased personal incomes, greater job opportunities, and an expanded tax base. The Commission believes that these recommendations are essential elements in a diversified technology investment program.

To guide us in developing a science and technology strategy for New Jersey, the Commission has relied on four principles:

- ☐ Policies must be aimed directly at removing barriers to and encouraging business development rather than at simply subsidizing individual firms and industries.
- ☐ Policies must be designed explicitly as part of an overall technology development strategy. These policies also must be publicized if they are to achieve their maximum effect.
- ☐ Policies must be based upon close cooperation among business, labor, academia, and government.
- ☐ Policies must be mutually consistent, and reflect a realistic assessment of economic opportunities within New Jersey.

The Commission has determined that the tax and regulatory incentives it proposes for technology-based businesses should be available statewide, and should not be targeted to specific geographic areas. The diversity of technology-based industries and the very different location requirements of individual technology-based companies make geographic targeting unwise. The Commission also has sought policies which are flexible and which can be easily adjusted over time.

Finally, although we know the State has an important role to play, we recognize it does not possess infinite fiscal resources. The Commission believes that public investment in technology should occur through a partnership with the private sector. Public investments in economic development are most effective when coupled with the financial participation of industry. This partnership is essential to assure that the

INVESTING IN IDEAS

SUPPORT MECHANISMS

New Jersey State Library

limited resources of both government and industry are directed toward the state's most promising development opportunities in three principal areas: *investments in ideas*, *investments in enterprise*, and *investments in people*. Coordinated public and private investment is needed in all three areas to promote the growth of New Jersey's technology sector.

The Commission believes that government in New Jersey must be more active in fostering the conditions necessary for industries dependent on the new technologies to evolve and grow. Evidence from other states has shown that strong institutions of higher education play a key role in increasing economic development. Linkages must be forged between academia and industry to encourage collaboration and effectively transfer scientific and technological advances. The inventions and techniques developed through scientific research can give rise to new technology-based businesses and assist the expansion of more established firms. Investments in ideas provide the raw material for economic development, while improving the quality of the educational institutions.

Investing in ideas means more than increased spending on applied research. It means fostering an environment that attracts outstanding faculty to the state's higher education institutions. New Jersey also must attract more high quality graduate students and encourage these students to remain within the state as scientists and entrepreneurs. Investing in ideas requires an investment in the people who generate them, and provides a basis for excellence in the future.

To help create this environment, we are employing four complementary approaches to promote academic-industrial collaboration in applied research. These four support mechanisms are: 1) Advanced Technology Centers; 2) Innovation Partnerships; 3) Business Incubation Facilities; and 4) Technology Extension Services. Each of these mechanisms addresses a need to provide funds and services targeted to support the basic investment in ideas. They are structured to be flexible and adaptive to changing needs in various technological fields.

Academic-Industrial Centers

A system of *Advanced Technology Centers* would provide substantial and concentrated financial support to research institutions. These centers of excellence, built on outstanding programs or departments at New Jersey's public and private higher education institutions, would be developed into national-level bases for innovative technology research.



These centers would be funded for the acquisition of state-of-the-art equipment and for the performance of advanced research. Public support would be augmented by various private industry affiliates programs, which would contribute to the centers through such means as annual memberships, matching grants, and in-kind forms of support. Similar activity has been launched throughout the nation including New Jersey's neighboring states. New York State has established a system of centers for advanced technology at seven universities, while Pennsylvania has created the Ben Franklin Partnership Program which is providing \$10 million in matching grants this year to regional advanced technology centers.

Research Grants

A program of *Innovation Partnerships* would provide matching grants of \$10,000 to \$250,000 to individual academic researchers performing applied research in emerging technologies that are of strategic importance to the New Jersey economy. The program is designed to promote higher levels of applied research at the leading edge of technology, as well as more cooperative research arrangements between New Jersey's technology-based companies and the state's public and private research universities. This should stimulate a progressive improvement in the quality of research performed by these higher education institutions. It also will make it easier for the state's universities to attract and retain researchers and graduate students of the highest professional caliber. In time, Innovation Partnership support can lead to the aggregation of sufficient strength to sustain an Advanced Technology Center.

Projects eligible for Innovation Partnership support would be limited to those which have the potential for commercial importance to the New Jersey economy. All projects in these designated fields would be selected through open competition. Eligible applicants would be required to secure a conditional commitment of financial support from one or more companies. Matching grants also could be used to purchase equipment or to pay graduate student stipends.

Space for New Business

A program to establish *Business Incubation Facilities* would build and maintain a modest, targeted network of developmental facilities. These facilities would provide low cost space to new companies employing selected technologies. Each incubator facility would be oriented to companies involved in a single, broadly defined technology (such as biotechnology or materials science) and should be located in areas with appropriate concentrations of academic and entrepreneurial activity. These facilities would be established and operated by a sponsoring higher education institution(s) which would be responsible for tenant selection.



TECHNOLOGICAL FIELDS FOR INVESTMENT

As appropriate, these incubator facilities would provide access — on a cost-shared basis — to computer facilities, support laboratories, or other technical needs. Where possible, these facilities should be provided through the rehabilitation of existing structures and could be financed through the issuance of State-backed revenue bonds. Qualified entrepreneurs would be permitted to rent space at subsidized rates for up to three years.

Technical Assistance

A *Technology Extension Services* program would accelerate the application of technological innovation to existing industry. It would foster new applications of technological innovation, and work with the state's existing small- and medium-sized businesses to adapt these innovations to the requirements of individual business operations. The precedent for such activities was set by the agricultural extension service, which, beginning in the last century, sought to apply scientific methods to improve farm productivity.

This program would employ the resources of the public and private universities to promote the diffusion of information and technology throughout the state's existing industries. It would focus on the technical and managerial needs of small- and medium-sized businesses in selected industries, emphasizing the application of technical hardware for general business purposes and the automation of production routines. These needs would be met through various forms of technical assistance, conferences, seminars, and continuing education.

Smaller businesses can rarely afford to operate full-time research operations, and, as a result, they are frequently unaware of important technological developments within their field. Technology Extension Services would give smaller businesses expert advice and university-based resources to draw from when confronted with technology-based problems. Such a program would provide the state's small business community with information on scientific breakthroughs that are relevant to their own specific operations. The Technology Extension Services Program would charge appropriate fees for the services provided; however, the program would require State subsidization initially. We anticipate that, in time, some aspects would become self-financing.

The four approaches to academic-industrial collaboration constitute only the support mechanisms for New Jersey's ideas investment strategy. The more significant aspect of the strategy is the selection of technological fields for investment. Because the State's resources are not infinite, they should be targeted to those technological fields — generic scientific disciplines — where their economic impact, including

Because the State's resources are not infinite, they should be targeted to those technological fields where their economic impact, including employment and income growth, will be greatest.

employment and income growth, will be greatest. The Commission assessed the relationship between dozens of advanced technologies and the New Jersey economy. It formed special working groups chaired by Commission members. These groups were composed of scientists, engineers, university faculty, and industrial researchers, expert in their respective fields. The fields selected for technology development meet the following criteria:

- ☐ Provide direct employment opportunities in New Jersey.
- ☐ Address an identified or potential need for a product or service.
- ☐ Do not unproductively duplicate efforts elsewhere in the nation or world.
- ☐ Rest on a strong existing, or potential, academic or industrial base in New Jersey.
- ☐ Attract industrial support to supplement public investments.

Through these investigations by its task forces and working groups, the Commission narrowed to five the number of advanced technology fields that should receive *priority* support in the coming decade. These are:

- ☐ Biotechnology
- ☐ Hazardous and Toxic Substance Management
- ☐ Materials Science
- ☐ Food Technology
- ☐ Telematics (a field encompassing both computers and communications).

The five fields were then subjected to a further review by peer review panels made up of outstanding experts drawn from industry and academic institutions. The purpose of the panels was threefold. First, they validated the initial task force recommendations that support of each field would lead to greater economic development in the state. Second, the panels made site visits to New Jersey academic institutions to assess their research programs and to recommend areas for additional support. Third, the panels met with representatives of New Jersey-based industries to identify support mechanisms that would match industries' interests with existing areas of academic strength. By drawing upon the knowledge and expertise of nationally known experts, the Commission was thus able to develop specific blueprints for action in each of the five fields.

Biotechnology

RECOMMENDATION 1 Create a world class infrastructure in biotechnology research by establishing an Advanced Technology Center on the adjoining campuses of Rutgers University and the University of Medicine and Dentistry of New Jersey in Piscataway; provide Innovation Partnership grants for industry supported research at the



New Jersey is a major center for the health care, pharmaceutical, chemical and food processing industries...

state's higher education institutions; and make low-cost Business Incubation Facilities available to new firms engaged in the field.

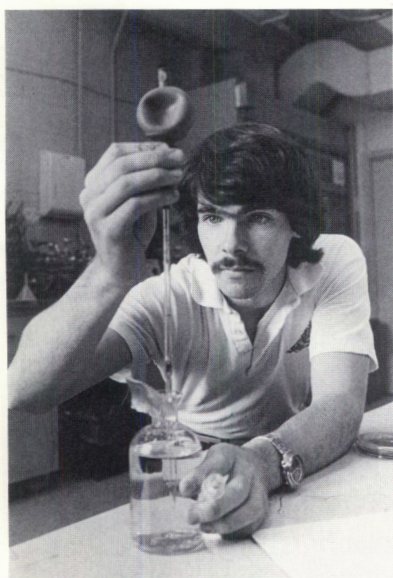
Biotechnology is the application of scientific and engineering principles to the processing of materials by biological agents to produce goods and services. Biotechnology is not a new commercial phenomenon. It is a well-established factor in the world economy. For example, biotechnological techniques are important in the production of such common products as copper (through microbial leaching), antibiotics, alcohols, yeasts, and vitamins.

In recent years, biotechnology research has become fast moving and dynamic. For example, progress has included gene splicing, monoclonal antibody technology, protein engineering and large scale plant and animal cell culture. There are, nonetheless, many important scientific and other obstacles to successful commercialization of products that must be overcome, and vast areas of new research to be conducted.

New Jersey is by all measures a major center for the health care, pharmaceutical, chemical, and food processing industries, all of which now benefit from and will increasingly depend upon advances in biotechnology. Unfortunately, the state's share of national employment in biotechnology-related industries has declined. For example, New Jersey's share of United States employment in pharmaceuticals dropped from 20.7 percent in 1975 to 18.4 percent in 1980, and the state's employment shares in medical and surgical instrumentation and food manufacturing also have declined.

In recognition of the economic importance of biotechnology to New Jersey's industries, a special panel was convened by the Governor to review New Jersey's academic and industrial strengths and needs in this field. The panel concluded that the establishment of an Advanced Technology Center in biotechnology could rapidly strengthen the universities' capacities and serve as a stimulus for technology-based industrial growth.

The Commission envisions that the Center should consist of a core facility, established within the joint academic governance of Rutgers University and the University of Medicine and Dentistry of New Jersey (UMDNJ), and located on their adjoining campuses in Piscataway. Satellite facilities to this Center would include a fermentation and separation unit at the Waksman Institute of Rutgers, and a clinical research unit in biotechnology at the Middlesex General-University Hospital affiliate of the UMDNJ-Rutgers Medical School. In addition, laboratory modifications for existing research units at Rutgers and UMDNJ are needed. Finally, a significant contribution is proposed to assist in the establishment of the new molecular biology facility at Princeton University. This department of molecular biology will provide important complementary research strengths to the activities of the Center.



In accord with the panel's findings, we further recommend that:

- ☐ The core of the Center for advanced biotechnology should be a new structure, sufficiently coherent as an architectural unit so that its singular purpose and direction are unambiguously identified. Such an arrangement will provide direct contact for a large number of students who have a wide range of interests and provide a focus for the recruitment of leading researchers.
- ☐ Public funds should establish and maintain the Center. The level of funding should allow the Center to secure the primary capitalization for the structure and necessary equipment, and provide sufficient operating funds to accommodate the yearly uncertainty of federal and contract support.
- ☐ The appointment of the overall Center director should be viewed as a critical priority.
- ☐ To be effective, the Center must have a critical mass of several senior researchers with appropriate support personnel.
- ☐ All sectors of private industry should have ready access to the personnel and programs of the Center by way of the traditional consultant and contractual patterns of collaboration and support.
- ☐ The Center should have the advice and guidance of a blue-ribbon advisory committee consisting of leaders from New Jersey's industrial firms and academic and scientific institutions. This will enable the Center to conduct research that is relevant to the needs of New Jersey's industries and economy.
- ☐ The Center should draw upon the related efforts of all of New Jersey's research universities in basic biological and medical sciences.
- ☐ An Innovation Partnership program to encourage initiatives of consequence already underway in other public and private academic institutions also deserves State encouragement and support.
- ☐ Finally, a Business Incubation Facility to provide low cost rental space to start-up firms in the biotechnology field should be situated in proximity to the Center, thereby affording opportunity for interaction and technology transfer.

Hazardous and Toxic Substance Management

RECOMMENDATION 2 Establish an Advanced Technology Center in hazardous and toxic substance management in Newark through a research and public policy consortium led by the New Jersey Institute of Technology

New Jersey can serve as a
model for other states.

(NJIT), and including Stevens Institute of Technology, the University of Medicine and Dentistry of New Jersey, and Rutgers University.

New Jersey's ability to address and meet the challenges of improved hazardous and toxic substance management could create the basis for new industrial start-ups and help transform the image of the state. The safe disposal of hazardous and toxic substances is of enormous concern; if the problem is not solved, it will severely limit industrial growth.

Four types of industrial firms, petroleum, chemicals, electronics, and pharmaceuticals, make up approximately 36 percent of New Jersey's current industrial output. All of these industries handle some hazardous and toxic substances in their production processes. Firms require management systems and technical options which will allow them to deal effectively with these substances, at a reasonable cost, over the long run.

The development of new products or processes can involve the use or generation of hazardous substances. This is particularly true for many technology-based firms. Unfortunately, firms currently have no way of judging whether new or existing processes of disposing of the wastes generated will be safe and acceptable, nor of judging how new substances will react using existing disposal methods. Consequently, the normally high risk nature of product development is magnified. To the extent they are available, well conceived and technically effective systems for substance management and waste disposal will increase a firm's confidence in its ability to actually bring a product to market.

By improving hazardous and toxic substance management, New Jersey can serve as a model for other states. At the same time, the ability of the waste treatment industry to clean up existing sites and to manage future waste production, would be substantially improved, as would the growth potential of the state's resource and raw materials recovery industries. In addition, with adequate support from both public and private sources, these new technologies could play an important role in attracting the manufacturers of scientific and industrial instruments and equipment.

In addition to its direct influence in stimulating industrial development, the Center would be a repository for existing knowledge and serve as a forum for the exchange of ideas among industry, government, academia, and the public. It should be designed to become a source to which the press and citizenry, as well as industry and government, can turn with confidence for authoritative and objective information and guidance on the many controversial issues in this field.

The Commission engaged a peer review panel to determine the advisability of establishing an Advanced Technology Center in this field. The panel of experts judged that the state's academic resources and industry interest were

Advanced ceramics are emerging as materials of the future.

sufficient to launch such a Center. This judgment was further validated and refined through a National Science Foundation-Industry Planning Conference, which showed that 8 to 20 firms are prepared to provide support for a multi-university research consortium headed by NJIT. Additional start-up funding by the National Science Foundation, anticipated after February 1984, would represent a three-way partnership of federal and State government and industry in support of this Center.

These applied research efforts will buttress other important State initiatives to address the state's hazardous waste problems. These include the work of the Hazardous Waste Siting Commission and the Department of Environmental Protection.

Materials Science

RECOMMENDATION 3 Strengthen research in materials science by establishing a multidisciplinary Advanced Technology Center in ceramics at Rutgers University; by providing Innovation Partnership grants to support research in surface modification technology at the New Jersey Institute of Technology, Stevens Institute of Technology, and Rutgers University; by making low cost Business Incubation Facilities available to new businesses working in ceramics; and by providing Technology Extension Services to small- and medium-sized businesses engaged in polymer processing through Stevens Institute of Technology and the New Jersey Institute of Technology.

Materials science, the processing, design and use of advanced materials, is essential to most successful manufacturing today. Progress in this area is expected to produce significant economic growth and increases in productivity. New Jersey, with its academic and industrial strengths in this field, has the ability to capture a part of these economic benefits. Overall, the field of materials science provides several areas where additional research and technological innovations will generate economic growth. There are three areas where this might occur: ceramics, polymer processing, and surface modification technologies.

Based upon the findings of an expert peer review panel, we recommend the following actions:

Ceramics New Jersey should strengthen and augment the ceramics department at Rutgers University and create an Advanced Technology Center in this field. We also encourage current planning for a second stage of development at the Center to emphasize electronic ceramics and, in particular, composite optical fiber materials for telecommunications and related uses. Optical fibers are expected to be a high-growth field and Rutgers already has the necessary basic science in place.



High technology ceramics are very different from traditional ceramics. Examples of traditional ceramics are building materials such as brick, glass, tile, and cement. High technology ceramics, however, have a much wider range of uses because of their unique characteristics such as abrasion resistance and high temperature resistance. These advanced ceramics are emerging as the materials of the future. They are coming into use as automotive and engine parts, computer components, and optical fiber materials for telecommunications purposes. The competition for a worldwide annual market of approximately \$4.5 billion is primarily between Japan and the United States. Market data show that the size of business activity in these materials will grow as much as \$17 billion by 1992. New Jersey's investment in academic-industrial collaboration in this field could have a substantial payback.

Composite optical fiber materials for telecommunications and related uses are coming into limited use already, especially in certain trunk telephone lines. Explosive growth is anticipated because this technology is the key to a completely interconnected system of two-way video communication using glass fiber. In many ways this field, sometimes called "photonics," stands where electronics stood shortly after the invention of the transistor. A period of intense technical and commercial competition lies ahead with very high rewards to those who succeed.

The materials required for photonics technology include modified forms of ceramics and glass, produced through special chemical processing combined with advanced glass processing. The major industrial laboratories developing these materials employ ceramic engineers, including many Rutgers graduates, in key positions.

The recently established Center for Ceramics Research (CCR) at Rutgers is a cooperative program of the University/ Industry Cooperative Research Centers, with initial funding from the National Science Foundation. This research cooperation with industry should be expanded to encourage the economic development goals set forth by the Commission. Specifically, this should include a small business development program in advanced ceramics, emphasizing both new materials and manufacturing technologies.

The current activity of the CCR focuses on structural ceramics as well as on the future development of electronic ceramics. CCR currently has industrial membership from ten large corporations and two national research laboratories, each contributing \$30,000 per year. The expansion we are proposing could at least double the number of participating corporations. In addition, it would enable CCR to encourage the development of new companies in New Jersey as spin-offs from its research, as well as new facilities from expansion or relocation of major corporations.

Polymers Polymer (plastic) processing likewise presents excellent possibilities for augmenting economic benefits in New Jersey. Building on New Jersey's strengths in petrochemicals, both the manufacture of polymers and the making of articles from polymers is important to the state. The peer review panel found that there is a need to provide state-of-the-art information to small businesses engaged in polymer processing. The panel found two institutions that have excellent relationships with industry, particularly with small business. We recommend increased funding for the existing business outreach activities at the Polymer Processing Institute at Stevens Institute of Technology, which is complemented by the growing activity in polymers at the New Jersey Institute of Technology. This should occur through the creation of a Technology Extension Service in polymer processing. The current activity at these two institutions provides a good base upon which to build this additional support.

In many ways, the Stevens Polymer Processing Institute (PPI) is in the most advantageous position to provide central facilities and to serve as the primary channel for carrying out university-industry cooperation in polymer processing. As a free-standing, non-profit Institute supported largely by its industrial members, PPI is in a position to develop a very close relationship with industry throughout the state, as well as to maintain close links with all New Jersey academic institutions working in the field.

The basic components of extension activities in polymers also exist at NJIT, formally in the case of the instructional activities and informally in the case of providing technical support to industry. The establishment of the Extension Service would provide increased awareness of the technical and instructional services available at NJIT. Such increased awareness is expected to generate additional opportunities for NJIT to assist the plastics processing industry.

Surface Modification Surface modification technology has important growth potential both in terms of new science and technology and in terms of its economic benefits. Surface modification techniques are used to form a composite surface to protect basic structures from corrosion. The field is rapidly evolving beyond traditional technologies toward areas that exploit new instrumental developments in the directed energy, particle beam, and plasma fields. Good examples of evolving technologies are those that make use of lasers, electron beams, plasmas, and ion and molecular beams for inducing surface modification effects. An expanded research effort that exploits these opportunities should be encouraged. We recommend that this happen initially through an Innovation Partnership in the expectation that such activity will serve to bolster the human and physical resources already available in our research universities.



The Center could help reverse the loss of employment the food industry has witnessed in New Jersey...

The development of surface modification technology, in the long term, would best be advanced through the formation of an Advanced Technology Center. Such an institute would bring national and international attention to New Jersey and make the state a highly visible leader in a field expected to have a major economic impact. The formation of a successful surface modification Center would facilitate the work of scientists and engineers who will become leaders of new development in industry and academia.

Food Technology

RECOMMENDATION 4 Create an Advanced Technology Center in food technology at Cook College of Rutgers University in New Brunswick.

Food technology encompasses the study of the chemical, biological, and engineering aspects of food and food processing, packaging, and storing. The food industry is an important part of the state's economic base; food processing represents annual shipments of over \$6 billion in New Jersey. Located in the heart of the nation's major population center, New Jersey has a good transportation system, and varied and extensive agricultural and aquatic resources. By expanding its role as a major food processing and distribution center, New Jersey can increase employment and benefit from the business opportunities in related areas such as ingredient supplies, chemical and packaging instrumentation, transportation, warehousing, and waste disposal.

A successful Center in food technology also can increase the state's economic base in this industry by providing new food products, and developing more efficient and economical food processing and related techniques. The Center could also help reverse the loss of employment the food industry in New Jersey has witnessed over the past decade.

Based upon the findings of an expert peer review panel, we recommend the following thrust for the Center:

- ☐ The Food Science Department at Cook College should form the nucleus of the Center, but the Center should be an independent entity within Rutgers University.
- ☐ The Center should be interdisciplinary and coordinate personnel and other resources from the departments of Food Science, Biochemistry and Microbiology, Chemistry, Nutrition, Plant Physiology and Horticulture, Mechanical Engineering, Chemical Engineering, and Materials Science.
- ☐ The activity of the Center should focus on taking research through the generic problem stage, but stopping short of the product development stage.



- ☐ Strong links between research in agriculture and food science should be fostered.
- ☐ A well equipped pilot plant for food processing should be the focal point of the Center. The purpose of such a facility would be to bridge the technical gap between laboratory research and commercialization. Activities such as developing packaging systems would be conducted in the pilot plant.

Such a Center would strengthen joint research and development programs, offer scientific education, and provide programs for entrepreneurial assistance. The result not only would increase employment in food production, processing, and packaging, but also would spin off new businesses in such areas as ingredient supplies, chemical and packaging supplies, processing and sensory equipment, and instrumentation, transportation, warehousing, and waste disposal. Work should begin immediately to plan the construction of a physical structure to house the Food Technology Center which should include the pilot plant, additional laboratories, and office space.

Telematics

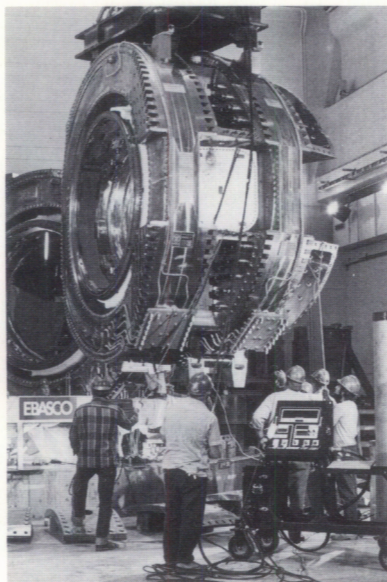
RECOMMENDATION 5 Build upon New Jersey's major industrial strengths in computer and information sciences (telematics) by developing those existing resources in higher education which can lead to significant forms of academic-industrial collaboration.

New Jersey must increase academic-industrial collaboration in those technological areas underlying telematics — such as software development and engineering, industrial productivity, and computer networking — where it can successfully compete. New Jersey also should seek to match its major industrial advantages in computer and information sciences (telematics) by encouraging significant concentrations of academic resources in this field. These concentrations should be focused at institutions of higher education in New Jersey where both major academic programs and interactions with industry are occurring. The Commission's Peer Review Panel on Telematics will focus its recommendations on how to create such concentrations, examining the use of all possible support mechanisms, including Innovation Partnerships.

The State should assist existing industries and businesses to increase their productivity by incorporating telematics into basic operations. We should ensure that our colleges and universities have sufficient computing power and that these computer resources are appropriately networked.

Future Fields

RECOMMENDATION 6 Continue to identify promising future fields for long-range development, including fusion technology, fisheries development, and materials handling.



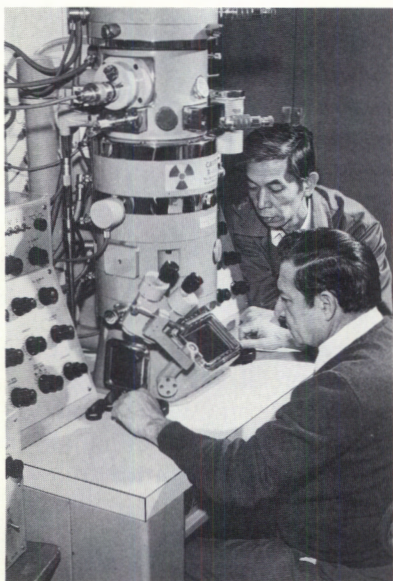
INVESTING IN ENTERPRISE

Fusion Technology New Jersey begins with a comparative advantage over many other states in fusion research and development because of federal funding of the Plasma Physics Laboratory at Princeton University. Accordingly, New Jersey has a special opportunity over the next several years to encourage the development and application of technologies related to fusion. In the near term, the State can play a modest, but nonetheless important, supplemental role in reinforcing efforts already begun at the Laboratory to expand its graduate student and mid-career educational programs in fusion engineering, and to augment its various relationships with industry. Over the longer term, as fusion research and development progresses and spins off new activities, the State should encourage the location in New Jersey of individuals and industries related to fusion technology.

Fisheries Development Its long coastline and its proximity to major population centers make New Jersey ideally situated for the further development of the fishing industry. A conservative estimate of the current annual market value of products generated by the commercial and recreational marine fisheries of New Jersey is over \$1 billion. By increasing applied research activity, there is great potential for enhancing the contribution that this industry, including the frontier area of aquaculture, makes to the New Jersey economy.

Materials Handling/Distribution Management Materials handling/distribution management encompasses production management, inventory management, material requirements planning, and purchasing. A number of developments combine to make this a promising field for New Jersey. First, the Port Authority of New York and New Jersey is currently developing an interdisciplinary approach to materials distribution that will focus on transportation modalities. Second, New Jersey is a major transportation hub for the eastern United States and should build upon this strength. Third, recent technological innovations in materials distribution can improve the productivity of the manufacturing sector, particularly through the application of computer technology to the distribution of raw and finished products. The Commission anticipates that these developments could make important contributions to the state's economy, particularly as academic institutions develop their resources in this field.

During the next decade, a substantial share of job growth will be dependent upon the development of new products and services. These products and services will come from new firms as well as existing firms. Recent economic history indicates that new businesses are a primary contributor of new jobs. The Commission believes the State has an important role to play in facilitating the acquisition of needed capital for new and



growing businesses and in promoting business development through tax and regulatory initiatives.

Capital is an essential ingredient in economic development, particularly for a state seeking to promote the growth of entrepreneurship and technology-based enterprises. Without ready and convenient access to capital, the birth and growth of businesses is easily thwarted. Companies at the cutting edge of new technologies need regular infusions of venture capital to turn their ideas and energies into new products and businesses. Existing enterprises need both equity and long-term debt capital to fuel their expansion and growth. At the same time, firms in mature industries require increasing amounts of capital to modernize their plants and equipment.

Unfortunately, the nature of capital markets inhibits many New Jersey enterprises from obtaining needed funds. Venture capital tends to be attracted to a few growth centers and to a limited range of technologies. As a result, enterprises outside these few glamour industries and locations are frequently deprived of this important source of business financing. Moreover, changes in the structure of the financial industry have decimated the market for long-term fixed rate loans to small- and medium-sized companies. These companies must either go without needed financing or accept capital on inappropriate terms.

The Commission determined that New Jersey must undertake several complementary steps to increase the availability of capital to the state's businesses. Some of these steps require the creation of new private investment partnerships. Others call for regulatory reforms to allow lenders to become more aggressive in seeking New Jersey-based investment opportunities. Others support the creation of new incentives to make various forms of productive investment more attractive to both individual and institutional investors.

New Jersey Venture Capital Partnership

RECOMMENDATION 7 The State should encourage the establishment of a New Jersey Venture Capital Partnership to make equity investments in new technology-based companies operating in New Jersey.

The partnership would be a privately managed pooled investment fund emphasizing diversified investments in seed, start-up, and early-stage financing. The capitalization of the fund would occur through investments made by a wide variety of institutional investors, including possibly public and private pension funds and insurance companies. The State would act as a catalyst in the creation of the fund; no State appropriation would be required. The fund would be structured to permit

participating investors the opportunity for co-investment with other, profit-oriented private investors. Each investor would have the option to contribute only a small fraction of total assets to the fund.

New Jersey Direct Placement Fund

RECOMMENDATION 8 The State should encourage the establishment of a New Jersey Direct Placement Fund to make intermediate- and long-term loans to growth-oriented, technology-based companies that have already established themselves in the marketplace, but which need additional capital to ensure their continued growth.

The fund would be structured as a pooled investment fund under private management. Again, without any need for State financial involvement, its investors could include a variety of institutional investors, such as public and private pension funds, banks, insurance companies, and other institutional investors. Private co-investment would be required on all fund investments.

Both the Venture Capital Partnership and the Direct Placement Fund would make an important contribution to New Jersey's capital base, particularly as it affects technology-based firms. Both could employ pension fund investments from a variety of New Jersey-based funds. Pension funds are extremely well-suited to this type of investment because of their large size and unique financial characteristics. Moreover, because these two investment vehicles are targeted to investments that offer substantially higher returns than are now achieved by most funds, they should represent an attractive investment option for many funds. The Commission or its successor should take the lead role in establishing these investment vehicles.

RECOMMENDATION 9 Revise the regulations governing permissible investments by domestic insurance companies to allow greater investment in venture capital institutions and in the equity and long-term debt of New Jersey-based companies.

Insurance companies are a major source of long-term commercial and industrial loans, as well as a growing source of equity placements with venture capital corporations. Yet the investment activities of insurance companies subject to regulation by the State of New Jersey are restricted by guidelines in the investment law manual. However, the growing sophistication and diversity of investment opportunities renders these guidelines obsolete. The result is a reduced flow of funds to new job-producing enterprises in the state. In place of these restrictions, the revised guidelines should be modeled after the type of "prudent investor" standards that now govern private pension funds under federal law.

New investment capital will
boost the state's young firms.

New Jersey State Library



RECOMMENDATION 10 Remove the restrictions on the ability of private insurance companies to insure commercial and industrial loans.

This would permit insurance companies to offer the same type of services on these loans that they now provide on residential mortgages and municipal bonds. Participating lenders would be able to sell in the secondary market the insured portion of their commercial and industrial loans, thereby increasing their liquidity and overall lending capacity, and improving the rate of return on their loan portfolios. Small and new business would find it easier to secure the financing they need to take advantage of technological change.

RECOMMENDATION 11 Permit banks and other commercial lenders to take "equity kicker" payments in lieu of interest on high risk loans to new businesses within the state.

By permitting commercial lenders to receive additional compensation (in the form of profit sharing, contingent payments, stock options, and similar arrangements), this exemption will encourage higher risk lending by providing the opportunity for greater "up-side" reward. Lenders will be able to recapture earnings on successful ventures which compensate for losses on unsuccessful ones. (This recommendation would not affect the usury restrictions on personal or consumer loans. Nor would it obviate the need to maintain standards to ensure the financial integrity of lending institutions.)

RECOMMENDATION 12 Exempt from State taxation any capital gains earned by New Jersey residents and corporations through investments in new productive enterprises in New Jersey.

Such a provision would encourage investment in new enterprises and thus contribute to increased employment. In order to discourage speculation, this exemption should apply only to investments held for a minimum of five years and should not be permitted for speculative investments in nonproductive activities (such as collectibles or real estate). This tax incentive would result in increased business activity of a magnitude that should offset any short-term revenue loss.

RECOMMENDATION 13 Expand the present efforts of the Department of Commerce's Office of Business Advocacy to assist businesses with permit and compliance procedures and other regulatory processes, and elevate the status and budget of that Office within State government.

The Office of Business Advocacy already undertakes many activities to assist business; this recommendation would enhance these efforts by giving the Office more authority and prominence. Steps also should be taken to increase awareness of the availability of its services. By assisting businesses to comply with regulatory procedures, the State can substantially lessen the burden of regulation.

INVESTING IN PEOPLE

...there is a widening gap
between the quality of public
education and the requirements
of the marketplace.

RECOMMENDATION 14 Businesses should be allowed to carry forward losses from prior years in computing business income taxable in New Jersey. (To lessen the initial impact on the State budget, no losses incurred prior to the current tax year should be eligible for carry-forward.)

The federal tax code allows loss carry-forward as do most states. Failure to do so in New Jersey discourages small and new businesses by treating losses and gains asymmetrically. Indeed, the unavailability of loss carry-forward may contribute to the state's high failure rate of new businesses. Without loss carry forward, State taxes are imposed in the first year a new business shows any profitability. Frequently this first year of profit follows a period of losses in which many debts were incurred. State taxes imposed at this point tend to slow growth and endanger future profitability.

A loss carry forward provision recognizes the fact that businesses are ongoing entities. Their ability to grow and invest depends on profitability over an extended period of years. A tax law that fails to recognize the long-term flow of business income will hamper the growth potential of cyclical businesses and reduce their ability to generate jobs and taxable income. The short-term revenue losses to the State incurred as a result of implementing this tax change should be offset in the long run by the additional revenue generated by increased business activity.

The Commission believes that investments in the education and technical skills of the labor force are as essential to economic growth as investments in plant and machinery. Technological change and the rapid specialization in economic activity among competing trading nations have dramatically escalated the demand for highly educated and skilled workers. Unfortunately, both in New Jersey and the United States, there is a widening gap between the quality of public education and the requirements of the marketplace.

As a result, the availability of skilled technical workers is sorely limited and may soon become a deterrent to industrial investment in New Jersey, particularly by technology-based companies. As economists Eli Ginsberg and George Vojta have written, "the skill, dexterity, and knowledge of the population...have become the critical inputs that determine the rate of growth of the economy." Without swift action by both government and business to improve the educational, technical, and professional skills of our workforce, New Jersey's economy faces perilous decline. Efforts need to be undertaken at all educational levels.

PRIMARY AND SECONDARY EDUCATION

Emphasis must be placed on
improving the higher order
verbal and mathematical
skills...

New Jersey recognizes these problems and is making a concerted effort to address them. A number of major initiatives already have begun. In September 1983, Governor Kean announced his blueprint for educational reform. The principal components, developed in cooperation with the Department of Education, are as follows: monitoring by the State of all school districts to ensure that they offer the essential elements of a sound educational program; provision of an alternate route for teacher certification to open up the teaching profession to a wider range of talented people; increased starting salaries for teachers, initially with financial support from the State; development of a Master Teacher Pilot Program to begin in September 1984 in five school districts; and establishment of an Academy for the Advancement of Teaching and Management that will focus on practical applications of the latest research findings.

The Commission applauds these efforts, which clearly reflect the new national consciousness as enunciated by the National Commission on Excellence in Education. We also believe that additional initiatives, in accord with the many recent national reports on education, are called for.

RECOMMENDATION 15 Implement the Governor's proposed educational program, specifically with respect to the directions indicated for teacher certification, higher salaries, a Master Teacher Program, and an Academy for the Advancement of Teaching and Management.

RECOMMENDATION 16 Highest priority must be given to the development of mechanisms to ensure that available school time is used more effectively, with maximum attention paid to rigorous academic subjects, including at least three years each of science and mathematics, and the equivalent of one-half year of computer science for all high school graduates.

Measures to increase the amount of time students spend in school also must be adopted. These should include an appropriate combination of the following: a seven hour school day, a 200 day school year, and the assignment of far more homework than has generally been the case. In recognition that there are significant cost implications attached to increasing real school time, we recommend that the longer school day and/or year be viewed not as an objective for immediate implementation but rather as a long-term goal toward which the State must strive.

RECOMMENDATION 17 Strengthen public school curricula to better prepare students for the challenges of our rapidly changing technological society.

This means that a new set of skills, including computer literacy, must be incorporated into public school curricula from the earliest grades. Emphasis also must be placed on

...the system must be designed to benefit all secondary students...



improving students' higher order verbal and mathematical skills, such as problem solving. For those students planning to attend college, standards of academic preparation by subject area must be established and widely promulgated. To these ends, we support the ongoing efforts of the Department of Education, which in some cases are cooperative initiatives with the Department of Higher Education.

RECOMMENDATION 18 Develop an optional statewide testing program, available to all graduating high school seniors.

Although high school graduation would not be contingent upon students' passing the test, performance on this exam would entitle students to a special State-endorsed diploma. The program would enhance other recent initiatives by the Department of Education directed toward upholding the integrity of the high school diploma. It should be designed to influence performance standards, not just for college bound students but for all students, in recognition of the fact that changing technologies affect the entire workforce.

RECOMMENDATION 19 Create special statewide programs for academically gifted high school students in science, mathematics, and other fields.

These initiatives should include the creation of specialized schools to serve the entire state, the design of new local or regional programs within existing schools, and financial incentives for superior programs already in place. While admission to these special programs should be based solely on academic qualifications, the overall program plan also must be designed to benefit all secondary students and schools in the state through outreach programs. These might include faculty exchanges, summer teacher institutes, and student seminars in satellite locations. Special emphasis should be placed on involving teachers from urban school districts.

RECOMMENDATION 20 As precursors to full statewide strategies, establish pilot projects in selected schools to develop innovative uses for computers, videodisks, and other new technologies in educational programming.

This effort should involve both elementary and secondary schools in urban, rural, and suburban districts. Special emphasis should be placed on the use of interactive systems. The projects must include a staff development component in order that teachers understand and properly use the new equipment and techniques. Careful monitoring and evaluation must be built into these projects.

The major initiatives outlined above must be viewed as components of a system, all of which are essential if public education in New Jersey is to provide its students with sufficient opportunity to function effectively in our rapidly changing world.

PROFESSIONAL EDUCATION



RECOMMENDATION 21 Improve the quality of education in New Jersey's public and private *undergraduate* institutions in order to attract more of the state's top high school students. We specifically recommend increased funding for a limited number of carefully selected programs within New Jersey's institutions.

These programs would be required to establish more rigorous, or maintain already high, admissions policies. New merit-based scholarships could be created while maintaining existing needs-based programs. In addition, more intensive recruitment efforts, including specialized financial aid packages, should be created to increase the number of college students majoring in the biological and physical sciences, mathematics, and engineering. Finally, all baccalaureate and community college transfer program students should be required to meet high standards of scientific, technical, and computer literacy. The Commission supports the current grant program of the Department of Higher Education which is funding proposals to integrate the use of computers into curricula at all institutions and to improve or expand existing technical and engineering education programs.

RECOMMENDATION 22 Support all undergraduate programs in engineering and applied science in New Jersey's higher education institutions through a targeted funding program which recognizes the heavy resource demands of these academic disciplines. A vital component of this support must be designed to address faculty resource needs, including financial assistance to talented young staff for research, differential salary scales competitive with industry, and faculty exchange programs with industry.

The highest standards of excellence must be our goal in this endeavor. Graduates of these programs will fuel the economic development not only of the state but also of the nation. The baccalaureate-level engineer is the key human resource in the creation of new, and maintenance of existing technology-based enterprises; it is this person who converts the work of the research scientist into the systems which yield economic results and employment. Continuous and substantial additional support is required to maintain and improve the quality of undergraduate programs in the face of rapidly changing technology. To help achieve this, it is essential that students receive greater exposure to the actual practice of engineering in the industrial world.

RECOMMENDATION 23 Increase the size, broaden the scope, and improve the overall quality of *graduate* education in applied science, engineering, computer science, biotechnology, and related technical fields.

New Jersey's major engineering schools have significant strengths, but overall, the engineering education system in the state is not in a position of excellence relative to other top United States technical institutions or to New Jersey's diverse

...public and private sources should be tapped to ensure that schools have state-of-the-art capabilities...

TECHNICAL EDUCATION

industrial strengths. To achieve this level of excellence, we recommend increased stipends in targeted disciplines for full-time doctoral students, who are United States citizens. Fifty new four year merit-based fellowships should be awarded annually in the designated fields. To attract scientists and engineers doing the most advanced research, the State also should establish at least five continuing professorial chairs to be awarded on a competitive basis to both public and private institutions. Except in special circumstances, no school should have more than one of these chairs at a time.

RECOMMENDATION 24 Provide funds to upgrade instructional equipment and facilities in engineering and science education at both the graduate and undergraduate levels.

Both public and private sources should be tapped to ensure that our colleges and universities have the state-of-the-art capabilities which play an essential role in attracting top quality faculty and in preparing students for employment in high technology industries. We are especially cognizant of the need in engineering programs for equipment to enable the schools to offer their students up-to-date instruction in computer-assisted engineering, manufacturing, and related disciplines. The Commission supports the current grant program of the Department of Higher Education for technical education, which includes support for equipment and facilities.

RECOMMENDATION 25 The Governor should establish an interagency cabinet level committee to coordinate all public vocational education and training programs.

At the minimum, this committee should be composed of the heads of the four State agencies that play a critical role in the formulation of employment and training policies — the Departments of Commerce, Education, Higher Education, and Labor. It should be responsible for evaluating current and future manpower needs, as well as for determining the ability of existing vocational education and employment training programs to meet these needs. It should develop new mechanisms for involving industry in employment training activities and should work to eliminate duplication among existing programs. This last function requires an awareness of the appropriate training roles of each educational sector, including an understanding of the importance of traditional vocational education programs, and recognition that community colleges have existing resources that qualify them to serve as a primary provider of technician training. The ad hoc committee of department heads called for by the State Job Training Coordinating Council may fill this role, provided its mandate is appropriately defined. Its functions would be served most effectively if the staff of the SJTCC were to include representatives of all agencies that play an important role in the State's education and training programs.



RECOMMENDATION 26 Develop and regularly update a centralized labor market information system as a high priority State responsibility.

Data should be collected by local geographic area and occupational category and should be used to identify high-growth areas and emerging employment fields. The State Occupational Information Coordinating Committee should be allocated sufficient funds to develop this system. The current efforts of the State Job Training Coordinating Council to expand and maintain such a system should be supported.

RECOMMENDATION 27 Develop an extensive customized employment training program which is fully responsive to the needs of New Jersey businesses.

The recent allocation of Department of Labor monies for this purpose is to be commended. Funds should be specifically targeted to rapidly growing and newly emerging technological fields, as well as to traditional occupations in which retraining is needed to keep workers abreast of changing technological requirements. The criteria for program selection must be designed to avoid training for dead-end jobs. The program should be structured to use proven deliverers of technician training, such as the community colleges. Other resources, such as the vocational-technical schools, should be tapped as appropriate.

RECOMMENDATION 28 To the extent practical, target a designated portion of the federal monies allocated to New Jersey through both the Vocational Education and Job Training Partnership Acts for programs in rapidly growing and newly emerging technological fields.

We commend the current practice of the Department of Higher Education's postsecondary vocational education program in advancing this objective. We recognize that a number of fine technical training programs are already available in our vocational educational system; however, there should be increased responsiveness to the changing needs of industry. In general, funds should be used both to upgrade the technical skills of workers in traditional industries and to retrain dislocated workers for new employment in technology-based fields.

RECOMMENDATION 29 Promote new forms of apprenticeship training for industries in high technology fields and appropriate funds for this program.

Apprenticeship training has been used successfully by technology-based companies in other states and has generally resulted in increased retention of the technical workforce. New Jersey should move toward granting to the State sole responsibility for the approval of apprenticeships, as is the case in other states with innovative apprenticeship programs.

CONTINUING EDUCATION

OTHER STATE POLICIES

...a vital nexus between
technology-based firms and
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established.

RECOMMENDATION 30 Create a clearinghouse that maintains an up-to-date inventory of continuing technical education courses and industrial training needs in New Jersey.

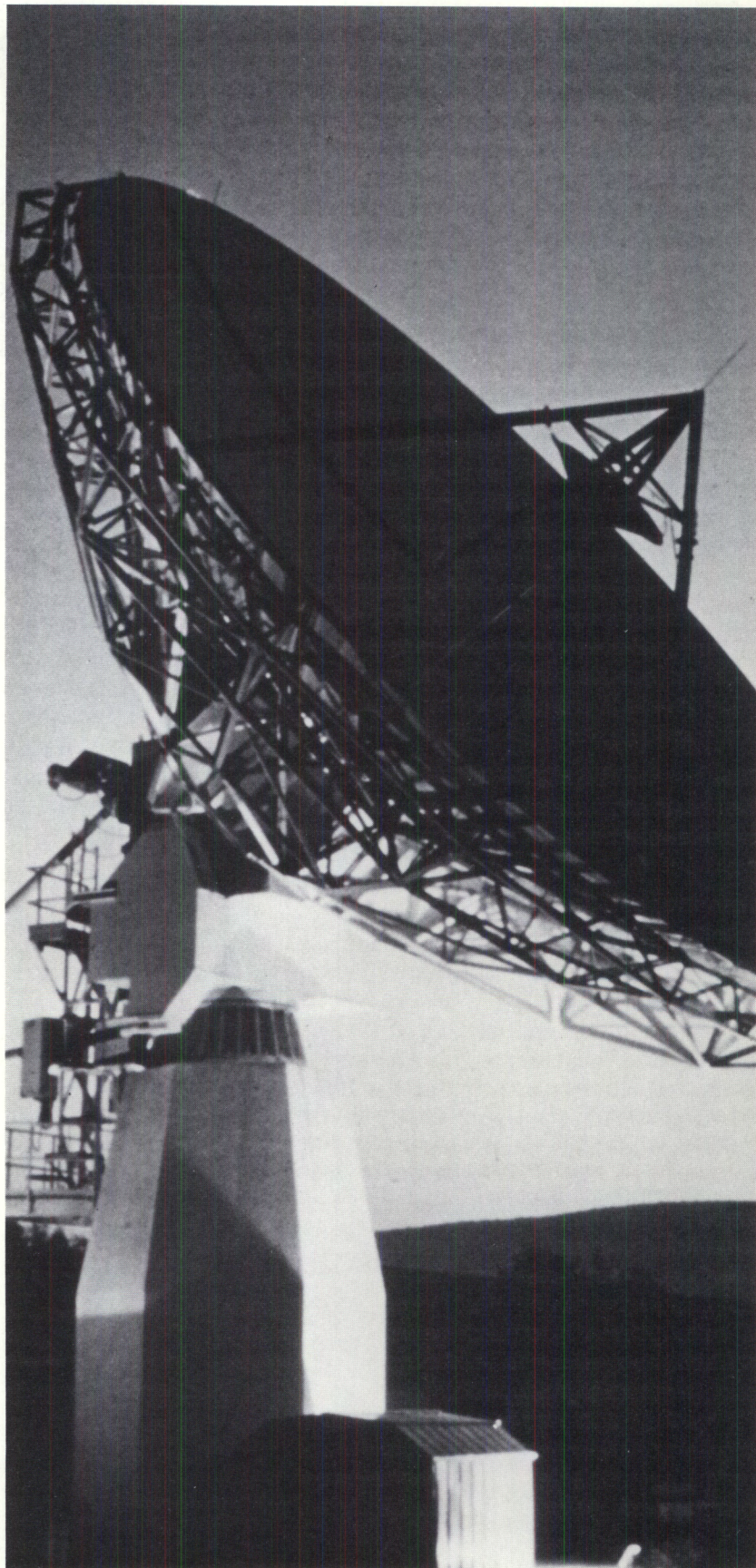
Although there is an increased need for continuing education programs to help employees stay abreast of changing technologies, there is no established mechanism in the state to insure systematic communication between the business and academic communities regarding the supply of and demand for such programs. Establishment of a clearinghouse at an educational institution with a strong continuing education program should promote a freer flow of pertinent information between industry and academia. The cost of maintenance and access to the computerized data base should be borne by the business community.

RECOMMENDATION 31 Enact a tax credit for corporations donating designated types of high technology equipment to primary and secondary schools, colleges, and universities.

This tax credit would increase the effectiveness of the recommendations described above by expanding the resources available to educational institutions. The cost to the State, in forgone tax revenue, will be relatively small, but the benefit to the education sector, of the donated equipment, will be great. Moreover, a vital nexus between technology-based firms and educational institutions will be established. Building these academic-industrial links will benefit the economic climate of the state.

3 COMMISSION RECOMMEN- • DATIONS:

**MAKING THE
SCIENCE AND
TECHNOLOGY
STRATEGY
WORK**



IMPROVING THE ECONOMIC CLIMATE

Adequate public infrastructure
is essential for the expansion of
economic activity.

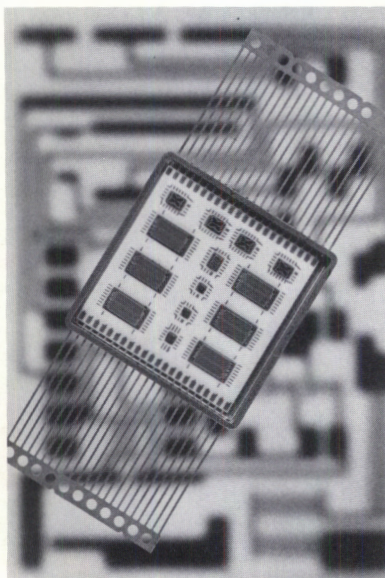
The recommendations outlined above address the specific goals of increasing investments in ideas, enterprise, and people. Even if these initiatives are vigorously pursued, however, the goals will not be fully accomplished unless the State initiates a coordinated and effective development strategy that improves the overall economic climate in the state. Therefore, the Commission recommends the following set of policies to help make the science and technology strategy work.

Policies of State government influence many aspects of the business and residential environment in New Jersey. The multitude of social objectives and goals pursued through public policy — a clean environment, income maintenance, equality of opportunity, improved quality of life, orderly markets, and improved education and health — have led to many policies that shape the economic and regulatory environment for technology-based industry in the state. For example, the public infrastructure of utilities and transportation systems must be adequate to meet changing freight and commuter demands. Regulatory policies must not pose unnecessary barriers to economic growth. The state must be perceived as an attractive place in which to live and conduct business.

The state's economic climate is defined by these and many other factors that differ widely among industries and firms. Recognizing that the State's resources are finite, the Commission has chosen a set of policies that will have a positive impact on a broad range of firms.

RECOMMENDATION 32 The Governor and Legislature are urged to establish policies and programs to improve the state's infrastructure including water supply networks, wastewater treatment plants, transportation systems, and other public works.

Adequate infrastructure is essential for the expansion of economic activity. A good water supply network and wastewater treatment facilities influence a firm's choice of location. An efficient road network and air transportation facilities are vital to industries that require the movement of goods and people.



RECOMMENDATION 33 Conduct a full review of public regulatory and tax policies and programs affecting the telecommunications industry in order to develop a comprehensive strategy that promotes the rapid development of the industry and its deployment to serve all industries within New Jersey.

This recommendation, related to Recommendation 5, is an important collateral aspect of encouraging the further growth of the telematics industry. Effective telecommunications systems are an essential part of the infrastructure supporting development in all sectors of the state economy. Yet, the evolution of these systems can be inhibited by restrictive State regulatory and tax policies, such as cable franchising, tax treatment of information and data sources, and licensing of communication systems.

RECOMMENDATION 34 The Legislature should make fundamental reforms in the State's system of unemployment compensation.

New Jersey's unemployment compensation tax rates, which are 27 percent higher than the United States average, greatly increase the cost of doing business in New Jersey. At the same time, due to the structure of the program, payouts frequently exceed revenues. To finance this deficit, the State is forced to borrow from the federal government. Repayment of this debt further increases the cost of the program to New Jersey employers. There is now substantial agreement among labor, business, and government leaders concerning the need for reform, and legislation to modify the current system already has been introduced in the legislature. The Commission urges swift action to secure these necessary reforms.

RECOMMENDATION 35 The Governor is urged to establish a special group within the executive office to review regulations proposed by all State agencies in order to evaluate their effect on New Jersey's economic development goals. Regulations must be carefully designed based upon firm scientific evidence and upon careful and rigorous risk/benefit assessment.

In the area of environmental regulations, special care should be taken to ensure that these regulations protect the health and safety of New Jersey residents as well as improve the quality of life in New Jersey. The State also should seek to make its regulations as reasonable as possible, so as to be competitive in attracting desirable industry to the state.

RECOMMENDATION 36 The New Jersey Legislature should consider the impact of the *Beshada* court decision on the state's business climate.



New Jersey's competitive position in attracting and retaining new technology investment may be adversely affected by the New Jersey Supreme Court's decision in *Beshada v. Johns-Manville Products Corp.*, 90 N.J. 191 (1982). In *Beshada* the Court held that the "state of the art" defense is no longer valid in product liability cases.

RECOMMENDATION 37 Publicize widely New Jersey's most attractive attributes by increasing expenditures on advertising that conveys the advantages of New Jersey as a place in which to live and conduct business.

The state's business climate is powerfully influenced by popular perceptions. If New Jersey is viewed negatively, businesses may be unwilling to locate plants here, entrepreneurs may go elsewhere, and existing employers may find it more difficult to recruit new employees.

Taxation

The Commission reviewed many possible tax code changes that would improve the business climate in New Jersey and spur investment. However, with a realistic eye on the State's revenue needs, the Commission is recommending only three tax changes for enactment at this time. (Recommendations 12, 14, and 31.)

The Commission considered five other changes in the State's tax code which it felt would stimulate economic development. The Commission recognized that the State's fiscal position did not permit consideration of these additional changes at this time. However, the following suggested changes in the tax code would, in the Commission's opinion, stimulate economic development. Therefore, they are listed below as a frame of reference for the Governor and the Legislature in the event the State's fiscal condition permits their consideration at some future time.

- ☐ Phase in conformity with the federal Accelerated Cost Recovery System. This measure would keep New Jersey competitive with most other states, which have already taken this step.
- ☐ Enact a tax credit against the State corporate business and personal income taxes for increases in research and development spending. This measure is designed to increase the level of research and development in the state. Several competing states have enacted such a measure modeled after the federal research and development tax credit.
- ☐ Enact a tax credit against the State corporate business tax for increases in the level of capital investments. This measure would improve New Jersey's competitive position relative to other industrial states and encourage productive business investment in the State.

CONTINUING THE WORK OF THE COMMISSION

A catalyst is required to bring academia, business, and government together.

- ☐ Enact a tax credit against the State corporate business tax for contracted research at universities. This measure would spur academic-industrial links by encouraging firms to use universities for needed research.
- ☐ Exempt from the State corporate business and personal income taxes the income from patent royalties for patents first commercialized in New Jersey. This measure would capitalize on New Jersey's high rate of receipt of patents by encouraging patent-holders to commercialize them using local firms, thus creating jobs and investments in New Jersey.

The Commission is firmly committed to seeing its work implemented, while also recognizing that the policies and programs recommended here must be sustained and modified over time if the ambitious goals we have outlined are to be accomplished. As a result, the Commission believes there is a need for an oversight group to accomplish two broad functions.

The first function of this agency would be to monitor the Commission's recommended policies and programs and ensure their viability and direction. It is crucial that the focus of these policies remain firmly fixed on the science and technology sector of the New Jersey economy. The agency would be required to be responsive to the needs and resources available in the research laboratories of academia, business, and government. A catalyst is required to bring them together. Other states also have recognized the need for a formal organization that would promote these ties. The agency should play a supportive role in assisting the implementation of the two recommended investment vehicles — the New Jersey Venture Capital Partnership and the Direct Placement Fund.

The second broad function of such an oversight agency would be to carry out long-term evaluation and analysis of the State's science and technology policies. It would be responsive to economic change and begin early to develop short-term and long-term policies to promote investments by industry and academia in technologies which may emerge in the years ahead.

RECOMMENDATION 38 Establish a new oversight group responsible for implementing and evaluating the outcomes of the Commission's recommendations, and for formulating long-range plans and programs for science and technology in New Jersey.



Structure

This organization should be governed by a Board of Overseers, with a membership composed of senior representatives of business, labor, academia, and State government. The Chairman would be designated by the Governor, from among the membership he appoints with the advice and consent of the Senate, for five year terms. This group should not be a simple extension of the Commission; its membership must be constituted to suit new purposes. Representation of small industrial firms should be provided for explicitly. Competency and experience in technology and business start-ups should be a prime consideration in selecting industry representation. The Chancellor of Higher Education, the Commissioner of Commerce and Economic Development, the Chairman of the State Board of Higher Education, and the Executive Director of the Economic Development Authority should have *ex-officio*, voting membership on the governing board of this agency.

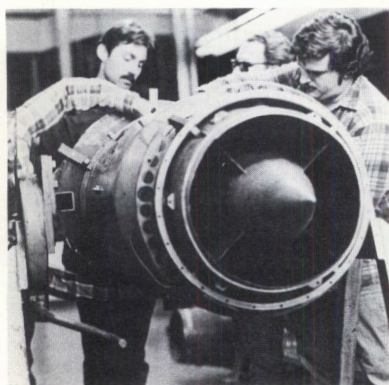
This agency should be structured as a semi-autonomous body and established through enabling legislation. As such, it should be located administratively in the Department of Commerce and Economic Development, but also should be accorded a precise level of independence. The Board of Overseers should appoint an executive director, who will serve at its pleasure. The Executive Director should be responsible for the selection of the remaining staff — individuals with a strong background in science and technology as well as in economic and academic development. The agency must be free to adopt, amend, and repeal bylaws for the conduct of its own affairs, and it must have flexibility with respect to employment and procurement practices. Precedent for such a semi-autonomous agency, encompassing most of the features mentioned above, is found in the relationship of the Economic Development Authority to the Department of Commerce.

In addition, this agency should make periodic reports on its activities to the Governor and the Legislature. Each such report should set forth a complete operating and financial statement covering the agency's operations. Its books should be audited, once a year, by certified public accountants.

Responsibilities

The functions of this agency should include a responsibility to develop and oversee policies and programs in science and technology for New Jersey, and to ensure that the programs are adequately funded to achieve their stated goals. Program development should specifically include stimulating academic-industrial collaboration through such mechanisms as Advanced Technology Centers, Innovation Partnerships, Business Incubation Facilities, and Technology Extension Services. The precise relationship of this agency to

**We have the resources — both
financial and human...**



these support mechanisms will vary. With respect to both the Advanced Technology Centers and the Business Incubation Facilities, the agency will plan and assist in the launching of new centers and facilities, but will limit its ongoing responsibility to funding recommendations and to monitoring the progress of the centers. The agency will coordinate the activities of the Technology Extension Services in conjunction with designated academic institutions. For the Innovation Partnerships, it will recommend funding levels, determine eligible fields, and supervise the process of awarding grants.

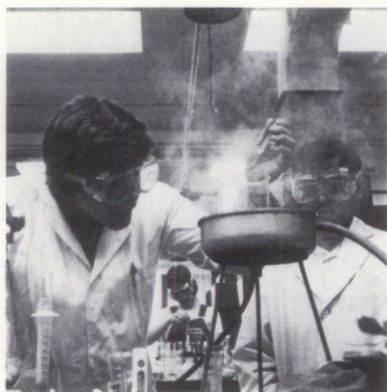
The responsibility of the agency would be to continue identifying and supporting research opportunities at New Jersey academic and other institutions that can advance economic development and employment. In addition, this group would encourage and coordinate activities to help entrepreneurs and inventors. The implementation of this pre-venture assistance should receive high priority.

This agency also would help to stimulate technology transfer between higher education institutions and industry. Federal agencies such as NASA and the Departments of Defense, Transportation, and Agriculture have impressive amounts of technology available for transfer and exploitation. The skillful dissemination of this information can make the difference between effective utilization and neglect.

In all situations involving either competitive applications for agency support, or judgments on complex scientific or technological matters, the agency should appoint a peer review committee for each of the fields or technologies, drawn from the academic, scientific, and industrial communities. Neither reviewers nor their affiliated institutions should be eligible as applicants. All of the programs funded through this agency must be held accountable for the quality and productivity of their activities. On the other hand, detailed direction to the various centers and services, focusing on procedures rather than content — what has been characterized as micromanagement — must be avoided.

This agency should play an important role in monitoring changes in national and international economic conditions that might justify a reorientation of the State's technology program. It should identify future fields that offer potential for application in New Jersey and help to find necessary funding sources.

To provide technical assistance and expert advice to the agency and to others in State government, we urge the creation of a New Jersey Academy of Applied Science. The primary function of the Academy would be to provide, on request, advice on scientific issues to the executive, legislative and judicial branches. The Academy would be a private non-profit corporation under the laws of New Jersey. The Academy



could receive a charter from the State but would not receive any State funds. The formation of the Academy would foster the expansion of collaborative professional relationships and exchanges among colleagues, which are vital to scientific and technological development. It also would help make the resources of this state's extraordinarily gifted and diverse scientific community available to decision makers in State government.



The Commission has identified the components of a technology development strategy that builds on New Jersey's numerous industrial and academic strengths. The strategy requires investment in ideas, enterprise, and people who can help to reaffirm New Jersey as a technological leader. Many groups in the state, including business, labor, education, and government are needed to work together to achieve the goals set forth here.

The Commission recognizes that it has set an ambitious agenda for State action. But we are convinced that the challenge confronting New Jersey is great and cannot be met by half measures. We do not have the luxury of time; the situation is serious enough to demand immediate action. We have the resources — financial and human — to achieve national leadership. We must now demonstrate that we have the will.

FISCAL IMPLICATIONS

The following discussion addresses the cost implications of the Commission's recommendations for State action. The major expenditures proposed are for capital construction requirements, program support, and research equipment for the Advanced Technology Centers and Innovation Partnerships. It is anticipated that State appropriations will serve to leverage federal and private sector matching contributions. State support will be reduced as these Centers become self-sustaining.

1. Capital Needs

The successful development and implementation of New Jersey's science and technology program will require, in most instances, capital expenditures for research facilities and laboratories at the Advanced Technology Centers. Table I separates these needs as they are now identified into two stages — priority funding and second-stage development. In both cases, these are the Commission's best estimates at this time. Detailed supporting documentation is being developed.

The principal vehicle for financing these capital improvements should be State-issued general obligation (G.O.) bonds. Consideration also should be given to the use of the institutional bonding authority of Rutgers University and the UMDNJ to offset, by \$20 million, the capital construction costs of the biotechnology center, and reduce by the same amount the funds to be raised through G.O. bonds.

In addition, the Commission recognizes that substantial capital funds are necessary to maintain high quality science and technology education at the state and community colleges, as well as at many independent institutions of higher education. These needs are projected at \$23 million and also should be funded through G.O. bonds. The Commission urges the Chancellor of Higher Education to identify the

priority needs in this latter area for incorporation into such a bond issue. We strongly recommend that a referendum be included on the ballot in November 1984 to cover all of the above requirements.

Table I
Capital
Budget Projection

A. Stage One Needs (Priority)

1. Advanced Technology Center for Biotechnology	\$40,000,000
2. Cooperative Research Center for Hazardous & Toxic Waste	7,000,000
3. Center for Ceramics Research (CCR)	9,000,000
4. Center for Food Technology ..	6,000,000
	<u>\$62,000,000</u>

B. Stage Two Needs

Although we are not able at this time to ascertain certain additional needs with the same finality as those identified for stage one, the Commission is convinced that over the next several years there will be capital requirements in several, if not most, of the following fields: additional ceramics development, fishing and aquaculture, materials handling, surface modification technology, telematics, as well as possible other areas which the Commission's successor will identify. For this reason, we strongly urge that sufficient funding be available to permit timely forward movement in such areas as soon as their importance is confirmed and their requirements more precisely identified.

	<u>\$77,000,000</u>
Rutgers/UMDNJ Revenue Bond to be applied to the cost of the Biotechnology Center	(20,000,000)
	57,000,000
Community Colleges, State Colleges, and Independent Institutions	23,000,000*
Recommended Science and Technology General Obligation Bond	\$80,000,000

2. The Recommended FY 1985 Operating Budget Request

The FY 1985 science and technology operating budget request is recommended at \$9,327,000 (Table 2). It provides funding for a significant program which will signal to New Jersey and national industry that the State is ready to play its part in reaffirming New Jersey as a technological leader. This budget request is comparable to, but somewhat less than, the FY 1984-85 budgets proposed for similar programs already established in the surrounding states of New York and Pennsylvania. These funds also will be subject to matching requirements according to guidelines adopted by the Commission.

This budget request has two parts: \$9,036,000 to launch major initiatives in five priority technological fields and other emerging fields, and \$291,000 to establish a science and technology agency to succeed the Commission.

Table 2
FY 1985
Operating Budget
Request

Program	FY 1985 Request
A. Technology Field	
1. Biotechnology	\$1,900,000
2. Hazardous and Toxic Substance Management . .	1,200,000
3. Material Science	2,511,000
4. Food Technology	1,200,000
5. Telematics	1,600,000
6. Future Fields	
a. Fusion Technology	100,000
b. Materials Handling	200,000
c. Fisheries Development/ Aquaculture	250,000
d. Other Potential Fields . . .	75,000
B. Science and Technology Agency Support	291,000
TOTAL FY 1985 REQUEST	\$9,327,000

We project that this level of funding in the future, in constant dollars, will at least equal this recommendation and probably grow. We believe that this measured growth rate will permit sufficient support of the Commission's present program recommendations and provide some additional activities in other emerging fields.

*These funds will be applied to the construction and improvement of instructional laboratories, computer and education facilities, and the overall provision of space for equipment installations which serve to improve the general education base in science and technology. All such construction projects will receive the prior approval of the Chancellor and Board of Higher Education.

ACKNOWLEDGMENTS

The Commission's work is the result of the collaborative efforts of many people. It was gratifying for us to participate in a project where so many gave freely of their time and expertise to improve the quality of life in New Jersey. In the following pages we have listed those who were helpful to us. To those listed, and to those many whom space considerations have forced us to omit, we express our gratitude.

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ANNOTATED BIBLIOGRAPHY

The following background papers provide detailed analysis and support for the recommendations found in this report. Single copies of reports, prepared under the auspices of the Commission, may be obtained through the Commission's Office at 225 West State Street, CN542, Trenton, New Jersey 08625. These reports are marked with an asterisk.

GENERAL BACKGROUND — NATIONAL

America's Competitive Challenge: A Report to the President of the U.S. from the Business-Higher Education Forum, April 1983. This report covers a wide array of economic and educational issues in outlining an action plan for restoring America's competitive position in the world.

The Condition of Teaching: A State-by-State Analysis, The Carnegie Foundation for the Advancement of Teaching, September 1983. The report explores the conditions affecting the teachers in the nation's schools and makes recommendations for change.

High Schools, The Carnegie Foundation for the Advancement of Teaching, September 1983. This report, which is the culmination of a comprehensive three-year study of the American high school, calls for improvements in teacher education and working conditions, and strongly recommends widespread collaborative efforts between high schools and colleges.

A Nation at Risk: The Imperative for Educational Reform, Report of the National Commission on Excellence in Education, April 1983. This landmark report confirms the existence of a national crisis in education. It recommends the establishment of more rigorous high school graduation requirements, the devotion of more time to schooling, the payment of higher salaries to teachers, and the implementation of incentives to attract more qualified people into the profession.

Report of the Commission on Precollege Education in Mathematics, Science and Technology, National Science Board, September 1983. This National Science Foundation panel report presents a national action agenda for improving mathematics and science education.

Report of the National Task Force on Education for Economic Growth, Education Commission of the States, June 1983. The report of this panel of eleven governors and seventeen leaders of business, academia and labor calls attention to the national need for a well-educated labor force and recommends a number of educational initiatives, many directed at fostering excellence in teaching.

Report of the Task Force on Federal Elementary and Secondary Education Policy, Twentieth Century Fund, May 1983. Although this group supports continued state and local responsibility for providing public education, its report stresses the importance of federal funding to sustain a high-quality system open to all Americans.

GENERAL BACKGROUND — NEW JERSEY

New Jersey's High Technology Economy, New Jersey Department of Commerce, February 1983. This paper identifies major components of high technology industry in New Jersey and compares their employment trends between 1975 and 1980 with those in 15 selected states.

The Performance of High Technology Manufacturing Industry in New Jersey, prepared by Joseph J. Seneca and Adam Broner of the Economic Policy Council, March 1983. This report quantifies growth in New Jersey's high technology manufacturing sector during the 1970's. It charts changes in employment, productivity, and the value of the State's manufactured goods.

The Status of High Technology Industry in New Jersey, prepared by Louise Westerholm, Rutgers, The State University, January 1983. This paper develops a model for identifying high technology fields and compares New Jersey's performance in these fields with other selected states and that of the nation as a whole. The study focuses on the mid 1970's.

INVESTING IN IDEAS

***Academic-Industrial Innovation in New Jersey: Final Recommendations for New Public Programs**, prepared by Michael Barker for the Task Force on Academic-Industrial Innovation Centers, May 1983. This paper examines in detail the recommendations for the several complementary programs to promote academic-industrial collaboration. Each of the following proposals is addressed:

Innovation Partnership, Technology Development Centers, Advanced Technology Centers, and Technology Extension Services.

***Evaluation of the Impacts of State Investments in New Technologies in New Jersey**, prepared by Roger J. Vaughan for the Task Force on Academic-Industrial Innovation Centers, April 1983. This paper presents a framework for determining what types of technology the State should focus its investment upon to promote academic-industrial collaboration.

***Leadership Factors in the Development of High Technology Complexes**, prepared by Jonathan J. Fleming for the Task Force on Academic-Industrial Innovation Centers, January 1983. This paper discusses leadership as an essential ingredient in technology-based business growth. It examines the role leadership has played in a variety of arenas and the circumstances that could foster its growth in New Jersey.

***Report of the Committee to Explore the Possible Establishment in the State of New Jersey of an Advanced Technology Center in Biotechnology**, November 1983. This is the report of the special biotechnology panel convened by Governor Kean.

***Report of the Task Force on Academic-Industrial Innovation Centers**, July 1983. One of the Commission's four major background reports, this paper synthesizes and prioritizes the findings of the Task Force's four subordinate Working Groups (see below), each of which addressed the question of how to encourage collaboration between the state's universities and industrial firms. Several financial structures are suggested to ensure implementation of the policies.

***Report of the Working Group on Biotechnology**, for the Task Force on Academic-Industrial Innovation Centers, June 1983. This paper presents essential background information on biotechnology and analyzes the state's strengths in both the industrial and university-based biological research communities. The report makes recommendations on how the State can stimulate this emerging field.

***Report of the Working Group on Biotechnology, Concerning Food Science and Technology**, for the Task Force on Academic-Industrial Innovation Centers, June 1983. Assessing New Jersey's commercial and academic resources in this interdisciplinary field, the report provides the framework for making precise recommendations for food technology in New Jersey.

***Report of the Working Group on Future Fields**, for the Task Force on Academic-Industrial Innovation Centers, May 1983. This paper explores a variety of established and emerging fields in New Jersey's universities and firms. It presents background information on the growth potential of thirteen different technological areas, including materials sciences, fishing, materials handling and hazardous and toxic substances.

***Report of the Working Group on Integrated Manufacturing Processes**, for the Task Force on Academic-Industrial Innovation Centers, May 1983. This report analyzes New Jersey's academic and industrial strengths in this field which applies new technologies to traditional manufacturing processes.

***Report of the Working Group on Telecommunications**, for the Task Force on Academic-Industrial Innovation Centers, May 1983. This paper discusses how New Jersey's industries and academic institutions will benefit from technological and administrative change in this rapidly evolving field. It also assesses the state's industrial and university-based strength in telecommunications.

INVESTING IN ENTERPRISE

***High Technology Enterprise Development Areas for New Jersey: Policy Guidelines and Alternatives**, prepared by Scott M. Reznick, for the Task Force on Improving New Jersey's Economic and Regulatory Climate, April 1983. This paper examines how geographically targeted tax, regulatory and financing tools can be used to promote high technology economic development.

***Pension Fund Investments**, prepared by James J. Marino, Esq., for the Task Force on Capital for New Technologies, May 31, 1983. This legal memorandum explores the issue of statutory or regulatory changes for pension fund investments in high technology business development.

***Regulatory and Other Policies to Encourage High-Technology Development in New Jersey**, prepared by Roger J. Vaughan for the Task Force on Improving New Jersey's Economic and Regulatory Climate, May 1983. This report presents background information and recommendations for regulatory reform for high technology development.

***Report of the Task Force on Capital for New Technologies**, July 1983. Prepared by Michael Barker, this paper is one of the four major background reports of the Commission. It presents recommendations for establishing mechanisms to increase the availability of capital for business start up and expansion.

***Report of the Task Force on Improving New Jersey's Economic and Regulatory Climate**, July 1983. This is one of the four major background reports of the Commission. It presents recommendations in the areas of tax, regulatory, and other policies to improve New Jersey as a place to conduct business.

***The Role of New and Small Business in High Technology Development in New Jersey**, prepared by Roger J. Vaughan for the Task Force on Improving New Jersey's Economic and Regulatory Climate, January 1983. This paper reviews what is known about the role of small and new business in determining the local rate of economic growth and in developing new products and processes.

***Tax Policies to Encourage High-Technology Development in New Jersey**, prepared by Roger J. Vaughan for the Task Force on Improving New Jersey's Economic and Regulatory Climate, March 1983. This paper presents a taxation strategy and examines various tax reform proposals.

INVESTING IN PEOPLE

***Addressing New Jersey's Manpower Needs in a Technological Economy**, New Jersey Department of Higher Education, August, 1982. The study examines employment and educational trends in New Jersey in engineering and related fields, and makes recommendations to address current and anticipated faculty and equipment shortages in technology-based educational programs.

***Determinants of Academic Achievement: A Review**, prepared by Jane Hannaway for the Task Force on Technology Trained Manpower, April 1983. This paper reviews research findings that pertain to the effectiveness of elementary and secondary schools. The importance of such factors as administrative leadership, time in the classroom, discipline, and parental involvement are discussed.

***Employment Policy in an Era of Economic Change**, prepared by Michael Barker and Roger J. Vaughan for the Task Force on Technology-Trained Manpower, May 1983. This paper presents policy options for the State in the areas of technical education and vocational training.

Recommendations for Engineering Education in New Jersey, by John G. Truxal, for the N.J. Department of Higher Education, October 1982. This report presents the results of a study of the current state of engineering education in New Jersey. It provides guidelines for a long range plan to assist that system to grow from its current status to the higher level needed to serve industrial and public interests.

***Report of the Task Force on Technology-Trained Manpower**, July 1983. One of the four major background reports of the commission, this paper identifies problems of the state's education and training system and recommends an agenda for reform and revitalization.

Graphic design and technical assistance for the production of this report were provided by Public Service Electric and Gas Company.

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