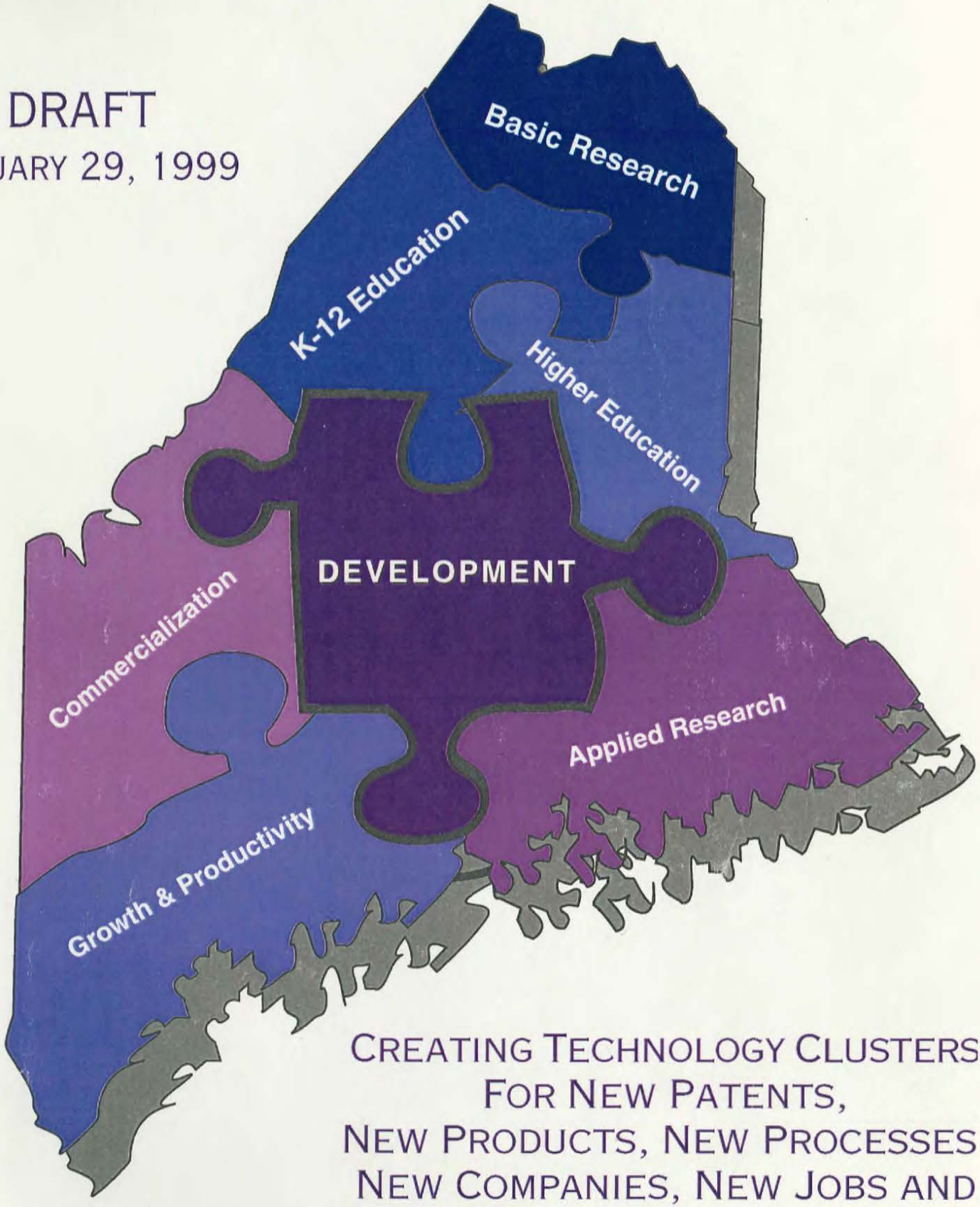
LEVERAGING MAINE'S TARGETED TECHNOLOGIES

DRAFT

JANUARY 29, 1999



CREATING TECHNOLOGY CLUSTERS FOR NEW PATENTS, NEW PRODUCTS, NEW PROCESSES NEW COMPANIES, NEW JOBS AND INCREASED TAX REVENUE

PREPARED BY THE TARGET INDUSTRIES COMMITTEE

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Supporting education, research and commerce through science and technology

January 29, 1999

Sen. Carol Kontos, Rep. Scott Cowger and Members of the Joint Select Committee on Research & Development
State House
Augusta, Maine 04333

Dear Members of the Joint Select Committee on Research & Development:

On behalf of the Target Industries Committee of the Maine Science and Technology Foundation, it is my pleasure to submit a draft report entitled "Leveraging Maine's Targeted Technologies". This report is in response to a legislative request that a private-sector working group develop recommendations on the "structure, process and distribution of $15 million a year to Maine's targeted technologies".

We hope this report stimulates a constructive dialogue leading to a program that will encourage exciting and successful innovation in Maine's economy.

We look forward to working closely with the committee in the weeks and months ahead.

Sincerely,

Joel B. Russ
President

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I. EXECUTIVE SUMMARY

In December 1998 the Joint Select Committee on Research and Development requested a private sector driven working group to develop recommendations on the "*structure, process and distribution of $15 million a year to Maine's targeted technologies*".[1] This summary responds to that request. It represents a consensus of Maine's targeted technologies, members of the King Administration and a member of the Joint Select Committee on Research and Development on the appropriate partnership between these targeted technologies and the State in significantly increasing the contribution of these technologies to the Maine economy. Guiding principles for this initiative are:

- ✓**Focus on commercialization of new technologies and products**
- ✓**Primary outcome is high wage jobs**
- ✓**Focus funds on state's targeted technologies**
- ✓**Funding levels should be substantial enough to make a difference**
- ✓**All targeted technologies can compete for resources**
- ✓**Targeted technologies agree on the organizational structure's delivery mechanism & governance is industry driven**
- ✓**An umbrella organization assumes fiscal responsibility**
- ✓**Administrative costs are kept low and non-duplicative of existing organizations**
- ✓**Grant funds are provided on a matched, competitive peer review basis**
- ✓**Return on investments is expected**
- ✓**Outcomes are defined and measurable**
- ✓**Program evaluation is routine and tied to sunset provision**

Based on these principles our recommendation is to create the Maine Technology Institute. Critical elements of this Institute include:

- **Mission statement** -- The Institute, through an effective public and private partnership, will stimulate research and development activity leading to the commercialization of new products and services in the State's targeted technology-intensive industrial sectors to enhance the competitive position of those sectors and to create new jobs for Maine people.
- **Institute organization** -- The Maine Technology Institute will be a not-for-profit organization governed by a 12 member, private sector driven board that consists of seven representatives from the targeted technologies and five public sector representatives including the Legislature, DECD, MSTF, the University of Maine System, and SPO. The Board will have two primary responsibilities:
  - First, it will serve as the fiscal agent for the Legislature to ensure the state's annual investment of $15 million in grants to private companies is wisely used and accounted for. This involves the full spectrum of application, disbursement, accounting and evaluation/monitoring of grant activities.
  - Second, it will work directly with the targeted technology sectors to stimulate and manage the research and development grant process in private companies through sector-specific boards. Where necessary, the MTI will provide start-up organizational and development grants to the targeted technology sector boards. The MTI will also identify crosscutting linkages between the technologies. It is anticipated that the Institute could be formed promptly and pursue its mission in the Fall of 1999.

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[1] See page 18 of the Committee's 12/98 report to the 119th Legislature. In it the R&D Committee adopts the Maine Science and Technology Plan as the basis for making investments in R&D. It identifies the most promising technologies that Maine should focus on.

- **Technology Development Boards** -- The Institute will support Technology Development Boards that are dominated by the private sector. They will identify promising technology developments, solicit competitive proposals, conduct peer reviews of the proposals and fund only the proposals that are most likely to lead to commercialization of a new technology or product.
- **Eligible uses of the funds & matching requirements** -- The primary use of the grant funds will be to develop new technologies and processes, product ideas, and to test prototypes. These are the necessary precursors to commercialization of products and services. For-profit companies and not-for-profit research organizations will be required to provide a minimum dollar for dollar match.
- **Return on investment** – The State will realize a return on its investment in two ways: 1) through direct payback from companies that successfully commercialize a product or process and 2) through the creation of new jobs and the increase of both individual and corporate tax revenues that result from those jobs.
- **Institute management and overhead expenses** -- The Institute will operate under an administrative cap. No more than 7% of the funds provided will be used for management and related overhead expenses. (This is comparable to or below other state grant programs.)[2]
- **Performance assessment and monitoring** -- The Institute will require applicants, based on established criteria, to identify quantifiable measures of performance to which they will be held accountable. For example, number of new jobs created, sales generated, patents produced, and corporate income taxes paid. Applicants will report on these measures during the grant period and for five years after the grant expires. The Institute will be required to annually report to the Joint Select Committee on R&D on these and other measures including the ability of technology sectors to create/expand clusters of economic activity.

The Institute will have a 7-year Legislative "sunset clause". To assist the Legislature in this review process the Maine Science and Technology Foundation will produce a comprehensive, biennial report that assesses the performance of the Institute and recommends modifications.

- **Targeted technology clusters** -- Through the State's *Science and Technology Plan*, the state has made strategic decisions about Maine's most promising technology areas where focused investments can produce significant results. The Maine Technology Institute will stimulate activity within these technology clusters and between technology areas.
- **Institute's guiding operating principles**:

  - The MTI **supports** rather than controls the technology sectors
  - The MTI incorporates **centralized administration** for efficiency
  - The MTI provides for **de-centralized decision-making** for effectiveness
  - The MTI provides **opportunity** without entitlement.

The success of the Institute in achieving its objectives requires a sustained infusion of substantial public and private funds. The $15 million proposed by the R&D Committee and supported by the King Administration is appropriate. If considerably lower funding levels are approved by the Legislature, the MTI should focus resources on the most promising technologies to attain the desired cluster of activity.

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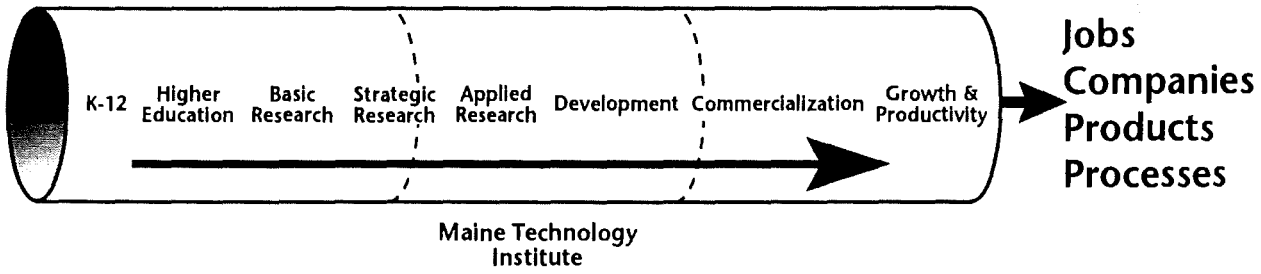
[2] DECD Community Block Grant Program, 10%. Small Enterprise Growth Fund, 2% management fee on $5 Million in investments plus $200,000 per year in administrative cost, plus in-kind contribution of volunteer Board that performs due diligence. CEI venture fund, 3% management fee; when allowed CEI recovers 10% in overhead costs. Maine Technology Investment Fund, 10% in start-up year, less 3% processing fee recovered on investments

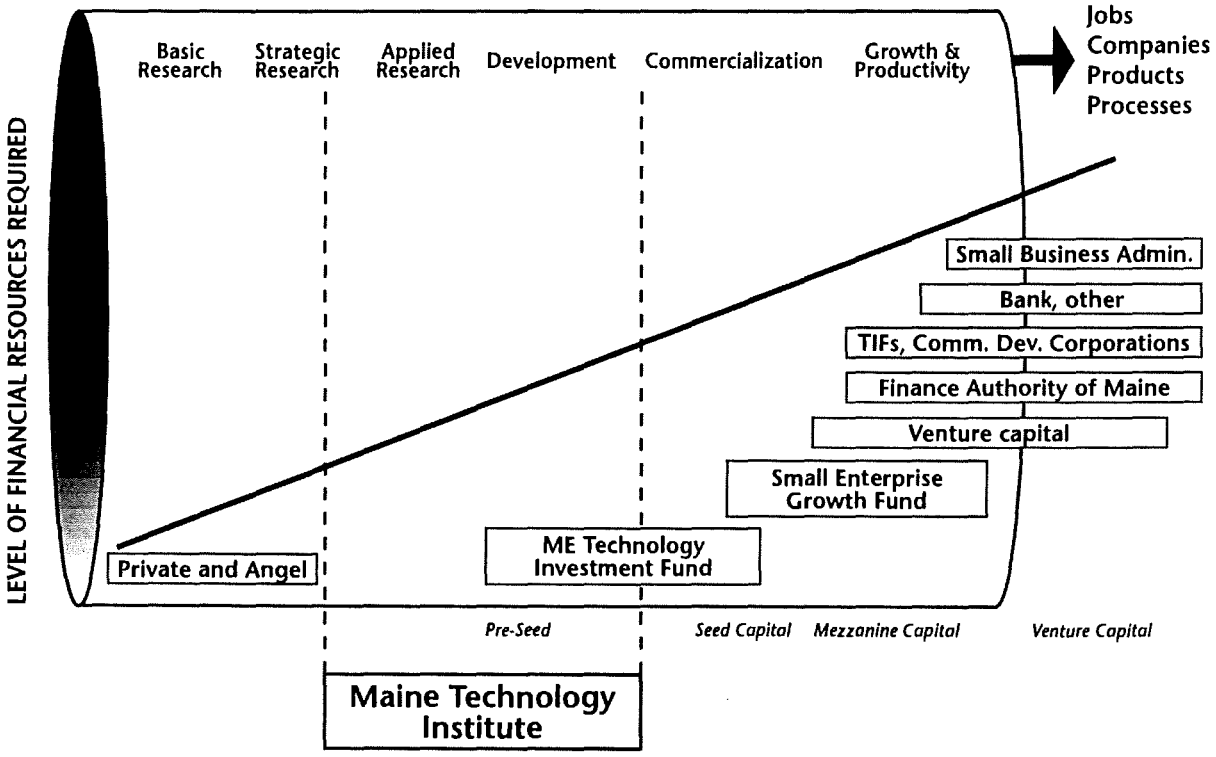
II. LEVERAGING COMMERCIALIZATION THROUGH A PUBLIC/PRIVATE PARTNERSHIP

The Science & Technology Pipeline



Maine is not void of entrepreneurs. To the contrary, Maine is void of a critical mass of ideas or innovations that reach the marketplace. Without a critical mass of innovations, venture capital firms are reluctant to invest substantial money in Maine. Without a critical mass of innovations, we lose the opportunity to ensure that Maine's technology intensive sector grows and creates high wage jobs for Maine residents. We also lose the opportunity to increase the competitiveness of Maine's natural-based industries through product and process enhancements. The solution is to ensure the presence of an adequate supply of *capital resources* to stimulate more quality innovations. As depicted on the graph below that illustrates the funding continuum in the technology life cycle, the deficiency in Maine's S&T financial capacity is in the early stages of development, before the technology products or processes are developed sufficiently to attract venture capital, mezzanine capital, and traditional bank financing.

Funding Continuum for Growing Technology Companies



Policy makers have consistently considered it the role of government to provide for traditional infrastructure needs such as transportation and utilities. Because of the blurring of the lines between science and technology and economic development, policy makers must also consider providing for the infrastructure that will foster the development of a critical mass of human and financial resources and innovations that will significantly contribute to economic growth in Maine. Examples of this type of infrastructure include research facilities, favorable tax incentives for R&D investments, and funding for grants that support innovations in the private and public sectors. Globalization of markets and the pace of technology change continue to drive private R&D to narrower, shorter-term investments to maximize returns to the company. Most private capital is reluctant to invest in anything less than a "sure thing" in terms of its own returns. In sharing the relatively high development risks of technologies that potentially enable a broad range of new commercial opportunities, possibly across several technologies, the state can foster projects with a high payoff for the state as a whole.

Addressing this financial gap will foster an **innovation environment** that will significantly contribute to strong employment growth in Maine's technology intensive sector and to innovations that will increase the competitiveness of Maine's natural resource-based industries.

Rationale for investing in the for-profit sector — This proposal for a Maine Technology Institute represents the second, key component of a comprehensive strategy to dramatically increase the level of R&D in Maine. The first component, focusing directly on the University of Maine System, is designed to expand its capacity to compete more successfully for federal government and national foundation grants in basic and early-stage applied research. Maine currently ranks last in the nation in the amount of university spending for research.

The Maine Technology Institute is directed at private companies and not-for-profit laboratories where the combined level of R&D activity has been traditionally low. This initiative is directed to emerging technology-intensive clusters of companies with great potential that are still comparatively small and, therefore, at a competitive disadvantage in national and international markets. Significant levels of R&D capital are the critical foundation required to test and develop the new ideas of small and mid-size technology-intensive companies that are developing and commercializing new products and processes. For some mid-size and large companies, potentially good ideas are often placed on a slow development track because their limited R&D resources require them to focus on only the most promising ideas or on those in which they have substantial sunk costs. This is a particular challenge for biotechnology companies where the time frame from idea generation through field-testing to FDA or USDA approval may be as much as 5-7 years.

In addition to the demonstrated need for this type of capital investment, the MTI is justified by the fact that this type of capital investment has worked successfully, often for as long as a decade, in other states and in programs of the federal government. Other models we have reviewed in the design of the MTI initiative presented in Appendices 4 through 7.

III. MAINE'S TARGETED TECHNOLOGIES

The *Maine Science and Technology Plan* identifies technologies that are conducting cutting-edge innovation and, therefore, represent sectors with high potential for growth, job creation, high wages and significant contribution to Maine's economy into the 21st Century. These technologies include Biotechnology, Advanced Materials and Composites, Environmental Services and Technology, Precision Manufacturing, Marine Science and Aquaculture, Software and Telecommunications. (Profiles of each technology sector are continued in Appendix 2.)

The Plan focuses on technologies rather than industries. Many Maine businesses in the traditional industries of fishing, farming, forestry paper products and textiles can and will use these innovative technologies in producing their products and services. Investments in these innovative technologies will yield processes and resources that will increase their competitiveness through value-added technology enhancement. In recognition of this, Advanced Technologies for Forestry and Agriculture is addressed in the Maine Technology Institute as a seventh technology sector.

IV. MAINE TECHNOLOGY INSTITUTE

A. Mission

The Institute, through an effective public and private partnership, will stimulate research and development activity leading to the commercialization of new products and services in the State's targeted technology-intensive sectors to enhance the competitive position of those sectors and to create new jobs for Maine people.

B. Goal

The goal of the Maine Technology Institute is to develop and support seven technology clusters that contain a critical mass of human resources and innovations that significantly contribute, on an ongoing basis, to the growth of Maine's economy in the 21st century. These clusters are identified in the State's Science and Technology Plan that serves as the foundation for the Institute's activities. Additional technologies desiring to be identified as targeted technologies may request that the Maine Science and Technology Foundation consider that technology as a priority during its biennial review of the Plan.

C. Measurable Objectives

The Institute will achieve this goal by investing in development activities that have high potential for commercialization that produce high wage jobs, expanded sales taxes, greater corporate income taxes, and other forms of economic return to the state. These objectives will ensure direct accountability to the legislature and facilitate annual reviews of the Institute's performance.

D. Principles

The Legislature's 1998 Joint Select Committee on Research and Development provided some guiding principles that it required be embraced in any proposal to stimulate commercialization. These included:

✓**Focus on commercialization of new technologies and products**

✓**Primary outcome is high wage jobs**

✓**Focus funds on state's targeted technologies**

✓**Funding levels should be substantial enough to make a difference**

✓**All targeted technologies can compete for resources**

✓**Targeted technologies agree on the organizational structure's delivery mechanism & governance is industry driven**

✓**An umbrella organization assumes fiscal responsibility**

✓**Administrative costs are kept low and non-duplicative of existing organizations**

✓**Grant funds are provided on a matched, competitive peer review basis**

✓**Return on investments is expected**

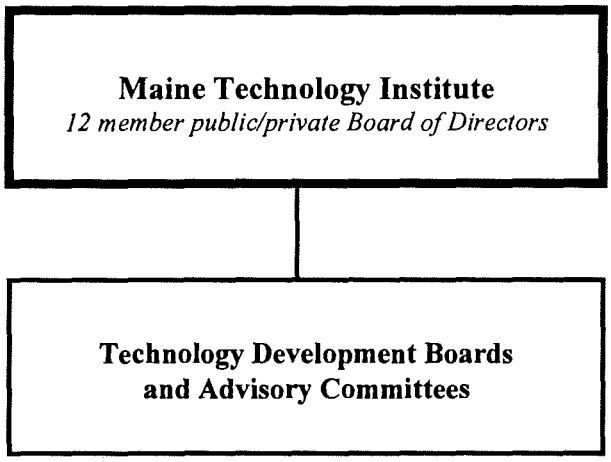
✓**Outcomes are defined and measurable Program evaluation is routine and tied to sunset provision**

E. Governance

1. The Maine Technology Institute

Establishment — The Maine Technology Institute will be a not-for-profit organization created in state statute.[3] The Institute's Executive Director will be a State employee, hired by the Department of Economic and Community Development and confirmed by the Institute's Board. It is anticipated that the Institute could be formed promptly and begin operating in the Fall of 1999.

MAINE TECHNOLOGY INSTITUTE
Organizational Structure



Composition — The Institute will be governed by a 12 member, private sector driven board of directors consisting of one representative appointed by each of the state's seven targeted technologies and five public sector representatives including the Legislature, Department of Economic and Community

[3] Example of a comparable not-for-profit entity within state statute is the Maine International Trade Center.

Development, the Maine Science and Technology Foundation, the University of Maine System, and the State Planning Office. The Institute's chair will be selected by the members on an annual basis.

The Maine Science and Technology Foundation will take the lead in forming the Board through a call for representatives as prescribed above.

Responsibilities — The Board will have two primary responsibilities. First, it will serve as the fiscal agent for the Legislature to ensure the state's annual investment of $15 million in grants to for-profit companies and not-for-profit research laboratories is wisely used and accounted for. This involves the full spectrum of application, disbursement, accounting and evaluation/monitoring of grant activities.

Second, it will assist in organizing the targeted technology sectors. This involves providing organizational and development grant funds to the targeted technologies and facilitating linkages between the technology sectors.

Staffing — The Department of Economic and Community Development will hire an Executive Director with confirmation by the Institute's Board of Directors at the time of hiring and thereafter on biennial basis. The MTI will hire clerical staff and a business manager/bookkeeper to ensure a high degree of accountability. The MTI may secure additional assistance depending on the level of granting being performed.

The Maine Technology Institute at a Glance

Type of Organization	Not-for-profit organization created in State statute
Governance	12 member private sector dominated Board with 5 from the public sector
Services	Grants/fiscal management & technical assistance to targeted technologies
Administration	Executive Director (additional staff dependent on level of grant activity)
Eligible technologies	Biotechnology, Marine Technology, Information Technology, Environmental Technology, Precision Manufacturing, Advanced Forestry and Agriculture Technology, Advanced Materials and Composites
Eligible activities	Within targeted technologies, the development of new products and processes, the development of product ideas, and the testing of prototypes.
Eligible applicants	For-profit companies and not-for-profit research laboratories
Operating budget	$15 million in state funds that are matched dollar for dollar from other sources. Administrative cap of 7%.
Financial mechanism	Grants
Return on investment	Program royalties are returned to Institute for disbursement
Technology participation	Targeted technologies form Research Development Boards to solicit competitive, peer reviewed proposals & monitor grant performance
Legislative review	Annual Legislative report requirement, biennial evaluation, and sunset provision

2. Technology Development Boards

Composition — The Institute will foster and support Technology Development Boards that are dominated by volunteers from the private sector who represent the full range of activities contained within a targeted technology (see Appendix 2 for profiles of the seven targeted technologies). The makeup of the Boards is expected to be diverse, and may include representatives from the academic

research community, not-for-profit research laboratories, and individuals working in the public sector on commercialization activities. The Institute will develop guidelines that articulate the expectations for Board composition, how a Board is operated, how it is to interact with other Boards and its relationship with the Institute.

Responsibilities — The Institute will develop guidelines that describe the scope of responsibilities for each Board. At a minimum these will include:

- Develop and implement procedures to broadly solicit competitive proposals, within that technology area, from all for-profit companies and not-for-profit research laboratories in Maine;
- Establish procedures for proprietary information and conflicts of interest;
- Establish peer review panels and manage the peer review process;
- Stimulate joint ventures within the technology area and with the other targeted technologies;
- Negotiate grants, consistent with MTI procedures, and fund proposals that are most likely to lead to commercialization of a new technology or product;
- Work with MTI to disburse funds as appropriate;
- Monitor and report on grant progress to the MTI;
- Identify promising technology developments and areas of research and assess the ability of Maine companies to respond to these global influences; and
- Cultivate the growth of for-profit companies in the targeted technology area through such activities publicizing the Institute's programs and encouraging participation.

Board Staffing — The level of Institute funding for staff support is proportional to the amount of grants the Board will issue and manage on an annual basis. It is expected this will not exceed one full-time equivalent position. The Board does have the discretion to solicit and obtain funding from non-Institute sources for other staff they deem necessary and appropriate.

Relation to the Institute — On request from a targeted technology, the Institute may provide initial seed funding to form a Research Development Board. The technology area, working with MTI criteria, will internally organize and petition the Institute to form a Board capable of performing the responsibilities articulated above.

Relation to Industry Associations — Industry associations offer a wide range of services to their members. It is anticipated these associations will continue to offer these services. Perhaps the most important distinction is that the Boards are not member driven organizations. Individuals will serve as volunteers on this public board.

Technology Development Boards at a Glance

Type of organization	To be determined at time of formation (e.g., Division of Maine Technology institute, not-for-profit corporation, etc.).
Governance	Non-member board representative of the widest breadth of the technology sector including for-profits, academia, not-for-profits and public sector.
Institute support	Technology sector organizational development necessary to operate grants program, proposal solicitation, peer review, and grant monitoring.
Non-Institute support	Board may solicit and receive funding from other sources to offer services requested by companies in the technology sector.
Administration	Cap of 10% of grant portfolio -- maximum of 1 full-time equivalent .
Relation to trade organization	Synergistic relationship that avoids duplicating services traditionally offered by associations

3. Technology Advisory Committees

In the formative years of the Maine Technology Institute, its Board of Directors will recognize that Maine's seven technology sectors are in varying degrees of internal organization. Some sectors will be able to immediately form Technology Development Boards that meet MTI criteria while others can petition to form a Technology Advisory Committee (an interim step toward forming a Technology Development Board). The primary difference between a Committee and a Board is that final grant-making authority rests with the Board. Rather than the MTI allocating an amount to a Technology Advisory Committee, as they do with a Board, the MTI will accept a prioritized list of peer reviewed proposals deserving of funding. The full MTI Board will then act collectively on all proposals from each Technology Advisory Committee.

If a technology sector is in the process of organizing, but does not yet have an MTI-approved proposal review process in place, a company in that sector needs a mechanism to go forward in the interim. There would be two alternative routes a company could follow:

1) A company can apply through an existing Technology Development Board. An existing Board will have the granting process in place to handle such an application. It would be the responsibility of the MTI staff person assigned to that board to find appropriate technical reviewers for the application.

2) A company can apply directly to the MTI. The Executive Director and Technical Manager would provide processing assistance and find appropriate technical reviewers for the application.

Once the technology sector has a Technology Advisory Committee in place and MTI has approved the Committee's proposal review process, a company could no longer apply directly to the MTI. The company would apply through a Technology Advisory Committee, or through a Technology Development Board, as appropriate.

F. Fiscal Management

The Maine Technology Institute will be responsible for all fiscal management activities (e.g., grants accounting, contracts with grantees, auditing, personnel & employee benefits, etc.) associated with the intended grant making process. This will streamline and minimize administrative costs, create predictability in internal processes among the Technology Development Boards, and make the application as simple as possible for applicants to access. To ensure the envisioned efficiencies and cost containment principles are realized, the Institute and the Boards will operate collectively within a maximum cap on administrative expenses of either 7% of the annual state appropriation or $350,000 -- whichever is greater.

G. Grant Administration

Characterization of grant program — It is expected that during the first year of operation, the Maine Technology Institute will receive and review 150-200 applications for R&D commercialization projects from for-profit companies and not-for-profit laboratories. Awards averaging $150,000 each will be made to 65-90 companies depending on the total funds available, though the average size of award may vary by technology sector. In those sectors where a Technology Development Board has been established and

its regranting procedures approved by the MTI via Board Operation Grants below, those boards (probably 2-3) will be responsible for the entire peer review and award process in at least two and perhaps as many as four award cycles. These boards are expected to process up to half of the applications and available funds. The remaining applications and funds will be processed by the MTI directly with the assistance of Technology Advisory Committees for those sectors that do not have development boards with granting authority.

Grants Management Procedure — On an annual basis, the Maine Technology Institute will use the following procedure to discharge it duties:

1) Board Operation Grants — The Institute will support two types of activities within the Boards. The first is technical assistance in the form of either financial or human resources to help a technology sector create a Board. A single financial assistance award to a technology sector will be negotiated and awarded for up to a two-year period. Further financial assistance will be dependent on the sector meeting minimum MTI organizational criteria for establishing a Technology Development Board. The second is an annual grant to established Boards to solicit, peer review, negotiate and fund grants, monitor performance and report to the Institute's fiscal management staff.

2) Annual commercialization grants — The Institute will use the following process to annually distribute grant funds to companies and not-for-profit research laboratories through Boards or Committees.

Boards —

- Institute assesses Board's performance and, if appropriate, provides a block grant;
- Boards develop Requests for Proposals, solicit and receive proposals, conduct the peer review, select the most competitive proposals using standard scoring criteria (e.g., technical/scientific merit, proximity to commercialization, market potential, business merit, due diligence, leveraging other funding, multiple technologies involved, matching requirements met or exceeded, participation by higher education, etc.);
- Boards negotiate the terms of the grant with the applicant;
- Board may request additional funds if the initial MTI block grant is insufficient to fund the highest quality proposals;
- Board and MTI financial staff finalize contractual arrangements with grantee;
- Board monitors progress, reports to MTI which makes grant payments
- Board issues closeout report to MTI which closes out grant

Committees —

- The Institute advises the Committees of the availability of funding and requests funding proposals
- Using Institute guidelines, the Committees develop Requests for Proposals, solicit and receive proposals, conduct the peer review, select the most competitive proposals using standard scoring criteria (e.g., technical/scientific merit, proximity to commercialization, market potential, business merit, due diligence, leveraging other funding, multiple technologies involved, matching requirements met or exceeded, participation by higher education, etc.) and place them in rank order;
- Institute decides on proposals and MTI staff negotiate contractual arrangements with grantee;
- Committee monitors progress, reports to MTI which makes grant payments
- Board issues closeout report to MTI which closes out grant

Company and Not-for-profit Laboratory Access to Grants — Eligible applicants may apply to any relevant Board for grant funding. For example, an information technology company with a proposal to create marine biotechnology analysis software may apply to the Information Technology Research Development Board, to the Marine Technology Board or the Biotechnology Board. In fact, the Institute will continuously foster this "cross-fertilization" among the technology sectors.

To ensure access to grant funds, the Institute's Board, in its formative years, will be flexible in its approach to eligible applicants that do not have a specific Technology Development Board to which they can apply.

Standard Grant Conditions — The Institute will promulgate standard terms and conditions that all Boards will use in contracting with grantees. Examples of these include:

- Matching funds — Meets minimum of 1-1 match requirement (cash, equipment or labor)
- Outcomes defined — the Board and grantee will define measurable outcomes and report on these to the Institute
- Return on investment — The Institute will award two types of grants:

    1) **Seed Grants** — These grants are targeted at early stages of the development/commercialization process (like proof of concept) and are expected to range from $40,000 to $150,000. Seed grants will not require any payback because (1) grant funds can be put to work much more rapidly in more companies if the contract is not complicated by ROI requirements and negotiations; (2) the time lag between the project and actual introduction in the market may be quite lengthy -- often as long as 4-8 years for new products that require FDA or Dept. of Agriculture approval; and (3) the amounts of individual awards are comparatively small. In addition, comparable federal government programs such as SBIR do not require paybacks.

    Despite no direct payback on Seed Grants, there are other indicators of success that will bring benefits to the state and to the process. In addition to the direct jobs created by the project while it is in progress, successful projects will lead to follow-on funding including SBIR phase I and II awards and Challenge grant awards (which require a direct ROI), and perhaps investor capital.

    2) **Challenge Grants** — These grants are targeted at the later stages of the commercialization process, which are closer to market (like field trials or beta tests). These are expected to range from $100,000 to $500,000. Challenge Grants would require a specific payback, say, twice the original award amount and/or some variation to be established for all projects if the product gets to market or the new process is put in place. In essence, this is a "forgivable loan" if the project does not lead to a new product or process.

Although the Institute might expect fewer Challenge grants than Seed grants the total dollar value will probably be much larger for Challenge grants. Therefore at a potential 2:1 payback there would be a significant amount of cash return to the MTI within the first 4-5 years of the program.

Beyond the "accounting perspective" on ROI there are other outcomes associated with a program of this type. Examples include more patents and licensing agreements, increased sales and stronger competitive position for a company and for the industrial sector, more jobs, higher corporate and individual income tax payments. The MTI Board will also focus on its success in building technology clusters.

Eligible Activities —

Examples of grants that might be eligible would include:

1) XYZ manufacturing company has a product that is losing market share. In order to produce a new product with market potential, it needs to develop new process technology.

2) BBB Biotechnology Company has acquired the rights to certain antibodies. The company may seek to do strategic research to determine technical feasibility.

3) NNN Environmental Co. has developed a new product prototype, on which it has filed for patent protection. The company is seeking funds for final design in order to ramp up production and roll out the product.

4) SEA Co. is in early stage development for a new aquaculture process. It seeks funds to test the process at a laboratory scale.

For-profit, not-for profit organizations and other activities that foster the development of technology clusters, such as incubators, would be eligible for funding by the Maine Technology Institute. Incubator proposals supported by companies and/or not-for-profit organization can submit competitive proposals through the appropriate Technology Development Board for review. The MTI will also work with the incubator applicant(s) to identify other sources of funding such as the Community Industrial Building Program at the Department of Economic and Community Development.

Technology Business Incubators — Technology incubation involves the linkage of public and private sector resources to enhance and accelerate the transition of research and development ideas into commercial opportunities. Technology incubators assist new ventures in the transfer of technology, access to intellectual property support, and access to managerial, technical, and business know-how. These elements of support include educational programs, development and management of technical support networks, providing shared infrastructure and providing specialized equipment.

Other expertise provided by incubators may include management, marketing, finance, accounting, production, manufacturing, legal, scientific, and engineering disciplines. In addition, incubators may provide help in developing access to capital and financing, access to external technical facilities, assistance in forming technical teams, and assistance with technical reviews, peer review assistance, and assistance in forming strategic partnerships.

Through partnerships with local educational institutions, technology incubators may administer student intern programs and may assist in identifying and contacting academic expertise. Finally, incubators may assist in integrating new ventures into the technology cluster through the network of supporting resources that are facilitated at the incubator.

Firms that start in technology incubators generally stay for a period of three years or less, then graduate to be free standing, and usually settle within a short distance from their starting point. Evidence from a 1998 national study by the University of Michigan, Ohio University, The Southern Technology Council, and the National Business Incubator Association showed a survival rate of 87%. The study showed that incubator company growth exceeded national averages, with annual sales growth of more than 400 per cent.

H. Legislative Accountability and Support

The Maine Institute of Technology will be created in state statute as a not-for-profit entity. It will be held accountable through a variety of mechanisms including:

1) Annual Reporting Requirement -- The Institute will produce an annual report to the Legislature on its granting activities and the results of those grants.
2) Public Sector Serves on the Board -- The Institute's 12 member Board contains one Legislator and two cabinet appointments. In addition, the Institute's Executive Director will be a state employee.
3) Legislative Sunset Clause -- The legislation forming the Institute will contain a 7-year sunset clause that will explicitly require a through review and conscious decision to continue the Institute's mission.
4) Biennial Evaluation -- The Maine Science and Technology Foundation will assist the Legislature by conducting a biennial evaluation of the processes and results of the Institute.

I. Funding Levels

The Institute will receive $15 million/year to invest in Maine's targeted technologies. Accordingly the funds will be used as follows:

- For-profit company and not-for-profit research laboratory grants $13.95 million
- MTI & Technology Development Board management (7% cap) $1.05 million

APPENDICES

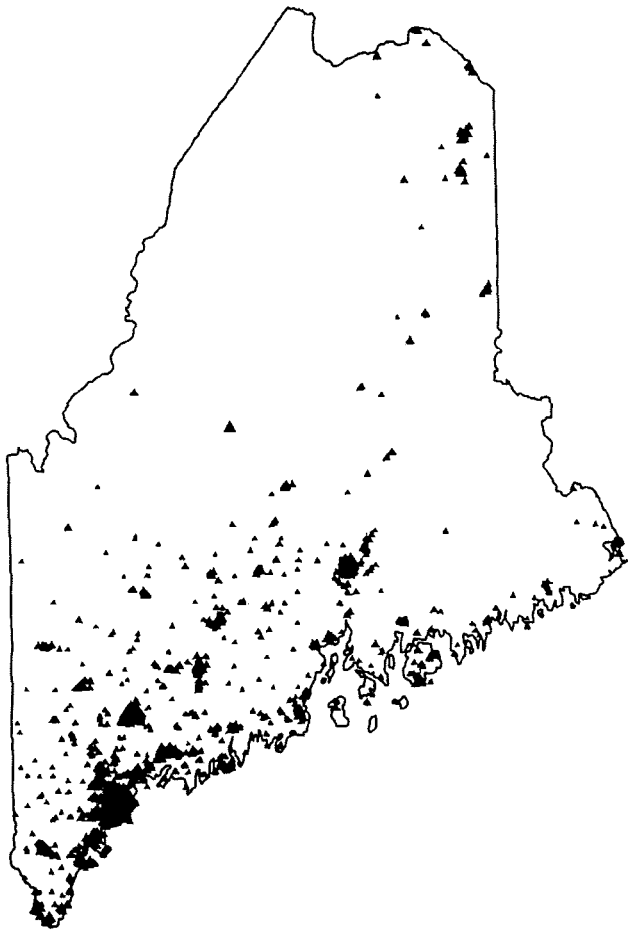
Appendix 1. Context for the Maine Technology Institute — A Time Line

1992	Legislature requests Maine Science and Technology Commission, predecessor to the Foundation, to develop a Research and Development strategic plan for the state.
1994	Maine Chamber and Business Alliance issues *Charting Maine's Economic Future*
1995	Maine Economic Growth Council issues *Measures of Growth*
1995	Maine Legislature approves Maine Technology Investment Fund
1995	Legislature authorizes and Maine citizens approve $5M Bond to fund the Small Enterprise Growth Fund
1996	Legislature approves Seed Capital Tax Credit
1997	Legislature forms the Joint Select Committee on Research and Development
1997	Maine Science and Technology Foundation releases *Maine's Science and Technology Action Plan*
1997	Governor King releases his *Economic Development Strategic Outline*
1998	Legislature authorizes and Maine citizens approve $20M R&D bond issue
1998	Joint Select Committee on Research and Development requests the Target Industries Committee of the Maine Science and Technology Foundation to develop an industry driven Maine Technologies Institute proposal
1999	Target Industries Committee presents its Maine Technology Institute proposal to the Joint Select Committee on Research and Development

Appendix 2. Profiles of Maine's Targeted Technologies

- Biotechnology
- Marine Technology
- Environmental Technology
- Information Technology
- Precision Manufacturing
- Agriculture and Forestry Technology
- Advanced Materials and Composites

Geographic Distribution of Maine's Technology-Related Companies



Biotechnology Profile

1. ***How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?***

   Maine's biotechnology industry cluster has over 70 for-profit companies plus a number of nonprofit research and clinical centers or institutes as well as research and academic programs at the UMaine and USM. Maine's industry produces products and services primarily in the areas of veterinary and medical diagnostics (64% of employment), agriculture (19%), and bioindustry suppliers (15%).

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

   The great majority of biotechnology companies have fewer than 50 employees with a large number less than ten.

3. ***Are there nonprofit or university-based research labs that are considered part of sector?***

   The principal nonprofit and academic institutions are the Jackson laboratories, Maine Medical Center Research Institute, Eastern Maine Medical Center, the Foundation for Blood Research, the Mount Desert Island Biological Laboratory, the University of Maine, the University of Southern Maine, and the University of New England.

4. ***What is the size of the sector 's workforce?***

   The biotechnology sector employs 4,700.

5. ***What is the average salary in industry?***

   More than $40,000 annually – 150% of the state average.

6. ***What are the anchor firm(s) in the sector?***

   The cluster's anchor institutions are Idexx on the commercial side, one of the ten largest biotech firms in the U.S., and the Jackson Laboratory, a world-class research laboratory in Bar Harbor.

7. ***What is the estimated volume of sales for the most recent year available?***

   Gross revenue of $400 million exceeds the combined gross revenues of the potato, aquaculture, finfish, lobster and sea urchin industries.

8. ***What portion those sales are to national and international markets?***

   It is estimated that 90+% of sales are out of state and 40-50% international.

9. ***What is the sector's estimated competitive position relative to national and international competition?***

   Major competitive strengths: Maine ranks 8th or 9th nationally in number of biotech firms; Idexx is 9th largest biotech firm in U.S.; some Maine firms hold a significant share of national or global veterinary markets; important "products from the sea" opportunities.

Major competitive weaknesses or challenges: Very limited connection of Maine biotech firms to academic and nonprofit lab activity; absence of med school in Maine; Maine not seen by non Mainers as a logical or safe place to start and grow a biotech company and/or career; heavy reliance on "old" biotech technologies [converting techniques already applied in one area to new markets] rather than new discoveries in molecular biology or genetics; over emphasis on niche market diagnostics rather than therapeutics; limited investment capital to support R&D on new products/services.

Major opportunities: To build on current presence by growing small and mid-size firms; diagnostic and therapeutic bio products from the sea; opportunity to build stronger linkages between private firms and Maine's nonprofit labs as well as well as academic departments; role of Idexx and Jackson Laboratories, in particular, in attracting top flight industry folks to Maine.

10. What are the sector's needs for R&D capital?

Major challenge in biotech industry is the long time-line of testing required to obtain FDA approval to get human diagnostics and therapeutics to market so that ROI's can be realized — and often the tests don't work out and a product never gets to market. It's almost as long to get USDA approval for the veterinary market. In those cases where FDA or USDA approvals are not required, new diagnostic products can be "leap frogged" within a number of months [similar to new software products]. Additional R&D capital resources from the "proof of concept" through the field testing stages would help small and mid-size companies [and labs] develop more products and get them through the process faster.

Marine Technology Profile

1. How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?

The term "marine" is defined in the dictionary as relating to the ocean. Many jobs in Maine relate to the ocean, or have ocean aspects including: food harvesting (commercial fishing and aquaculture), food processing, food packaging; commodity transport; commodity marketing; vessel design and construction; electronics; transportation; wildlife preservation, recreation, biotechnology, /pharmacology, and many other pursuits.

Throughout the discussion of the Maine Technology Institute (MTI) proposal, emphasis has been placed on new types of employment, new methods of production, the transfer of new types of technology and the creation of new sources of wealth for Maine people in the 21st Century.

For purposes of this profile document, the marine technology sector is defined to include the aquaculture and commercial fishing because the technologies involved in these subsectors do not fit discretely in any other industry sectors highlighted in Maine's Economic Strategy Outline.

For example, food processing and food packaging both employ technologies of concern to the precision manufacturing industry sector, and therefore are not covered in this profile. Marine vessel construction likewise employs technologies of primary concern to the composites industry sector, and therefore is not discussed here. Marine electronics, transportation, wildlife preservation,

recreation, and biotechnology/pharmacology all are similarly excluded by design from this profile because they fit better elsewhere.

While the wild harvest, ocean fishery is discussed in this profile, in all likelihood it will not be a prime industry candidate for MTI support because governments -- state and Federal-- are seeking to substantially reduce harvesting capacity by decreasing the number of Maine people who are engaged in commercial fishing. This is being done to preserve marine resources of commercial and social value, and to insure that a sustainable commercial Maine fishing industry will survive over time. Only by limiting harvesting technology, limiting harvesting effort, enhancing co-management structures, and putting in place advanced, restrictive, enforcement technologies will a smaller, leaner commercial fishing industry be assured of survival. A case will be made that MTI resources, in part, should be devoted to improving monitoring science and enforcement technologies.

Aquaculture, the farming of aquatic organisms in captivity, is conducted largely in, or on, the ocean in Maine, although some fresh water aquaculture is conducted at inland sites. The Maine aquaculture industry is relatively new, having begun here roughly forty years ago. Atlantic salmon, European mussels, and American oysters are the primary commercial products. Cultured seaweed also has been sold commercially during the past five years, and existing farms and potential new farmers are considering the future commercial culture of sea scallops, halibut, haddock, and soft shell clams.

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

The wild harvest, commercial fishing subsector consists of between 7 to 9,000 firms, stretched along Maine's 3,000 miles of coastline. The aquaculture industry subsector consists of roughly 25 firms, concentrated primarily in Washington, Hancock, and Lincoln Counties.

The typical commercial fishing firm is comprised of a lobster catcher, with a spouse who keeps the books. Often the primary license holder is assisted by a "sternman" who is frequently a minority partner in the fishing venture. In Maine's more active ports, firms operate with vessels requiring larger crews. Members of these crews are sometimes partners in the venture, and in other instances they are "Employees" in the usual sense. In Portland, a small number of individual entrepreneurs own several large vessels with employee crews. For the most part, commercial fishing operations are privately held corporations or limited partnerships.

The diffuse, owner-operator model, which dominates the commercial fishery, has benefited coastal communities and the state as a whole. Individuals hold 14, 000 commercial fishing licenses or

permits. Many fishermen hold multiple permits, and move from one fishery to another as stocks and markets fluctuate. In the national and international marketplaces, however, it is becoming increasingly difficult for Maine's owner-operators to compete with large corporations structured to survive bad economic times, and prolonged slumps in market prices.

Internationally cultured species account for roughly 25% of seafood production. Nationally the figure is 20%. In Maine, Atlantic salmon farming predominates in finfish aquaculture. Two large corporations produce a total of two-thirds of the total cultured product, the total "farm gate" value of which was $65 million in 1997. Resource economists familiar with marine products estimate the indirect value of Maine aquaculture to be $200 million, i.e., roughly three times the farm gate value. The total number of finfish aquaculture firms is 15, and the total number of shellfish farms is 12. Maine has two seaweed aquaculture companies.

3. ***Are there nonprofit or university-based labs that are considered part of the sector?***

The commercial fishing subsector works closely with university or college-based scientists and policy analysts. It also collaborates with scientists based at the University's Darling Marine Center, the Gulf of Maine Aquarium, the New England Aquarium, the Bigelow Laboratory for the Ocean Sciences, and the University of Maine at Machias.

The aquaculture subsector works with the same labs as the commercial fishing subsector as well as with the Mount Desert Island Biological Laboratory, the Beals Island Regional Shellfish Hatchery, and a private diagnostic lab, Microtechnologies, Inc. of Richmond. The Rockland-based Island Institute, although not a lab, conducts an impressive aquaculture field demonstration program. The Maine Aquaculture Innovation Center, a not-for-profit organization located in Brewer, arranges research and development partnerships between industry and members of the research community. The Marine Technologies Center of the Washington County Technical College has backstopped salmon aquaculture industry growth for over 15 years.

4. ***What is the size of the sector's workforce?***

The Commissioner of Marine Resources states that 22,000 Maine jobs are dependent on marine resources, including 850 jobs directly related to finfish shellfish and seaweed aquaculture. The 22,000 figure includes both direct and indirect employment. It should be noted that the indirect category includes processors, packagers, transporters, and marketers of marine products.

5. ***What is the average salary in industry?***

No average salary figures are available for the marine sector as a whole. Nor is there available an average salary figure available for commercial fishing subsector or the aquaculture subsector. In Washington County, workers on salmon grow-out catch sites earn $17.000 to $30,000 annually, depending upon their years of experience and levels of responsibility. The rate of pay increases as one moves westward toward Penobscot Bay.

Income from shellfish and seaweed aquaculture in many cases supplements family income from other source. Six to eight shellfish/seaweed aquaculture companies employ people on a full time, year-round basis.

6. ***What are the anchor firms in the sector?***

The anchor firms in the commercial fishing subsector are Stinson Canning Company (Prospect Harbor, Belfast, and Bath), TR Fish (Portland), Otonka Inc. (Portland), Roger Libby /Edward Thorbjornsen Partnership (Port Clyde), David Jordan (Scarborough), The Stonington Lobstermen's Cooperative (Stonington), and William Atwood Lobster Co. (Tenants Harbor).

Anchor firms in the aquaculture subsector include: Atlantic Salmon of Maine (Fairfield, Machiasport, Milbridge and Oquossuc); Connors Aquaculture (Eastport and Lubec); Great Eastern Mussel Farms (Tenants Harbor); Dodge Cove Marine Farm (Newcastle); Mook Sea Farm (Damariscotta); Spinney Creek Shellfish Company (Eliot), and Phycogen, Inc. (Portland).

7. ***What is the estimated volume of sales for the most recent year available?***

For the commercial fishing subsector the volume of sales is estimated to have been $273 million in 1997. For the aquaculture subsector, the volume of sales during the same year is estimated at $65 million.

In terms of pounds, the commercial fishery harvested 271 million pounds of seafood in 1997 and the aquaculture industry cultured 28.5 million pounds during the same year.

8. ***What portions of those sales are to national and international markets?***

A significant portion of Maine's annual lobster catch and farmed Atlantic salmon harvest are processed in Atlantic Canada, and conversely, some Canadian product is processed in Maine. Other products, such as monkfish tails and urchin roe, ultimately are destined for the Asian market, primarily Japan. Overall, it is estimated that 40% of Maine's seafood production moves overseas.

Much of the remaining 60% is sold as "fresh" product, and of course, nearly half (46%) of the Maine's total harvested product is Atlantic herring, a large proportion of which becomes bait for other Maine-based fisheries.

As value-adding, packaging, and transportation of seafood becomes more sophisticated, products originating in Maine are being marketed to distant destinations In recent years, fresh Maine lobsters, have been the subject of a successful overseas marketing campaign.

9. ***What is the sector's estimated competitive position relative to national and international competition?***

Maine is a minor player in every global seafood marketing sector with the exception of lobster. Due to our relatively low production levels, Maine is a market follower, rather than a market leader.

10. ***What are the sector's needs for R&D capital?***

The commercial fishery subsector is overcapitalized. Vessels and equipment are being taken off the water and processing plants gradually are being closed. Only the most modern and technically sophisticated processing facilities will remain competitive. Effective management of the commercial fishery in the future will require a substantial increase in monitoring science, now grossly underfunded.

Maine firms have invested roughly $60 million in aquaculture capital infrastructure over the past twenty years. The finfish aquaculture industry operates eight modern hatcheries and depends on state of the art processing facilities, the most recent of which, a $2 million building, was opened in 1997 in Machiasport. Since 1990 capital infrastructure growth has been financed either by firm owners, or by conventional means. Comprehensive incentive programs, which would encourage entrepreneurs to undertake long-range research and development initiatives, do not exist.

Environmental Technology Profile

1. ***How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?***

Environmental Business International Inc. is an organization that has been tracking the environmental industry for over 5 years. For purposes of tracking the industry, EBI has divided the environmental industry into three primary categories and fourteen segments:

SERVICES
Analytical Services
Wastewater Treatment Works
Solid Waste Management
Hazardous Waste management
Remediation/Industrial Services
Consulting & Engineering

EQUIPMENT
Water Equipment and Chemicals
Instruments & Information
Air Pollution Control Equipment
Waste Management Equipment
Process & Prevention Technology

RESOURCES
Water Utilities
Resource Recovery
Environmental Energy Sources

Each of these segments is represented in Maine. Although many of the segments are limited to for-profit companies, there are several segments that include services provided by municipal, quasi-municipal, and private businesses. Examples of these segments are: solid waste management, wastewater treatment works, water utilities, and resource recovery.

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

Inventories of Maine's environmental business sector have indicated that over 200 environmental businesses, including quasi-municipal organizations such as the Bangor Water District and Regional Waste Systems (Greater Portland Area) are operating in Maine. The great majority of environmental businesses have fewer than 50 employees.

3. ***Are there nonprofit or university-based research labs that are considered part of sector?***

The principal nonprofit and academic institutions are, the University of Maine, the University of Southern Maine, the University of New England, Bigelow Laboratory, Maine Maritime Academy, as well as privately funded research and product development performed by tenants of the Center for Environmental Enterprise and companies such as Kady International. According to the January 1998 report entitled, "An Initial Review of Maine's Academic and Non-Profit Research Development Assets", prepared for the Maine State Planning Office and the Maine Science and Technology

Foundation, environmental research and development performed by non-profits in Maine in 1997 was $2.56 million.

4. ***What is the size of the sector's workforce?***

Total employment in Maine's environmental sector is estimated at over 4000.

5. ***What is the average salary in industry?***

No industry specific data is available for the State of Maine. However, based on the high percentage of engineering and science positions in the industry, it is projected that the average salary in the industry is over/approximately $35,000.

6. ***What are the anchor firm(s) in the sector?***

The cluster's anchor institutions vary depending on the market sector. For example: Water Utilities include Consumers Water. Resource Recovery includes KTI, which owns MERC, and PERC. Consulting engineering includes Woodard & Curran, Wright-Pierce Engineers, and Harding Lawson Associates. Equipment/Technology companies include Kady International, Vortechnics, and U.F Strainrite. Environmental information technology includes TerraLink.

7. ***What is the estimated volume of sales for the most recent year available?***

According to the January 1994 report, "Charting Maine's Economic Future" , Maine's environmental equipment, goods, and services were $600 million in 1991. Due to the recession in the early 1990's, it is unlikely that this value has increased significantly since 1991.

8. ***What portions of those sales are to national and international markets?***

According to Environmental Business International, the market value for environmental service and technology worldwide is estimated at nearly $300 billion. If Maine can capitalize on just a small piece of this existing market it could mean millions in new market share and a substantial number of new jobs.

There is no environmental industry specific information on Maine's exports. However, based on U.S. environmental industry data approximately 10% of sales are for exports. Based on anecdotal evidence, Maine's environmental international exports are significantly less than the national average. Due to the infrastructure nature of much of Maine's environmental expenditures (water utilities, solid waste management, resource recovery) over 70% of the expenditures are in Maine. It is estimated that between 10% and 20% of the sales are outside of Maine.

9. ***What is the sector's estimated competitive position relative to national and international competition?***

Major competitive strengths: Maine's only business incubator supports start-up environmental companies with new technologies. The Center for Environmental Enterprise (CEE) currently has six start-up environmental companies employing over 20 people. These companies offer great growth potential in terms of new jobs in the environmental business sector. There is a strong linkage among CEE, the University of Southern Maine, and the Southern Maine Tech College where the incubator is physically located.

A recent NSF report on the status of science and engineering in the various states notes that in 1996 Maine invested up to 16% of its R&D monies in "environmental science." The national average of investment in this area is 6%. This relates to both an interest in this type of technology development but also to some existing R&D infrastructure in this sector. As one example, the University of Maine has a recognized strength in R&D work in new environmental sensor technologies including neural network sensor technology. One relatively new company, Sensor Research Development, which currently employs ten people, is a spin-off company resulting from this research effort.

Charting Maine's Economic future cites Maine's environmental management expertise, its clean environment, and its 30-year track record of compliance with stringent environmental regulations as advantages.

Major Opportunities: The energy-related environmental business opportunities are just on the horizon as a result of an emphasis locally and nationally on energy conservation technologies and alternative fuel technologies, i.e., fuel cells. This is a yet to be tapped area of growth for Maine as it heads into a deregulated energy marketplace by the year 2000.

10. What are the sector's needs for R&D capital?

The three research areas of greatest strength in Maine: biotech, composites, and marine science are strengths for the simple fact that millions of dollars of R&D money have gone to support them in a consistent fashion over the last ten years. There is a direct connection between such

investment and the strength of any given sector. The environmental sector has not seen such a sustained or substantial amount of R&D investment in its infrastructure at either the University or industry level. Greater access to appropriate levels of R&D funding, especially as match to attract greater federal dollars, which is steadily available over a number of years is what is needed in this nationally recognized growth sector.

Information Technology Profile

1. How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?

Information Technology is ubiquitous. It is apparent at software development companies as well as at a blueberry processing plant. It is as critical for agriculture transportation systems as it is for gene mapping. Improvements to Maine's legacy industries can be traced to productivity increases and value added enhancements through the introduction of new technologies. New companies and products are producing the technological breakthroughs that will ensure our competitiveness in traditional industries as well as in developing new industries and markets. Because of the scope of Information Technology (IT) in our economy, any definition will inevitably fall short. IT can be broken down into two broad areas: Software and Hardware. The primary services within Software would include: Retail (shrink-wrap and direct) development, Firmware and Custom application development, Internet development, Enterprise application development, Electronic Commerce and Telecommunication development. Companies such as SeaFax outsource the software development while others such as UNUM have extensive development staff in the IT department. The principal hardware categories would be: Telecommunication equipment, Microprocessors, Networking and

Computers and peripherals. Equipment manufactured in Maine has microprocessors that are programmed but are not attached to or a part of a computer or network. IT occurs in companies focused within each of the above categories as well as within companies across the State. Custom application software development is the area contributing the largest number of jobs and revenue to the industry.

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

The Maine Software Developers Association (MeSDA) is conducting an industry survey in 1999 to establish the number of firms in the industry. MeSDA is a statewide industry trade association for the software and information technology industry in Maine. The current database includes more than 1200 companies involved with software development and hardware equipment. This number does not contain companies without a true IT focus. The average employment size for firms in this sector ranges from 4 to 7 with several companies employing more that 100.

3. ***Are there nonprofit or university-based research labs that are considered part of sector?***

Current members of the Maine Software Developers Association include Jackson Laboratories, the University of Maine, the University of Southern Maine and the University of New England.

4. ***What is the size of the sector 's workforce?***

Current estimates range from 5,000 to more than 15,000. Data that are more complete will be available from the MeSDA Industry survey in 1999.

5. ***What is the average salary in industry?***

The industry average for professionals is $40,000 with many positions commanding more than $100,000 annually. The companies that pay these wages typically offer outstanding benefits to their employees.

6. ***What are the anchor firm(s) in the sector?***

DeLorme dominates the retail category. Wright Express is a major developer of custom software applications, Trefoil recently completed a major Federal project, James Sewall is a leader in digital mapping services, Aerohydro designed the hull for the most recent America's Cup victor. Envisionet offers tiered technical support for national companies - such as Prodigy, SeaFax is the industry leader offering 24 products and Techknowledge has developed a nationally recognized e-commerce program which currently runs the Maine Made web site.

7. ***What is the estimated volume of sales for the most recent year available?***

While sales numbers are not current, it is very interesting to report that the estimated spending on IT projects (excluding Year 2000 issues) at the Dunn & Bradstreet Maine 100 companies exceeded $450 million.

8. ***What portion of those sales are to national and international markets?***

It is estimated that 75+% of sales are out of state and 10-15% international.

9. ***What is the sector's estimated competitive position relative to national and international competition?***

Major competitive strengths: Maine is a leader in Geographic Information Systems (GIS) due in large part to the Spatial Information program offered at the University of Maine - one of three such programs in the country. DeLorme is a nationally recognized leader in the industry. Autometric, a Virginia based company, recently closed their Missouri facility and expanded their Bangor operation. Southern Maine's telecommunication infrastructure has allowed many new companies to locate to the area from other states.

Major competitive weaknesses or challenges: Poor reliability of telecommunication service and cost of service in central and northern Maine are constantly cited as negatives to growth. Maine currently lacks a Ph.D. program in computer science. Growth of new high technology companies typically is centered around areas with strong computer science programs. The University has been able to secure federal grants, but this opportunity will dramatically increase with a doctoral level program in computer science. Maine is only now beginning to make visible a growing computer technology industry. This exposure must continue to draw venture capital from outside of the area.

Major opportunities: The proposed Ph.D. program in computer science at the University is one of the greatest opportunities at this time. A strong statewide program will offer the support that all Maine businesses will need for the next century. Computer technology jobs can be created anywhere in our state. These jobs are not dependent on nor do they damage any of our natural resources. New technology companies can bring their businesses to Maine for quality of life issues. Software development and Information Technology can truly be a cottage industry with an adequate and reliable telecommunications infrastructure. Current developments and proposals that will enhance Maine as a location for high technology companies are Internet2, a Technology Center and Technology Incubators.

10. ***What are the sector's needs for R&D capital?***

Speed to market is essential for most developments in IT. Talent in the form of Intellectual Property is the asset in demand. Most investments in IT create jobs immediately. An excellent vehicle to support new companies and new ideas is a business incubator. Bringing together the support and mentoring infrastructure for creative ideas has proven to be an effective approach in growing the IT industry. The development of applications for new Internet and Telecommunications services will be a focus area of cutting and bleeding edge development.

Precision Manufacturing Profile

1. ***How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?***

The Maine Precision Manufacturing industry is a diverse collection of metals, electronics and transportation. For purposes of tracking the industry, the metals industry is divided into five primary technologies and ten products markets:

Metal foundry's	SIC 33
Metal Fabrication Shops	SIC 34
Metal Precision Machine Shops	SIC 35
Electronic Industry	SIC 36
Transportation Industry	SIC 37

MMPA members manufacture precision products for markets that include:

- Shipbuilding Industry
- Defense Industry
- Jet Aircraft Components
- Spectator Seating Industry
- Power Generation Industry
- Automotive Industry
- Medical Testing Industry
- Consumer and Industrial Precision Machine Tools
- Computer and Electronics Industry
- Industrial Machine Industry

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

Inventories of Maine's precision manufacturing industry employ over 400 businesses are operating in Maine. 90 % of precision manufacturing businesses have fewer than 50 employees.

3. ***Are their nonprofit or university-based agencies that are considered part of sector?***

The principal nonprofit and academic institutions are Market Development Center, the Maine Manufacturing Extension Partnership, the University of Maine at Orono IAC Program and the University of Southern Maine's ATEC development program in conjunction with Fairchild Industries and National Semiconductor in South Portland.

4. ***What is the size of the sector 's workforce?***

Total employment in Maine's precision manufacturing sector is estimated around 20,000 employees.

5. ***What is the average salary in industry?***

According to the Maine Department of Labor 1997 statistics, the average salary is $35,000. Approximately 15% higher than the average for other Maine manufacturers, and nearly 40% more than the average wage in Maine. Wages for the precision manufacturing industry has grown by 15% since 1994 and 58% since 1987.

6. ***What are the anchor firm(s) in the sector?***

The anchor institutions are Bath Iron Works, Fairchild Industries and National Semiconductor, GE-Bangor, Lemforder Corporation, SRD, Pratt & Whitney, Chinet Company, Edwards System Technology, Mid-State Machine and others.

7. ***What is the estimated volume of sales for the most recent year available?***

The January 1997 Department of Labor, Labor Market Information Services Reported that Maine's metal, electronics and transportation planned sales were $381 billion in 1998.

8. ***What portions of those sales are to national and international markets?***

The Department of Labor, Major Capital Expenditures & Foreign Trade by Major Industry in 1997 reports $509 million dollars in exports; Maine imported 97 million dollars of other product. If Maine can capitalize on just a small piece of this existing market it could mean millions in new market share and a substantial number of new jobs.

9. ***What are the sectors estimated competitive position?***

Major competitive strengths: The precision manufacturing industry is represented by the Maine Metal Products Association. They support, promote and introduce new technologies to improve the industry competitiveness and promoting technical education to develop the high-skill knowledge workers that this industry seeks.

MMPA has provided a strong linkage between education and industry. We established a scholarship fund 10 years ago, specifically for interested metal trade students to attend the technical colleges. Our $100,000 endowment goal reached, we provide monies for qualified students to further their education in the metals trade. Projects with the National Association of Manufacturing, the Manufacturing Extension Partnership and the 4 +2+2 Program (Gray-New Gloucester High School, Central Maine Technical College and the University of Southern Maine) will supply the skilled labor pool for our manufacturers. ATEC (Advanced Technology Education Center) teaches the skilled employees further advancing, specific to their company technologies and the Manufacturing Extension Partnership strength and knowledge in addressing industry needs has given manufacturers the competitive edge they need to survive.

Lemforder Corporation in Brewer, designed, developed and patented a new plastic stabilizer bar for the automotive industry. With industry making advancements and breakthroughs on an international level, charting Maine's economic future cites the metals industries as the continued backbone of Maine's economy.

Major Opportunities: The metal industry opportunities are so abundant and our unemployment rate is so low that companies are temporarily recruiting employees, for permanent positions, from outside the state.

10. ***What are the sector's direct needs for R&D capital?***

The precision manufacturing industry has not seen a sustained or substantial amount of R&D investment in its infrastructure at industry level. Greater access to appropriate levels of R&D funding would enable precision manufacturers to develop and commercialize costly new equipment and technologies and compete with out of state outsourcing.

An example is Rich Technology International (RTI), a new business unit of Rich Tool & Die Company, was established to develop implement new technologies and processes needed for their customers to remain competitive in manufacturing. And Rich Tool & Die Company has purchased a

state of the art laser machine that has allowed their company to gain GE-Bangor work, and keep the work and money in Maine.

RTI is also working with a local inventor, Rocco DiSanto, to complete the demonstration of a new concept waste combustion system. The commercialization of this project would give Maine a lead in technology for power-generation turbines to produce electricity. Earlier prototypes of this new furnace have burned fuels such as waste rubber (shredded tires), plastics, carpet remnants and coal. Emission testing is scheduled for February 1999.

The precision manufacturing industry will demonstrate a return on investment through annual R&D funding. Consequential return on investment will be achieved through substantially increased employment and positioning Maine as a leading state for precision manufacturing and technology development.

Agriculture and Forestry Technology Profile

1. ***How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?***

The Agriculture & Forestry-related Industries include thousands of firms in Maine that provide the backbone of the rural economy in the State. The businesses are united in this sector because of the raw materials are derived from or grown on Maine's land base, be it wood, food, fiber, or other agricultural products. Because of the variability in product and technology, the sector has traditionally been defined by the products and by the relationship of these businesses to the land base.

While all of the firms operating in this sector use a technology as part of their operations, not all firms are technology innovators. Nevertheless, technological developments have been having a significant impact on this sector. For example, mechanization has completely changed the face of the industry during the past 50 years. Machines have replaced workers, typically yielding fewer - but more highly paid - jobs. Or one can look at the information derived from satellite imagery that is influencing the decision making process for farmers and foresters.

The sector is segmented many clusters; some of these clusters have achieved national or international recognition, and others are only vaguely defined. Here are some examples of clusters in this industry sector: Blueberries, Cranberries, Furniture, Lumber, Organic food, Potatoes, Processed foods, Pulp & paper, and Wood products. In terms of manufacturers of durable and non-durable goods, the following SIC codes are important in this sector: 20 (Food), 24 (Lumber & Wood products), 25 (Furniture), and 26 (Paper).

Under the umbrella of the Maine Technology Institute, some of the technological developments within this sector intersect with technologies in one of the other six sectors. In the computer age, information technologies have an influence on businesses in all sectors. Pollution control in this sector has obvious links to the environmental sector; technological research on advanced equipment may link with precision manufacturing; and some agricultural research is directly related to biotechnology.

Other technologies are unique to this sector.

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

The great majority of the firms have fewer than 50 employees and most of these have fewer than 10. Many are family firms. Among the larger businesses, some are owned by local families, while others are owned by out-of-state business interests. According to the State Department of Labor, there are over 1000 manufacturing firms in this cluster.

Please note that farms are NOT included in this statistic. In addition to manufacturers, the sector includes many non-manufacturing businesses that have technology needs. Hundreds of firms are involved in farming and growing agricultural products. The sector also includes those companies and family firms that own and manage forestland. Companies that provide vital services to this sector, including assistance with technological development, also are not included in the numbers below, but they are integral to the successful growth of the clusters in this sector.

Manufacturing Industry	# Firms
SIC 20 - Food	150
SIC 24 - Lumber & Wood Products	886
SIC 25 - Furniture	40
SIC 26 - Paper	44

The statistics in this summary are from the 1996 Census of Maine Manufacturers, with wage and employment data from the Maine Department of Labor, Labor Market Information Service.

3. ***Are there nonprofit or university-based research labs that are considered part of sector?***

Yes. The University of Maine system has an ongoing research agenda in this sector.

4. ***What is the size of the sector's workforce?***

Total employment in agriculture and forestry-related businesses easily exceeds 100,000. Please note that most of these people are involved in making products, growing products, or managing resources. While many people are working on the development of new products or services, fewer are involved in research and development toward new technologies or manufacturing processes.

Manufacturing Industry	# employees
SIC 20 - Food	51,150
SIC 24 - Lumber & Wood Products	10,350
SIC 25 - Furniture	1,090
SIC 26 - Paper	16,570

5. ***What is the average salary in industry?***

Salaries in this sector are highly variable, particularly because many people work part time. Salary employment estimates are based on payroll figures and include all full- and part-time wage and

salary workers. Sole proprietors, independent farmers and contractors and the self-employed are excluded from these figures.

Manufacturing Industry	Average wage
SIC 20 - Food	$19,750
SIC 24 - Lumber & Wood Products	$19,125
SIC 25 - Furniture	$22,525
SIC 26 - Paper	$36,824

6. ***What are the anchor firms in the sector?***

The anchor firms in this sector depend on the cluster. With the exception of the paper industry where large multi-national corporations are the key players, the anchor firms are primarily privately held businesses employing 25-400 people. Experience has shown that anchor firms may not be those that have the largest number of employees. In recent years, several large firms have closed because of foreign competition.

7. ***What is the estimated volume of sales for the most recent year available?***

Manufacturing Industry	Value of Product	Change 86-96
SIC 20 - Food	$857 million	up 12 %
SIC 24 - Lumber & Wood Products	$955 million	no change
SIC 25 - Furniture	$ 82 million	up 53 %
SIC 26 - Paper	$ 3.74 billion	up 21%

8. ***What portion of these sales are to national and international markets?***

The distribution of sales depends on the cluster or segment. Some are only local while others have significant national or international sales. Products valued at $180 million were exported by businesses in SIC 24 & 25 in 1997. ....

9. ***What is the sector's estimated competitive position relative to national and international competition?***

As above, this response is highly dependent upon which cluster or segment of the industry is being reviewed. Several segments have seen major employment shifts in the past twenty years because of mechanization, foreign trade, and technological innovation. In some segments, there has been growth because of innovations and positive developments in marketing, business management and manufacturing.

Major competitive strengths: The sector has several non-profit organizations that support, promote and introduce new technologies. Some of these are business leagues, such as the Maine Wood Products Association; others are charitable organizations dedicated to economic and community development. The Maine Manufacturing Extension Partnership has provided services to dozens of firms in the wood industry, helping them save hundreds of thousands of dollars per year.

As the most heavily forested state in the country, Maine has a vast timber resource available for the forest products industry. A 1998 study by the Maine Forest Service determined that this resource can be managed on a sustainable basis and produce a steady stream of raw material for the industry.

Recent real estate transactions suggest that while some firms are divesting of their land holdings, others see the potential for a long-term income stream from harvesting timber resources.

Maine has a significant amount of agricultural land, though in the Southern part of the state some of it has been permanently converted to other uses. Some clusters in the agricultural segment, such as cranberries or organic food, see great opportunities for growth in the coming years.

Major competitive weaknesses or challenges: There are several challenges for the wood and forest part of this sector. While forest regeneration works better in Maine than in many other parts of the world, the rate of growth per acre is less than that in more temperate climates. Maine may remain competitive because the land is less expensive, so the growth per dollar of investment.

We also note that the debate on clearcutting and timber management had a negative impact on some corporate investments in plants and equipment. This is a big concern because of the direct link between these investments and technological development.

In terms of selling fresh produce from Maine's farms or some of Maine's other products, our location at the edge of the United States and two states away from the nearest large metropolitan area (Boston) is a hindrance.

Major opportunities: Maine has an excellent image among consumers and an excellent reputation for quality. The state has the opportunity to strengthen this "brand" through its support for R&D in two of its key industries – agriculture and forestry. Maine is a relatively small state, so innovative technologies can quickly spread to other firms in a cluster if the funding is available to assist the firms in adapting and adopting such technologies.

10. What are the sector's needs for R&D capital?

Technological innovation will be a key factor to the stability of this sector if Maine firms and Maine products are to compete internationally with products made in low-wage countries. Because of the historic importance of this sector to the Maine economy, the University system generally has received some funding for research in this sector. Private sector research and development has been lagging in some segments of the sector, particularly among smaller firms where innovation may have the greatest potential to generate stable jobs.

The US Department of Energy recently targeted the Forest products industry as one of their "Industries for the Future" because this industry is so important to the US economy but has been lagging in comparison to other industries in terms of research and development. Some federal funding already has come to Maine to help firms reduce energy and use and match them with new technologies. Greater access by the private sector to appropriate levels of R&D funding is particularly relevant at this time because of the opportunities to match federal dollars.

Advanced Materials and Composites Technology Profile

1. How would the sector/cluster be described in terms of the principal technologies and/or business focus that characterize the industry?

The composites industry supports all of the following industries: Aircraft/Military/Aerospace, Appliance Equipment, Construction, Consumer Products, Corrosion Resistance, Electrical/Electronic,

Marine and Transportation. Within each of these industries there are a variety of subsets of technologies and a growing number of applications in the use of composite materials.

2. ***How many firms are in the sector and how can they be characterized in terms of size?***

   There are in excess of 70 companies in Maine that are involved in either the production or use of composite materials. Because of the nature of the composites industry, these companies vary in size from a company with four or five employees building kayaks entirely out of composite materials to Bath Iron Works with several thousand employees only a small fraction of whom, at the present time, are involved with composite materials for use in the construction of certain components of the destroyers they are currently building. It is important to note, however, that in the construction of other types of ships, the U.S. Navy and foreign navies already are making use of substantial quantities of composite materials and are actively engaged in the development of major ship components built out of composite materials for all types of ships. This is particularly desirable in the masts and superstructure of the ships because of the substantial savings in weight aloft with a consequent improvement in ship stability and also because the use of composite materials significantly reduces the ship's radar image. Bath Iron Works soon will be substantially increasing its composites work force.

3. ***Are there nonprofit or university-based research labs that are considered part of sector?***

   Yes. The University of Maine has been increasingly active in composites technology and has provided excellent laboratory services. Their new companies test laboratory will be capable of providing considerably expanded services.

4. ***What is the size of the sector 's workforce?***

   For reasons discussed in (2) above, it is difficult to isolate the composites workforce. However a comprehensive study of Maine's composite industry dated October 25, 1995 reported a workforce of about 1000 with anticipated growth of 10-15% per year. This would suggest a workforce of over 1,500 at the present time. The Maine Composites Alliance is in the process of compiling an up-to-date figure which should be available within two weeks.

5. ***What is the average salary in industry?***

   Approximately $35,000 annually.

6. ***What are the anchor firm(s) in the sector?***

   Bath Iron Works, Brunswick Technologies, Hinckley Yachts, Sabre Corporation, North End Composites, Kenway and Tex Tech Industries.

7. ***What is the estimated volume of sales for the most recent year available?***

   Approximately $150 Million, excluding Bath Iron Works.

8. ***What portion of those sales are to national and international markets?***

   It is estimated that about 80% of sales are out of state and 10% international.

9. ***What is the sector's estimated competitive position relative to national and international competition?***

From a quality point of view, the competitive position of Maine's composites industry is excellent. For example, the reputation of Maine's boatbuilding industry – nearly 100% of which has converted to the use of composites, is unexcelled. Because of the diverse nature of the industry, it is difficult to make direct competitive comparisons of the industry as a whole. It is the mission of the Maine Composites Alliance to establish Maine as a leader in the international composites industry.

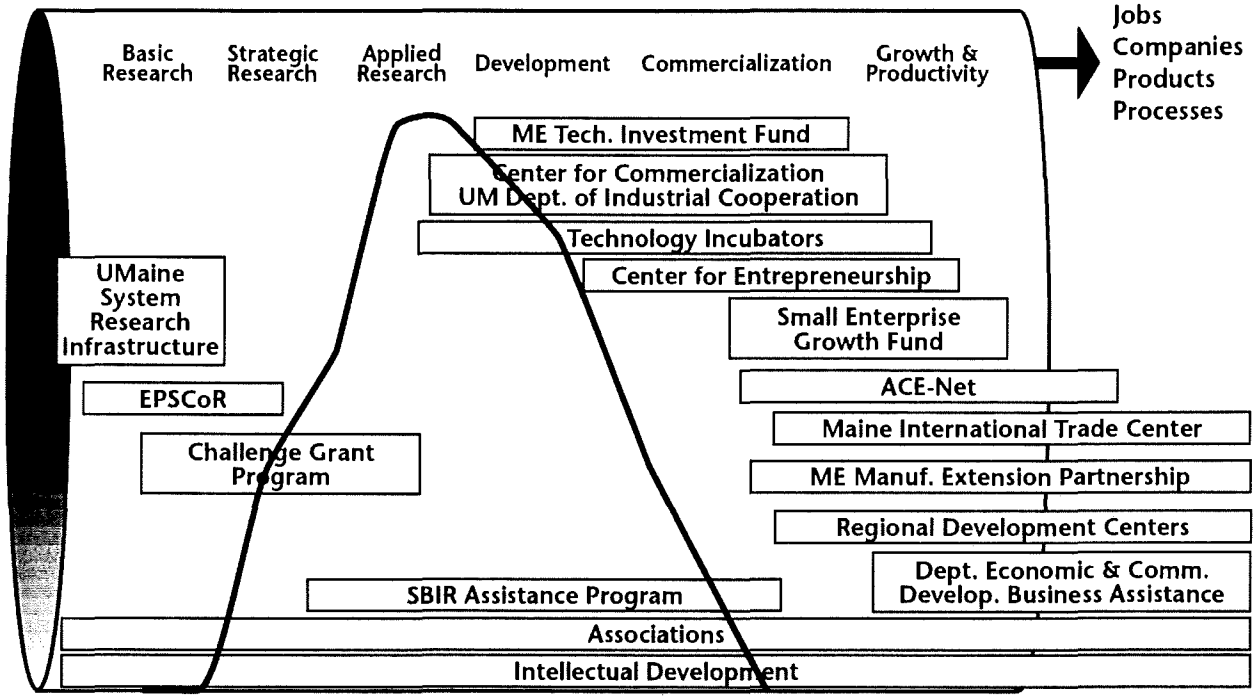
10. ***What are the sector's needs for R&D capital?***

The composites industry is relatively young. It has matured enough in recent years to make it increasingly clear that numerous products now constructed out of metal or wood can be made much more durable and require far less maintenance if built out of composite materials. This leads to a host of opportunities for product development. A number of companies in Maine's composites industry are eager to engage in product development but have not had the financial incentive to do so. This program opens up that opportunity. Maine's composites industry could demonstrate a meaningful return on investment through an annual R&D funding of at least $4,000,000. Significant return on investment of these funds will be achieved through substantially increased employment and positioning Maine as a leading state for composites manufacturing and technology development, further enhancing future returns on investment. Significant additional returns on such investment would also be realized through match investments into composite solutions for the construction industry in infrastructure applications and others.

Appendix 3. Commercialization of Technologies — how Maine Technology Institute fills a niche among other complementary initiatives supported by the State of Maine.

Commercialization falls within a continuum that begins with investing sufficiently in Maine's University System to provide adequate infrastructure: 1) to support basic and applied research at the University level; 2) to attract, teach and graduate quality students who can supply the technical skills required by Maine's growing high technology sectors; and 3) to create the critical mass of research and development talent to work with Maine's entrepreneurs and help them to innovate. The continuum continues through to the successful production and sale of new, competitive products and processes in the global marketplace. Along this continuum are a variety of service providers as arrayed on the following graph.

Relationship of Maine Technology Institute to Other Initiatives



- ***Challenge Grant Program – Bond Issue.*** In November, 1998 Maine voters approved a $20 Million R&D Bond that will support $1.5 Million of Challenge Grants to purchase physical infrastructure as part of collaborative research proposals from businesses, the academic community and the not-for-profit research laboratories in the targeted technologies identified in Maine's Science and Technology Plan. The Bond also supports $2.0 Million in grants for applicants from the marine sector. These grants are also targeted for physical infrastructure and must demonstrate how they increase collaboration among the marine research community.

- ***SBIR Assistance Program.*** The focus of this program is twofold: 1) Phase 0 to increase the number of successful first time applicants for over $1 Billion in funding available from 10 federal agencies in

small business innovation research (SBIR) grants; and 2) Phase II+ to help companies who have been awarded Phase I and Phase II grants to commercialize the technology developed with SBIR assistance. The program conducts workshops on how to write successful proposals; provides direct technical assistance to match companies with the appropriate funding agencies; and awards $5,000 grants, on a competitive basis, to companies who require technical assistance in either submitting a first proposal or in putting together a commercialization strategy. The program won the 1998 Tibbetts Award for its statewide implementation strategy from the Small Business Administration.

- ***Center for Commercialization.*** The University of Maine's Office of Industrial Cooperation has been awarded one-year funding for start-up assistance from the National Science Foundation to help develop the Center. The Center will help commercialize University developed technology. The program fills a void between quality University research and the marketplace.

- ***Maine Technology Investment Fund.*** This pre-seed capital fund invests in good technology ideas of Maine's entrepreneurs and provides from $25,000 to $100,000 to fund the necessary next step to get an idea from the research bench to the marketplace. Applications from Maine companies are funded on a competitive basis, must address one of Maine's targeted technology areas, and require a minimum dollar for dollar match. All investments require a return on investment, typically in the form of a royalty.

- ***Center for Entrepreneurship.*** Based at the University of Southern Maine, the Center for Entrepreneurship provides workshops and technical assistance for Maine's entrepreneurs to help them set up and grow their businesses within the dynamic environment of entrepreneurial start-ups.

- ***Small Enterprise Growth Fund.*** Funded by a $5 Million bond issue, this seed capital fund invests in companies that are in early stage of operation. Products are in the market and require funding to realize their market potential. The Fund requires a minimum dollar for dollar match and requires a return on investment.

- ***ACENet.*** A national program of the Small Business Administration, ACENet links entrepreneurs and companies with investors using a web-based matching service. Transactions are confidential. Inquiries are made directly to the companies seeking capital.

- ***Maine Manufacturing Extension Partnership.*** Part of a national network of technical assistance centers for small manufacturers, the Maine MEP helps manufacturers who need assistance with process improvement technology and production efficiencies. Maine MEP works closely and is co-located with Maine's economic development community. The program is co-sponsored by the National Institute of Standards and Technology.

- ***Department of Economic and Community Development and Maine's Regional Economic Development Centers.*** These agencies are the backbone for technical assistance to Maine's small businesses. They provide assistance to businesses in areas such as marketing, business plans, regulatory filings, and trade for business stabilization, growth and productivity.

The Maine Technology Institute fills the critical void between research and development activity among the academic sector, the not-for-profit laboratories and emerging technologies in Maine's businesses. The MTI seeks to increase the number of collaborations within the research community to identify and develop technology clusters – areas of development and support services within Maine's targeted technology sectors, with the goal of producing an increased number and pace of innovations within these technology sectors.

In order to avail itself of capital from sources outside Maine, and outside the U.S., Maine must increase the number and pace of innovations coming from its research community. One goal of the MTI is to provide a pipeline of such investment opportunities, supporting research and development grants with technical assistance activities available through existing programs in Maine's commercialization continuum. Fostering strategic alliances across the research community and among the available pool of service providers will be critical to the success of the MTI's goal.

Appendix 4. Commercialization of Technologies — state and federal initiatives

Providing state funds for applied research has always been a strong component of state government's role in supporting science and technology. However, only large states such as California, Florida, New York, and Ohio, to name a few, could afford to appropriate sufficient funds for applied research activities. Until recently, Kansas was the only small state to commit substantial state funds to support applied research. However, times have changed. The urgency to improve Maine's capacity to move innovations into the marketplace requires Maine policy makers to consider the best approach to provide state support for applied research. Entertaining a question of whether to provide such support is no longer an option. Although each state had its own unique program, there were similarities that made them successful and can serve as guidance in the development of the Maine Institute of Technology. These similarities are

1. well defined goals and objectives;
2. periodically review of purpose and impact;
3. industry defined focus areas;
4. competitive process
5. Reasonable match requirements
6. Collaborative activities
7. well defined request for proposals;
8. funding for projects at sufficient levels to make an impact;
9. well defined, professional peer-review process devoid of conflicts of interest; and
10. reasonable return on investment provision

The mechanism for disbursement of funds varied from state to state and depended on available resources, existing stakeholders, and political landscape. Mechanisms ranged from grant-making programs within a state science and technology organization, a state economic development agency, or a university. In most cases where the program was located in a university, the grant-making function was part of a research center specifically established by legislation to foster the development of technology in a particular field. These centers were either part of or independent of a university and included the conduct of research as a primary function.

A brief description of two of the most successful S&T programs in the country will provide a good presentation of how states are involved in supporting applied research activities specifically, and S&T in general. The selected programs are the Ben Franklin Partnership of the State of Pennsylvania and the Kansas Technology Enterprise Corporation of the State of Kansas. Also, brief descriptions of the most successful federal programs that stimulate commercialization are provided. These programs are the Advanced Technology Program and the Small Business Innovation Research Program.

The Ben Franklin Partnership

The Ben Franklin Partnership is an economic development program designed to stimulate business growth and economic development in Pennsylvania. A program of the Commonwealth of Pennsylvania, the Partnership is administered by the Department of Community and Economic Development. Four Ben Franklin Technology Centers (BFTC) have been established to bring together representatives of business, industry, and education. The Partnership invests financial resources on a project in technologies that will be used to: Develop new or improved products or processes. Create new jobs in Pennsylvania. Retain existing jobs in Pennsylvania. Attract investment capital to Pennsylvania-based companies. Start new manufacturing/technology-based companies

Challenge Grant Program

- The purpose of this fund is to provide financing for applied R&D projects, which will enhance the use of technology in Pennsylvania-based companies. The projects must be conducted as a joint activity between companies and nonprofit research institutions. Funding from this program is provided directly to the nonprofit research institution.

- Recipients of these funds must be Pennsylvania nonprofit research institutions engaged in joint R&D activity with Pennsylvania companies. While there is a preference for small companies with fewer than 50 employees, projects involving companies with up to 100 employees are eligible. Eligible projects consist of an applied R&D program with a near to mid-term commercial outcome. Projects may involve a new application of existing technology, or development of new scientific findings. Projects requiring up to three years of funding are eligible for support, although annual renewals are considered on a competitive basis. Companies are required to submit financial statements.

- Investments are made through a competitive proposal process. Proposals undergo a comprehensive technical evaluation and, in many cases, commercial evaluation. Applicants may be asked to make presentations to BFTC advisory committees.

- Awards from the Applied Research & Development Fund may be used for direct R&D expenses and for other expenses related to commercialization of the project. These funds may not be used for indirect costs, the purchase of equipment, or for overhead of the nonprofit research institution.

- The Applied Research & Development Fund is a cost sharing program, requiring applicants to commit other non-State sources of support to the project. This support can be provided in the form of cash and/or in-kind, and may come from the company's own resources, the nonprofit research institution, foundations, private investment capital sources, local or Federal grants and contracts, and other sources. Guidelines are provided for the level of matching support. Letters of commitment from other sources of funding must accompany the application.

- Investments from the Applied Research & Development Fund range from $25,000 to $100,000 and are provided directly to the nonprofit research institution. Applications are reviewed for technical feasibility and commercial merit by individuals with relevant qualifications. All reviewers agree in writing to maintain the confidentiality of applicant materials.

- Repayment is required in a maximum amount equal to 1.5 times the Ben Franklin funds invested. The repayment is based on a royalty of 3% of company (not product) revenues, beginning in the first quarter after completion of the funding period. A company may pay less than the 3% royalty may if that amount exceeds a stipulated maximum. A company may also pay less than 1.5 times the investment by prepaying the obligation according to a specified schedule.

Innovation Investment Fund

- The purpose of this investment is to provide initial funding for product/process development leading to commercialization or additional investment capital. Proof of concept or early product development is typically supported from the personal resources of the principals. Often these resources are not sufficient to bring the product or process to the point where it can attract investors, strategic partners, or demonstrate the likelihood of commercial success. The

Innovation Investment Fund is designed to bridge this gap. Funds are typically used to demonstrate technical and market feasibility.

- Award recipients must be Pennsylvania companies with not more than 10 employees. The principal(s) of the company must demonstrate a significant and ongoing commitment to the project. Individual entrepreneurs may apply. The specific project must include either the development of new technology or the application of existing technology in a new way. Companies may receive an Innovation Investment only once. Those who have received Emerging Company Investments are not eligible.

- Investments are made through a competitive proposal process. Proposals undergo a comprehensive technical evaluation, and in many cases, commercial evaluation. Applicants may be asked to make presentations to Ben Franklin advisory committees.

- Funding from the Innovation Investment Fund is generally used for the development of a prototype, proof of technical feasibility, and/or market research. Funds may not be used for indirect expenses, the purchase of equipment, nor may they be used solely for sales and marketing efforts.

- Successful entrepreneurial companies recognize their own limitations and are often able to take advantage of the resources of other in order to increase their capacity. Ben Franklin companies leverage the resources of others collaborators-investors, consultants, advisors, researchers, distributors, government agencies-and demonstrate those commitments, as well as their own commitments, through matching funds. Matching funds are provided either in cash, or through in-kind contributions, and must be at least equal to the amount of funding requested from the Ben Franklin Technology Center. Letters of commitment from collaborators must accompany the application.

- The maximum amount that can be requested is $25,000.

- Applications are reviewed for technical feasibility and commercial merit by individuals with relevant qualifications. All reviewers agree in writing to maintain the confidentiality of applicant materials.

- Ben Franklin funding is an investment which, although unsecured, is expected to be repaid based on company sales. Innovation Investment recipients repay the investment at the rate of 3% of sales up to one and one-half (1.5) times the amount of the investment. Companies have the option to limit the amount of repayment by prepaying their obligation. Repayment begins in the first quarter after completion of the funding period.

Appendix 5. Kansas Technology Enterprise Corporation (KTEC)

KTEC is a quasi-public corporation established by the State of Kansas to promote advanced technology economic development. KTEC strives to meet the needs of Kansas technology companies by providing access to individuals and resources. To achieve its mission KTEC has designed a suit of programs that fall in the following categories: Investment, Business Assistance, and Research Support.

Business assistance programs are a network of experts and financial resources to assist in the development of ideas. Programs include:

- Incubation/mentoring
- Manufacturing extension
- Research
- Information services

Research support programs fund basic and applied research that meet the following two objectives: to accelerate the rate of research and bring needed products to market sooner; and to help commercialize technologies that can create jobs and positively impact the Kansas economy. Programs include:

- Centers for Excellence (University-based)
- Applied Research Matching Fund (ARMF)
- Innovation Research (Phase 0 SBIR Program; SBIR Proposal Presentation Grant Program; SBIR Bridge Funding Program; and State-sponsored SBIR Program).
- EPSCoR (Oversight of the EPSCoR program and state match)

Investment programs help KTEC meet the financing needs of Kansas entrepreneurs. KTEC has a variety of investment programs from royalty grants to equity capital. The objective in each program is to not only help entrepreneurs realize their own dreams, but to assist in building and growing small companies that will contribute to the economic well-being of Kansas. Programs include:

- Applied Research Matching Fund (ARMF)
- The Innovation and Commercialization Corporations (ICCs) Pre-seed Funds
- Ad Astra I&II Funds - seed capital for emerging and start-up technology companies.
- Capital for Manufacturers (CFM) - helps guide manufacturers through the maze of financing options and connect them with the best financing solutions available to their organization. CFM serves as an intermediary between manufacturers seeking capital and financial sources seeking quality investment opportunities.
- ACENet Innovation Research

Of germane interest to Maine is KTEC's approach to supporting applied research. In this regard KTEC's ARMF and Centers of Excellence programs are worthy of some note.

1. Applied Research Matching Fund (ARMF)

   - The Fund is designed to provide funding to companies seeking to turn new technologies into market-driven products that will lead to retention or expansion of the company's market share and result in added skilled job opportunities. The program provides direct investments to companies for the purpose of conducting applied engineering or scientific research with the goal of developing a specific commercial product or technology. The role of funding is to buffer the risk, which a company takes in new product development.

- Eligible applicants are limited to for-profit business entities with either an existing or prospective Kansas business location. Awarded projects are those with a sound technical approach toward developing a commercial product with significant competitive features. Companies can apply for between $5,000 and $100,000 in ARMF assistance but they are required to make a 150 percent match.

- Typical time lag from initially funding a project to initial commercialization of a successful project is two years or more, followed by additional years for the product to reach full sales levels. Over the last few years, an annual average of about 200 jobs and 15-20 new products have come from this program, and a number of those products are just starting to increase their sales levels.

- Since 1994, when KTEC began taking royalty positions in companies receiving ARMF awards, 23 companies have made more than $256,529 in royalty payments. In all, KTEC has royalty relationships with 139 companies on 182 projects.

- In FY '97, 35 proposals were reviewed with 26 projects receiving ARMF assistance. ARMF awards totaled $1,094,403 with an industry match of $1,843,481, a total investment of more than $2.9 million.

- KTEC takes a royalty position on eventual product sales on commercially successful projects. All ARMF awards are tracked for a minimum of five years to record the success and economic impact of the project.

2. Centers For Excellence

- The Centers of Excellence are university-based research centers, each with its own technology specialization. The five Centers conduct innovative research and provide technical assistance with the overlapping aims of creating new companies, strengthening existing companies, and serving as expert resources to other KTEC programs.

- Viewed as part of a research and commercialization continuum, the Centers are investments in the early stages of the research pipeline and act as more immediate consultants and developers for modernizing manufacturers. The Centers provide the following services to client companies: basic and applied research, product and process development, technical consulting, training, seminars, and networking. With the exception of Higuchi Biosciences Center, each Center hosts a MAMTC regional office. An external review of the Centers Program in FY '97 concluded that it is a "very good program" which justifies the State's continued investment.

- In FY '97, KTEC Centers:
    - Received core funding of $4.35 million;
    - Received $4.16 million in funding from industry sources; and
    - Received $15.6 million in federal funding.
    - During FY '97, 85 companies participated in research and development and commercialization activities at the Centers resulting in:
    - Creation or retention of 140 jobs;
    - Increased sales of $2.2 million;
    - Reduced costs of $626,000;

- Development of 32 new technologies;
- Commercialization of 17 new technologies; and
- Formation of two new companies.

- Four of the five Centers of Excellence are also regional centers for the Mid-America Manufacturing Technology Center (MAMTC), a National Institute of Standards & Technology (NIST) Manufacturing Extension Partnership which provides hands-on technical and management consultation to small- and medium-sized manufacturers in Kansas, Missouri, Colorado, and Wyoming. A portion of the KTEC core funding matches NIST funding for technical assistance programs. During FY '97, 585 Kansas companies participated in the Centers of Excellence/MAMTC Technical Assistance programs, which received $849,914 from KTEC, $1.58 million from MAMTC, $1.62 million from federal sources, and $1.9 million from industry sources. The following results were reported:
  - Creation or retention of 149 jobs;
  - Increased sales of $157.7 million; and,
  - Reduced costs of $1.67 million.

In addition to the applied research funds, KTEC's Innovation and Commercialization Corporations (ICCs) provide business development and pre-seed financing to start-up, technology-based businesses. Each ICC is structured as a tax-exempt 501(c)(3) company whose for-profit management company also manages a for-profit seed capital fund. The ICCs and their pre-seed capital funds were formed through partnerships between KTEC, local communities/government and/or state universities. Each ICC is governed by a board of directors comprised of university representatives, state officials, and private industry professionals

Appendix 6. Study of State Supported Pre-Seed and Seed Capital Funds

Economic Innovation International conducted a study of investment opportunity in Maine as background research for the development of the Maine Technology Investment Fund. The following is an excerpt from this study.

ECONOMIC INNOVATION INTERNATIONAL, INC.

FOUR LIBERTY SQUARE
BOSTON, MA 02109

TEL: 617-542-1900
FAX: 617-542-1975

MAINE TECHNOLOGY INVESTMENT FUND

BEST PRACTICES REPORT

Submitted by:
Belden Daniels, President
Catherine Crockett, Vice President

May, 1996

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1.0 Maine Technology Investment Fund Best Practices

The Maine Technology Investment Fund is at the cutting edge of economic development strategies. Two factors make the concept of the Investment Fund innovative. First, technology-based economic development in general became common in the United States just ten to fifteen years ago. Second, the specific mode of operation in which money is invested seeking a risk-adjusted return, rather than granted, for technology development became prevalent only as recently as five years ago.

The trend toward ROI-oriented investment of R&D funds is driven by a number of factors:

- o the desire to demonstrate commercial success and tangible economic development results;
- o the need to reduce dependence on large, annual appropriations in the context of general government downsizing; and
- o the soundness, from a public policy standpoint, of recouping dollars from private companies that generate profit from public funds.

Organizations are only now beginning to develop sophistication in the management of these investment funds. Thus, experience and track records are in a formative stage. Nevertheless, a number of best practices can begin to be drawn from these models.

#1 Operate within a broader, systemic organizational and managerial framework wholly consistent with, and supportive of, the investment goals of the Fund.

In general, organizations similar to the MSTF might implement one of two broad strategies:

a) Culture Change -- One strategy is to invest in a diverse range of activities with long-term, broad-based pay off that enhance quality of life through utilization and development of science and technology. Example activities that fall within this category include basic research, grants-based applied research, Ph.D. development programs, K-12 math and science education enhancement, general telecommunications deployment, and science and technology marketing and education to the general population. "Customers" are defined very broadly to include the general population, universities, colleges, schools, and laboratories as well as companies.

The Kentucky Science & Technology Council, Inc. has implemented this strategy, and is detailed in Section 2.1 below. Generally speaking, a successful investment fund might be created by an organization pursuing a broad, culture change strategy, but must be managed *outside* of such an organization.

b) Technology Business Creation & Expansion -- Another strategy is to offer a highly focused set of services aimed at increasing business activity through the development and application of science and technology. Example activities that

fall within this category include market-oriented applied research and development stage investments, formation of seed stage investment pools, technology extension services, and management expertise aimed at high growth or technology-based enterprises. A subset of this strategy is to focus exclusively on finance for technology-based enterprises. "Customers" are defined narrowly as companies and their employees.

The Kansas Technology Enterprise Corporation implement a broad business focused strategy (see Section 2.2). Connecticut Innovations, Inc., and the Oregon Resource and Technology Development Fund implement narrow, financial-services-based business focused strategies (Sections 2.4 and 2.5 below).

We can find no example of an existing organization that has implemented both strategies well. We suspect this is because managerial and financial resources are limited and statewide needs and opportunities are enormous. Experience also confirms that the two strategies require staff with divergent skills, interests and disciplines. It is only through the focused, strategic deployment of limited resources that your peer organizations have succeeded in their respective strategies.

From this single best practice of proper organizational and managerial framework, all other best practices for management of a technology investment fund follow.

#2 **Operate with a strategic understanding of market opportunities.**
R&D funds that have begun to successfully invest have a strong, disciplined strategic sense of technological and industrial fields in which their economy excels, while remaining open and opportunistic. They neither fail to have strong industry relationships and expertise nor adhere religiously to a limited list of targeted industries.

#3 **Aggressively cultivate new investment opportunities.**
R&D funds that have begun to successfully invest pursue multi-faceted strategies to strengthen deal flow. First, they market themselves exhaustively to a diverse range of audiences to kneed out increased demand for R&D funding over time. Second, they relentlessly and single-mindedly strive to focus their own (as well as any other resources they can impact) toward activities that will strengthen deal flow for the technology investment fund.

#4 **Evaluate the technology, the management, the market opportunity and the economic development benefit.**
R&D funds that have begun to successfully invest look, first, to ensure that, at a minimum, the technology is sound. Second, they require that management is up to the task and that a good market opportunity exists. Given the choice between a project with superb management and acceptable technology versus a project with acceptable management and superb technology, they bet on management. Finally, it is generally presumed that if technology, management and market exist, economic development benefit will naturally follow.

#5 **Require portfolio clients to understand their own customers and to market themselves aggressively to those customers as a condition of receiving an investment from the fund.**

R&D funds that have begun to successfully invest emphasize marketing as an essential managerial qualification of their portfolio projects. In order to proceed with investment, good funds increasingly require management that needs no encouragement or training to work hand-in-hand with customers and the market place during product development.

#6 **Require companies to co-invest with the fund.**

R&D funds that have begun to successfully invest consider it self-evident and essential that the managers of the R&D project must be in a position of equal or greater financial risk on the particular project than the fund itself is. The R&D project must not be expendable to the core business of the project management team.

#7 **Commit dollars as financings, not grants, and behave consistently.**

R&D funds that have begun to successfully invest are careful to communicate under all circumstances that they are providing financing with an expected return -- not a grant that might, if all goes well, turn into a loan. The difference goes beyond semantics. Effective communication of an ROI perspective strongly impacts both the types of opportunities that tend to be brought to the technology investment fund, as well as the attitude of portfolio projects once they have received an investment from the fund.

#8 **Structure investment decision-making for high quality results.**

R&D funds that have begun to successfully invest are increasingly structuring investment decision-making to mirror that used by venture capital management companies -- a small, qualified investment staff with clear and unequivocal accountability for fund performance. This is in contrast to investment decision-making in which a staff-technologist or public policy expert uses an unpaid advisory board to select grant recipients, and then attaches a payback provision.

#9 **Offer more than money.**

R&D funds that have begun to successfully invest ensure that their investment is value-added by offering high quality management assistance similar to the role that a venture capitalist would play. The cost of this assistance is often covered through other activities of the parent organization, particularly in the early years of operation of the fund.

#10 **Operate within the context of a broader entrepreneurship development effort, and persistently cultivate this environment.**

R&D funds that have begun to successfully invest recognize their own singular limitation to build their own markets, and depend heavily on a broad range of other work force, technological, and financial activities designed to strengthen technology-based entrepreneurship.

2.0 Maine Technology Investment Fund Models & Options

The models which follow can be grouped into three broad categories:

1) "Culture Change" -- Technology development organizations that pursue business service and technology investment activities through outside affiliates. See Kentucky Science & Technology Council, Inc. (Section 2.1).

2) "Technology Business Creation & Expansion" -- Organizations that are wholly or primarily devoted to the formation and expansion of technology based business activity, and for which a technology investment fund is integral to the overall mission of the organization. These models are useful for their recent, though unproven, financial track records, as well as for what they learned *not* to do in their early years of operation.

   See Kansas Technology Enterprise Corporation (Section 2.2), the Alaska Science & Technology Foundation (Section 2.3), and Connecticut Innovations, Inc. (Section 2.4).

3) "Technology Business Investment" -- Organizations that are wholly devoted to investment in technology based companies, including applied research stage financing as well as subsequent stages. See Oregon Resource & Technology Development Corporation (Section 2.5), MBRI (Section 2.6), and the Enterprise Florida Innovation & Commercialization Corporations (Section 2.7). These models are particularly useful in suggesting the managerial structure and orientation necessary to operate on at least a break-even basis.

2.1 Kentucky Science & Technology Council, Inc.

Year Created	1989
Organizational Structure	Private, 501(c)(3) corporation with state enabling legislation.
Mission	(1) To develop programs for the enhancement of science & technology (2) To advocate the fundamental importance of science & technology to Kentucky's future (3) To stimulate technology-based development.
Total Budget	$3 million for operations $5-6 million for project costs.
Capital Sources	Grants, contracts and private contributions

The Kentucky Science & Technology Council, Inc. was created in 1989 by a group of private sector, public sector and university leaders convinced that a business recruitment strategy alone was not sufficient to ensure Kentucky's economic competitiveness into the next century.

They developed a plan of action, The Kentucky Innovation Compact, that established a goal: "to take measurable and achievable actions which pay off in 150,000 good, competitive jobs for Kentuckians within the next decade." The Compact identified three broad areas for action, with an immediate plan, identifiable actions, and a recommended initial investment in each:

1) Investing in Kentucky's People
2) Investing in Kentucky Enterprises
3) Investing in Kentucky Technology

Since 1989, the Council has implemented The Compact. It has focused first and foremost on "Investing in Kentucky's People", and is only now beginning to focus on "Investing in Kentucky Enterprises." Actions to-date include the following:

1) Investing in Kentucky's People

a) Investment in math & science education

- ACES (Activity-Centered Elementary Science) -- Comprehensive hands-on science program for K-6 funded by private foundations, a private corporation, the Kentucky Department of Education and user fees. The ACES program is now in use in 550 elementary schools in Kentucky since 1989.

- PRISM (Partnership for Reform Initiative in Science and Mathematics) -- 5 year, $17 million effort begun in 1992 that is managed by KSTC in partnership with the Kentucky Department of Education and the state's universities. KSTC led the effort to receive the federal award with state match. PRISM includes a broad-based marketing effort to inform Kentuckians on the importance of math and science education to every day life.

- Endangered Species Initiative -- Instructional experience for grades 4 - 8 utilizing electronic bulletin boards and interactive television broadcasts funded by the federal government and user fees since 1991.

- T4 Initiative (Transforming Teaching through Technology) -- Teacher and administrator training to plan more effective uses of computers and other technology to enhance learning. Funded by the Bell South Foundation, the Knight Foundation and user fees since 1991.

- Kentucky Educational Technology Conference -- Statewide conference in partnership with the Kentucky Department of Education with in excess of 4,500 educators in attendance. (Originated by the Department of Education.)

- Appalachian Rural Systemic Initiative -- Five year multi-state program to expand the science and technology curriculum of rural schools is selected low-income counties throughout the Appalachian region. Funded by the National Science Foundation with matching funds from each Appalachian state.

b) Investment in higher education
No actions to-date.

c) Investment in lifelong learning

- Creating the High-Performance State -- Industry-oriented effort to identify the life-long education needs of Kentucky industry, and ensure access to necessary educational resources. Training sessions conducted on a regular basis with between 20 and 100 participants. Funded by the Commonwealth of Kentucky and user fees.

- "Kentucky Science & Technology" -- Semi-annual magazine published by the Council to inform and educate Kentuckians about science and technology issues as they impact education, the economy and technological innovation.

2) Investing in Kentucky Enterprises
No actions to-date.

3) Investing in Kentucky Technology

a) Investment in Kentucky R&D

- EPSCoR (Experimental Program to Stimulate Competitive Research) -- Research program funded through the federal and state governments for research conducted at the state's universities. Since inception, Kentucky has received $19.6 million from the federal government with a total state match of $9.5 million. Kentucky ranks among the top states in the receipt of Federal EPSCoR awards.

- Kentucky Technology Infrastructure Fund -- Fund to invest in technology development opportunities with industry, private and university laboratories. Under development.

b) Investment in technology transfer

- The Kentucky Technology Service -- Comprehensive business modernization service incorporated as a separate entity in 1994 with beginning operations in January, 1995. Funded by state and federal governments.

- Kentucky's Competitive Edge -- Annual statewide conference on business and education opportunities through telecommunications. Sponsored by GTE, Bell South and the Kentucky Economic Development Cabinet.

- Kentucky Telecommunications Centers -- Development of two rural telecommunications centers for use by industry, health care and educators. Sponsored by GTE, Bell South, Herman Miller, and the Kentucky Economic Development Cabinet.

A number of factors are noteworthy in KSTC's approach. First, KSTC concentrated in its initial years on systemic approaches to improving K-12 science and math education and telecommunications usage. These two areas share the following characteristics:

- They were broadly relevant to the Kentucky population, with a particular emphasis on rural needs.

- They were underserved fields. A vacuum of activity existed that KSTC filled without treading on the turf of other organizations.

- They could be managed by KSTC staff as an integrated set of activities, often with KSTC as a central catalyst or coordinator but with significant leadership and day-

to-day responsibilities also lodged in other organizations. (KSTC staff includes individuals with public policy, education and engineering education backgrounds).

- They were readily fundable through the federal government with state match dollars.

KSTC is most relevant as a model to MSTF precisely because it has not yet developed a technology investment fund. It chose to concentrate first on a strategy to make science and technology part of the culture of Kentucky on a statewide basis. Only now is the Council beginning to address business-specific issues. Just as the Council pursues math and science education through a broad, systemic approach, so too will the fund be created as one of a broad set of systemic initiatives to address investing in Kentucky technology and Kentucky enterprises.

KSTC is currently developing the Kentucky Technology Infrastructure Fund. Legislation was passed one year ago that established the Fund, and provided a stream of revenues through a tax on incentives granted to companies relocating into Kentucky. KSTC is developing a plan to build the Fund, as well as other related technology and business investment funds. As currently envisioned, the Technology Capacity Fund, as well as any other related funds, would be managed by an affiliate organization with a separate board and staff, similar to the relationship between KSTC and the Kentucky Technology Service.

2.2 Kansas Technology Enterprise Corporation

Year Created	1987
Organizational Structure	Quasi-public corporation of state government with a thirteen member board of directors.
Mission	To create and maintain employment by fostering innovation, stimulating the commercialization of new technologies and promoting the creation, growth and expansion of Kansas enterprises.
Total Capital	Annual budget of approximately $13 million ($1 million operating costs). Applied Research Investment Fund: $1.26 m annually for each of the last four years. (Operating costs estimated at $80,000 annually).
Capital Sources	All Purposes: Federal government, state lottery funds, charges for services. Applied Research Investment Fund: State lottery funds, income from financings.

The Kansas Technology Enterprise Corporation is a quasi-public corporation of state government charged with promoting job creation and economic diversification through technology development. Unlike the Kentucky Science & Technology Council, which has focused on a broad, cultural science & technology strategy, KTEC focuses narrowly on building technology-based business opportunities.

Its former and current Presidents were both successful technologists and entrepreneurs, and bring a strong business orientation to the operation of the Corporation.

Specific KTEC activities include:

- Centers of Excellence -- KTEC operates five Centers of Excellence in partnership with four state universities (advanced manufacturing, biosciences, aviation research, computer-aided science engineering, and technology transfer). The Centers are closely integrated with overall KTEC strategy, and serve as spawning grounds for other downstream R&D and business services activities of KTEC. KTEC reviews the Centers annually and measures their achievements by a comprehensive set of qualitative and quantitative criteria. In addition, the Centers undergo a peer review by a team of national experts.

Current annual funding to the Centers is $4.35 million with the smallest receiving $450,000 and the largest receiving $1.1 million.

- Applied Research Matching Fund -- The Applied Research Matching Fund, although legislated to allow for investment, was implemented initially as a grant program. Beginning in 1992, KTEC management began to take serious advantage of language in its legislation and now requires payback on all projects undertaken. Thus, KTEC has a three year investment track record.

  Management indicates that the driving force behind the selection of projects is economic development. KTEC management finds that this is rarely in conflict with good financial returns, although, on occasion, KTEC will select a project that has very limited manufacturing potential in Kansas, but very good potential to provide a strong rate of return to the Fund.

  In general, a project must apply current or emerging scientific and technological knowledge, and lead to new developments that can have a positive impact on the Kansas economy. During the review process, particular attention is paid to the research plan, the business plan, management qualifications, and anticipated future economic impact. Due diligence includes review of financial statements by an intern team from the University MBA program, in-house credit checks, and contract due diligence for technical review and market analysis. On occasion, the management of the Ad Astra Fund, described below, also lends assistance during evaluation. Once reviewed and recommended by the applied research fund staff (who have a general business background), an investment committee of the board makes the decision to invest.

  Sample projects include:

  - Improvements to agriculturally-used ventilation fans (Osborne, KS) conducted by Osborne industries, Kansas State University and Kansas Electric Utilities Research Program.

  - Development of pharmacological products by Oread Laboratories (Lawrence, KS) utilizing the laboratories of the Higuchi Biosciences Center of Excellence at the University of Kansas.

  - Applied research to improve interior jet furnishings by Precision Pattern, Inc., (Wichita, KS) utilizing the facilities of the National Institute of Aviation Research.

  Approximately 35% of the projects undertaken involve one of the Centers of Excellence, either through a partnership with an existing company, or, more rarely, through an effort to create a new business around a technology emerging from the Center. The remaining two-thirds of the 30 or so projects undertaken annually are sourced through the field offices of MAMTC (KTEC's industrial extension service), and the new Innovation and Commercialization Corporations, described below.

KTEC, at times, will undertake projects that do not involve one of its operating organizations, but prefers not to, particularly when the project involves a start-up company. KTEC management has concluded that the KTEC affiliation helps to increase control and dedication to very long-term projects and avoids allowing financings to slip, through lack of attention, into effective grants.

KTEC funds 40% of the research with the company providing the remaining 60% of the costs. Average project size is $35,000 with multiple rounds conducted over one to two year periods each. If commercially successful, KTEC receives income, either through payment of principal and interest or through royalty payments.

To the extent that KTEC has an investment strategy, it is to seek moderate risk and moderate returns. In general, though, KTEC characterizes itself as more reactive than proactive in developing its portfolio, responding to factors such as entrepreneurial drive and market opportunity as they appear.

Between 1984 and 1996, 348 grants were awarded totaling over $10 million. Of these, just over 144 have royalty agreements attached, all since 1991. According to management, just over 100 of these agreements were priced and structured in a manner that leads KTEC to have confidence they can see a return, all since 1992.

Management expects to see commercial and financial results within approximately four years from those 100 projects where it deliberately gave priority to financial return. To-date, 14 of the 100 risk-priced projects are in repayment, approximately 35 have been written-off, and the rest are in a relatively early stage, seven or eight of which are considered to have noteworthy potential.

KTEC currently assigns a break-even valuation to its portfolio. Annual principal and income for 1994 and 1995 is approximately $200,000. Management anticipates a steady rise over the next several years. So far, though, this income is drawn primarily from one success in which a company sold its technology to John Deere, and has made repayment to KTEC at three times original cost.

Until 1992, KTEC, like the Alaska Science and Technology Foundation, either took no investment position, took investment positions on financings for which they did not expect a financial return, or took investment positions and applied a standardized pricing mechanism to all deals with no correlation to risk level. This standardized pricing was inherently flawed since it applied a two times cap to royalty financings, requiring a 50% success rate to break even. KTEC management determined in 1992 that its success rate would more likely be 35% requiring significantly higher pricing. KTEC currently prices deals flexibly, according to risk levels, but generally requires repayment at 3 to 3.5 times the original financing. KTEC has found that some entrepreneurs will initially walk away, concerned by the high price, but return when they find they can not receive comparable financing elsewhere. KTEC management indicates that it has not yet lost a financing it wanted to undertake because of the cost of capital.

- Small Business Innovation Research Awards -- KTEC operates two SBIR services, both closely related to its Applied Research Matching Fund. These include:

  - Technical Support Funds -- up to a maximum of $5,000 per proposal for preparation expenses, as well as technical support in putting proposals together.

  - Bridge Funding -- Between Phase I and Phase II up to $50,000. Repayment has been required since 1995 with five percent annual interest if the company's technology is commercialized. Two such financings were made in 1995.

- Training Equipment Grants -- Funding to vocational schools for equipment needed by Kansas businesses to train and retrain the work force.

- Industrial Liaison -- Assistance to Kansas businesses to identify and solve production or other technical problems. These services are provided through two regional offices.

- Ad Astra Fund -- A seed fund managed by a private venture capital manager with capital from KTEC (through state appropriations) and private investors.

- Mid-America Manufacturing Technology Center (MAMTC) -- A technology extension service funded by the Federal and state governments serving Kansas as well as parts of Colorado, Missouri, Oklahoma and Wyoming

- The Innovation & Commercialization Corporations (ICCs) -- A series of incubators that are owned and operated by urban economies under contract to KTEC that include access to expertise, financing, and office and laboratory space in exchange for ownership by the ICC in the emerging company.

2.3 Alaska Science and Technology Foundation

Year Created	1988
Organizational Structure	ASTF is a public corporation with a nine member board appointed by the Governor
Mission	ASTF has a broad mission to promote and enhance economic development, technological innovation and quality of life, including public health through the use of basic and applied research and technology development and commercialization.
Total Capital	Foundation -- All Programs: $13.5 million (including $3.5 m of ASTF funds earmarked by the State Legislature for non-ASTF purposes) Applied Research Funding: $3 million annually
Capital Sources	ASTF has a $100 million endowment that is co-invested with the state's Permanent Fund. A portion of the earnings from this endowment are available for ASTF operations and services. The endowment is capitalized by the State through oil royalties and severance taxes.

The Alaska Science and Technology Foundation is created with a broad based mission to utilize technology to enhance both economic opportunity as well as overall quality of life in Alaska. Toward this end, it administers a fairly narrow range of activities, including:

- Annual Science & Math Teachers Conference
- SBIR Bridge Funding
- Alaska Technology Transfer Assistance Center (jointly administered with NASA and the University of Alaska Small Business Development Center).
- K-12 Teachers Grants Program

The most significant activity of the foundation in terms of resources is its Applied Research Funding Program. Consistent with the mission of the Foundation, its applied research funding program is implemented in two broad categories:

1) Knowledge/Infrastructure Projects, including those projects that involve basic research, applied research, or development activities to address a particular Alaska problem or opportunity. The projects typically involve researchers and industry or natural resource

managers. Proposals are usually not proprietary and are not granted confidential status. Because of the unique challenges facing Alaska, public health projects are a significant component of this category. Knowledge/Infrastructure Projects currently account for approximately one-third of all project funds distributed, although historically they accounted for a larger percentage.

2) Technology Projects, including projects which develop and commercialize technology, spanning proof of concept (less than $50,000), prototype ($50,000 - $200,000) and commercialization stage activities (market analysis, pre-feasibility business plan, and business plan work in the $100,000 - $400,000 range). Strong emphasis is placed upon the interest and ability of project managers to involve other outside managerial, manufacturing, and marketing experts. Historically, successful ASTF projects have been those with strong management teams that have expertise in all facets of business management, though many projects involve a lone, inexperienced entrepreneur.

   Funds for technology projects which develop a new product or process are to be repaid from the revenue, economic value, or profit derived from the product through a percentage of revenues or income. ASTF places particularly strong emphasis on repayment for commercialization stage activities.

Since 1995, project applicants must bring in at least one co-applicant who will use the knowledge or technology. This is based on early experience by ASTF that indicated that successful projects overwhelmingly tended to be those that had strong linkages between their technology development process and consumer demands.

ASTF is unique because of the extreme economic environment in which it operates, and, consequently, because of the aggressive marketing approach it has implemented. The state is very large geographically, has a very small economic base with few manufacturing firms, and enjoys only minimal industrial and academic R&D activity. When created, ASTF undertook a pro-active effort to identify categories of scientific and technological pursuit that would benefit quality of life and economic opportunity in the state, and then went one-step further. Foundation management sought out companies and researchers in these fields and worked directly with them to identify areas of research that might be pursued. While these meetings often did not lead to an immediate project, they often did stimulate thinking leading to projects formulated over succeeding years. Sample projects include:

- Prototype development of a frost-heave resistant road construction method utilizing coal ash. Used successfully at Eielson Air Force Base last year.

- Prototype production and marketing of skinless, boneless pink salmon blocks to manufacture breaded salmon nuggets. The USDA purchased $1 million of nuggets for trial in the national school lunch program.

- Feasibility testing of calcitonin production, a seafood processing waste converted for pharmaceutical application.

ASTF has also been pro-active in providing continued assistance to projects through the state's technology extension service as well as through general and targeted workshops. It should be noted that, at least in the first six years of program operation, ASTF recipients of Applied Research Program funding considered assistance provided by the technology extension service to be of only moderate benefit to ensuring successful project completion.

Applied Research Program projects are selected by the board of directors based on advice from staff as well as peer reviewers. Staff has a background in technology development and public policy.

Financial return on project funds has been weak to-date, totaling roughly $100,000 on $12.7 million in total project funding since 1988. As a consequence, all operating costs associated with the Program are paid through the general operations budget of ASTF:

- ASTF did not attempt to secure repayment on any projects until those initiated in 1990. Allowing three to four years to reach commercial application, the first round of projects seeking repayment are only now maturing.

- ASTF historically committed approximately 50% of funds to knowledge projects. Management is currently reducing knowledge projects (on which ASTF rarely attempts to secure repayment) to approximately 30% of all project dollars.

- The program was legislated as a grant program. ASTF reports that this language is counterproductive to creating the business-like approach within which they would like to operate. Management considers itself a "public venture capitalist".

- ASTF does not have investment professionals on staff involved in the selection process.

- ASTF does not employ any particular portfolio management strategy.

- ASTF assigns standardized terms based on economic development objectives, not negotiated terms based on individual project risks and opportunities. 150% repayment is sought as a base return from all projects. Those that utilize the technology outside the state must repay 300% and those that eventually move their entire business out of state must repay 500%.

- All income generated through royalty and interest payments is returned to the endowment. The ASTF endowment is frequently subjected to redirection of resources for alternative uses by the Executive and Legislative branches, thus limiting the direct incentive to management to aggressively pursue repayment.

ASTF, since its creation in 1988, has served several masters. It has attempted to address the broad cultural environment in support of the use of science and technology through programs aimed at teachers and education, and has also attempted to provide business-oriented technology commercialization services. While the ASTF will continue to address both missions, the current management of ASTF is spending more of its overall budget on business-oriented technology

development activities and is also intensifying its financial and economic development return expectations from these business-oriented activities.

2.4 Connecticut Innovations, Inc.

Year Created	1989
Organizational Structure	Quasi-public corporation of state government
Mission	Development of Technology Businesses.
Total Capital	$43 million (since 1990)
Capital Sources	State of Connecticut G.O. Bond Issues Income from Financings

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Connecticut Innovations, Inc. was created as a quasi-public corporation in 1989 by combining various program activities previously managed by the Department of Economic Development and the Connecticut Product Development Corporation (CPDC).

CPDC, the predecessor to Connecticut Innovations, Inc., had been created through legislation in 1972 and made operational in the mid 1970s to stimulate economic development by stimulating product development. For more than a decade, the product development program was the only service offered by CPDC. CPDC received initial start-up funding from the federal government, and has been funded since that time primarily through the issuance of state general obligation bonds.

The first management team of CII was led by a strong Executive Director with a public policy and public relations background. The current Executive Director was an attorney with GE Capital, and has an investment background. He is currently implementing new methods to institute a more business-like approach to managing these technology business programs. Management indicates that many previous clients of CII are uncomfortable with these changes, but a new clientele developing consistent with the ROI goals of CII today.

The customer for Connecticut Innovations, Inc. is the business community, with a particular emphasis on industry clusters of strategic importance to the state. These include:

- o Aerospace
- o Biotechnology
- o Computer Applications
- o Energy Systems
- o Materials Technology
- o Medical Technology
- o Telecommunications

To meet the needs of its customer base, CII offers a range of business-oriented services:

Yankee Ingenuity Initiative Grant Program: CII offers grants to improve the ability of the education community to meet the high technology research and training needs of industry. The grants are administered by the Board of Governors for Higher Education in increments between $20,000 and $200,000. Applications include equipment for high tech instruction, as well as co-sponsored research with private business. Approximately $3 million in grants are distributed annually.

Small Business Innovation Research Award Bridge and Matching Funds: CII provides funding to be used for marketing expenses incurred by Phase I recipients in order to help commercialize their research projects while also winning Phase II grants. To qualify, the research must be originated by a Connecticut firm, must hold the potential to end with a finished product, must involve a product or process that is marketable and salable, and must have the potential to be manufactured in Connecticut. CII will also provide bridge financing to companies receiving awards through the federal Small Business Technology Transfer pilot program, a new federal award program that requires companies to secure a nonprofit research institution partner.

Beginning in 1994, those companies that receive awards and eventually achieve commercial success must pay back 150% of the original funding amount from CII. In FY 1994, CII awarded $150,000 ($50,000 each) to three companies, and committed funding to seven companies totaling $331,436 pending SBIR Phase II approval.

Product Development Financing Program: The Product Development Financing Program is the former Connecticut Product Development Corporation. Through this program, CII provides financing to companies for development of new products, services or processes. No repayment is required until a project achieves commercial success. Financings range between $100,000 and $1 million, averaging approximately $500,000.

CII management has made significant changes to the Product Development Financing Program beginning in 1992:

- Creating Image -- Initially, CPDC management executed its mission by marketing itself as the organization to which a company brought a project that they otherwise would not be doing. Current CII management markets itself as the organization to which a company brings a project vital to the future of their company, but for which they can not secure appropriate financing elsewhere.

- Avoiding the "Green Widget Phenomenon" -- Initially, CPDC management executed agreements with companies to develop green widgets, only to find that the market wanted blue widgets. The company would then successfully use the green widget knowledge to produce blue widgets but return no income to CPDC. Current CII management is both doing a better job of defining the product as well as making efforts to finance a product family rather than a single line. It should be noted that, as is currently the case with ASTF, interaction by a company with its customer base had been a problem historically

under CPDC management. Current CII management believes this is due to the low return expectations CPDC had of itself and the tendency to work with lone entrepreneurs. Today, CII focuses on management quality and market opportunity, and prefers to work with companies that have full management teams in place. Thus, it is implicit through the selection process that a company has a sound and current understanding of market opportunities.

- Pricing to Risk -- Initially, CPDC priced all projects on nearly identical terms. Today, CII prices to risk, at times applying rates close to those used in the venture capital industry. Approximately 50% of its financings are family businesses that present sound expansion opportunities, and approximately 50% are businesses that present the potential for venture capital returns through a variety of exit strategies.

  CII uses two basic structures. The first is the minimum royalty, in which a company pays a royalty of a predefined percentage until such time as CII has achieved a minimum pre-established IRR. The second is to take 5% of product income or 1.5% of sales, whichever is greater, until a pre-defined IRR is achieved by CII. A warrant may be attached in this latter instance.

  CII targets a return of 30% on each individual financing, expects an overall loss rate of 40-50% (although under CPDC it had been as high as 70%), and is targeting an overall ROI of 5-10%.

  NOTE: CII management indicates that imputed interest can be a problem when companies become successful, particularly if the accounting firm used by the company initially considers the project risk to be relatively low. When imputed risk has become a problem, CII has addressed this problem, where possible, by converting its royalty to a note.

- Follow-On Financings -- CPDC, for more than a decade, refused to do any follow-on financings with companies. It later developed the Product Marketing Financing program, described below. CII now presumes it will engage in follow-on financings using a variety of mechanisms. In general, an individual project requires five to seven years to make pay-off, although a number of CII projects financed in 1992 are already in repayment. (Under CPDC, the average project took ten years to return any income to the organization). A number of projects in recent years have not yet reached completion, but are solid enough that the company has been able to replace CII financing with traditional bank finance, allowing CII to exit after just three to four years.

- Monitoring -- Historically, CPDC required monthly documentation of all project expenses and used a grants-based approach to make disbursements. Currently, CII establishes milestones and will distribute financing to the company as milestones are achieved. CII takes non-voting board seats, and reviews all quarterly and annual financial statements of the company.

Product Marketing Financing Program: CII provides working capital financing to companies looking to launch new products or implement new processes and services. In FY 1994, CII made 10 working capital financings valued at $4.35 million through the Product Marketing Financing Program.

The Product Development and Product Marketing Programs are managed out of a single pool of funds, categorized as either equity or royalty financings and involving projects from either Program.

Within the equity portion of the portfolio, 18 projects have been undertaken since 1991 with $6.2 million out, $4 million returned, $1 million written-off, and a valuation of $6.2 million.

Within the royalty portion of the portfolio, 45 projects were undertaken since 1990 with $15.2 million out. $6.9 million has been written off, $6.5 million of which was financed prior to 1992. $2.2 million has been returned. CII assigns a valuation of $6.9 million to this royalty portion of the portfolio. CII management is confident, under its new policies, that the royalty portion of the portfolio can be brought to break-even operations, though it will take slightly longer than the equity portion.

Though clearly not solid enough to call a success, the last three years of CII performance appear to be a strong improvement over the last several decades of CPDC performance for which total receipts equaled just $13.8 million on nearly $60 million of investments.

Connecticut Seed Ventures: CII is a limited partner in the $10 million Connecticut Seed Ventures, a private venture capital limited partnership required to invest its capital within the state of Connecticut. CII owns 50% of Connecticut Seed Ventures, L.P.

Connecticut Seed Ventures is winding down, and current management is raising a second, balanced venture capital fund that will not be geographically restricted to Connecticut. CII is contemplating raising an early stage fund that would be managed by a team closely affiliated with CII.

CII management has made significant changes in an effort to bring its funds to break-even operations. In February, 1996 CII shows indications that it may, indeed, be able to succeed in reaching this point within the next two to three years though it is too soon to be certain. As an indication of the need for its activities in the market place, many strong companies are initially discouraged by the cost of CII financings, but return when they learn that they can not receive comparable financing elsewhere.

2.5 Oregon Resource & Technology Development Fund

Year Created	1985 (operational Sept., 1986)
Organizational Structure	Created as an independent public corporation. Restructured as a state fund under private management contract.
Mission	To invest in ideas and turn them into wealth-creating enterprises anchored in Oregon.
Total Capital	$15.65 million (Operating costs of approximately $500,000 annually paid through ORTDF net income since 1989 or within three years of start-up).
Capital Sources	$11.2 million -- State appropriations from State Lottery Fund (ORTDF received about 3% of lottery funds dispersed for economic development purposes -- approximately $1.1 million annually for 10 years) $4.45 million - retained earnings

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The Oregon Resource & Technology Development Corporation (ORTDC) was created in 1985 to address the need for applied research and seed-stage investment in Oregon. It is exclusively devoted to the finance of very early stage technology-based enterprises, and provides no other technology-related or finance services (though it takes actions, primarily through outside organizations, to strengthen its overall market opportunities).

ORTDC became operational in October, 1986, and thus has a ten year track record. It was originally created as an independent public corporation with an eleven-member board of directors selected by the Governor and approved by the Senate. ORTDC changed its name in 1993 to the Oregon Resource and Technology Development Fund (ORTDF), reduced its board from eleven to six, and changed the appointments process so that the Governor appoints members in consultation with the State Treasurer. It then privatized its management in July, 1994.

The original ORTDC staff now constitutes the private management team to the Fund. Management is now shifting from a salary-based compensation system to a compensation system consistent with the industry, including a 2 - 2.5% management fee and an 80%/20% split on the carried interest. The management team includes the President, the deputy director, a financial analyst, and an office administrator.

ORTDC invests in four main industry areas, including (1) computers, software & industrial electronics; (2) medical, biotechnology and environmental technologies; (3) natural resources; and (4) industrial & general.

ORTDC invests in:

1) Applied Research Projects -- Projects must demonstrate commercial potential. ORTDC will invest up to $100,000 per financing round with a one-to-one match from other sources.

2) Start-Up and Existing Companies -- Enterprises must be preparing to bring new technology and products to the market place. ORTDC will invest a maximum of $500,000 per financing round.

ORTDC takes a very long term approach to investing. It will often take a venture through several applied research rounds, and then one or more seed stage rounds before ORTDC receives liquidity. In fact, ORTDC has gone as many as ten rounds with some of its portfolio ventures. It recently raised its limit per company to $1.2 million or roughly 10% of total capital under management.

Whether applied research or start-up financing, ORTDC prices investments to risk using royalties, loans, warrants for stock, and convertible notes. ORTDC may not own stock and may hold a maximum interest of 49% in a company.

Management only considers ROI when selecting investments. Other objectives, such as expanding university research capacity or creating jobs are considered social benefits that are good side effects but not specifically sought. Management considers this approach essential to avoid the pitfall of mixed missions, which might lead management to try to justify investments to itself from an ROI standpoint in order to receive the other benefits. The two critical questions asked when reviewing all investments are (1) when the technology is expected to become a product, and (2) how much opportunity is there in the market place.

All of that said, ORTDC does also devote approximately 15% of total funds committed annually in activities designed to stimulate market opportunities, such as statewide networks to assist entrepreneurs and researchers. One reason for doing so is to reduce its own management costs in marketing, the review of inappropriate business plans, and providing management assistance to portfolio companies.

ORTDC has sought to build a portfolio of moderate risk and moderate return. In other words, it has not sought to build a classic venture portfolio in which one-third of the investments perform extremely well, one-third perform moderately well, and one-third fail. On the contrary, ORTDC has written off very few investments, and expects the vast majority of its portfolio to perform moderately well.

ORTDC estimates an annualized IRR of approximately 7% on its portfolio. It is important to note, however, that this return estimate is based primarily on unrealized gains. To-date, approximately $10 million has been generated as net cash income against just over $10 million invested, with $6 million earned in 1995 alone. A number of companies are expected to enter payback within the next year, serving as the basis for the estimated IRR.

Based on this performance, ORTDF management is raising a second fund from the private sector in Oregon to further the original mission of ORTDC, and has taken on management of an additional fund for a jurisdiction outside of Oregon. In total, ORTDC estimates a cumulative economic impact of $300 million against the state's $11.2 million investment, including state income taxes, portfolio company revenues, other investments and net income to the fund.

2.6 Massachusetts Biotechnology Research Institute (MBRI)

Year Created:	1986
Organizational Structure:	Private, tax-exempt corporation.
Mission:	To accelerate the commercialization of academically-based technology into commercial products.
Services/Activities:	Technology Evaluation & Transfer Company Formation & Investment Education & Training Reinvestment in Basic Research
Capitalization	CBI I: $5 million (1987) CBI II: $4.3 million (1989) CBI III: $10.6 million (1991) CBI IV: $16 million (1992) CBI V: $19 million (1993)
Economic Development Objectives:	To create a biotechnology industry within the Worcester region of Massachusetts.
Results:	20 new biotechnology companies Over 2,000 new jobs Over 400 workers trained

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MBRI is the creation of business and economic development leadership in the Worcester region of Massachusetts. Worcester, though located just 40 minutes from downtown Boston, had not shared in the high-tech boom that propelled Massachusetts through the 1980s. As a specific economic development strategy, Worcester business leadership pursued a strategy to position themselves as a location for biotechnology industry growth in the 1990s. This was a particularly aggressive strategy since no significant biotechnology company existed in the region when they began in 1984. Worcester did, of course, have the advantages of close proximity to Boston combined with comparatively low costs of doing business.

MBRI (originally called the Massachusetts Biotechnology Research Institute) is based on a system of interlocking services. While these services exist elsewhere, the degree to which an ROI driven strategy was pursued makes them somewhat unique nationally:

- Pre-Start Up: The MBRI Innovation Center provides a full range of science and business support. Selected research is brought to the Center's state-of-the-art molecular biology labs. Scientists responsible for the project are given extensive two-track support comparable to other incubator facilities nationwide: (1) scientific, to develop benchtop results, and (2) business, to develop a basic company structure. For example, the scientist

receives assistance with necessary health and safety permits, secretarial and personnel assistance, financing, and legal help. MBRI, in other words, does not just invest in the company; it becomes part of the company. In return for these services and the use of its facilities, MBRI takes an ownership stake in the company.

Prospects for the Center are identified either through independent industry and university contacts, or through pro-active efforts on the part of MBRI to find research with the potential to form a new commercial enterprise. MBRI services were developed specifically to bridge the gap betwee academia and the private sector, helping to establish a high comfort level with business culture in institutions where the focus has been on "academic purity." In particular, MBRI serves as a "unified office for technology transfer" for more than a half dozen institutions that lacked full scale commercialization services. The MBRI technology commercialization approach is heavily weighted towards "demand-pull", driven by the knowledge MBRI staff have of opportunities for biotechnology in the market place.

o Capital Funding: When it finishes its tenure at the Innovation Center, a "pre-company" typically will consist of two principal scientists, technicians and a business operations executive. At this point, the enterprise has a solid business plan, corporate structure and sufficiently developed research to attract initial private investment.

In many cases, this initial seed money may come from MBRI's affiliated venture capital company, Commonwealth BioVentures, Inc. (CBI). CBI was created to significantly accelerate the business development process for promising Worcester-based companies. Investors in CBI's first fund included Wyman-Gordon, insurance companies, a regional law firm, private foundations, the Worcester Polytechnic Institute, and others.

Financial returns to these investors were surprising. From the first fund, at least four companies went public and one was sold to private investors. In most cases, MBRI/CBI companies have realized value through an initial public offering. Whatever the exit strategy, MBRI receives value for its development role as determined by its equity agreement with the company, as well as from its share of CBI profits. Gross IRRs to investors on the first and second funds are reported to be in excess of 35% with most of the investments fully cashed out.

CBI is managed by Bob Foster, formerly with Corning Laboratories as well as a successful entrepreneur. Foster was fully responsible for all investing as well as fundraising from 1987 through 1995. Foster is currently closing out funds IV and V, and will then resign. A search is underway for a new manager to replace Foster

CBI and MBRI are necessary to one another. Not long after CBI was created, it became evident that significant effort would be required to prepare companies for CBI financing -- an effort for which only a portion of costs could be recovered. Thus, the surrounding services of MBRI were proven to be essential to the success of CBI. However, CBI does

finance technologies arising out of the MBRI process, and MBRI works with venture capital investors other than MBRI.

As CBI replaces Foster, they intend to strengthen the connection between CBI and MBRI to that which existed at the time of funds I and II. As the funds grew larger, the working relationship between CBI and MBRI became more distant. Thus, the next fund is expected to be limited in size to approximately $10 to $15 million, and focus on financings of approximately $250,000 to $300,000.

- o Investment Phase: If the start-up is successful, the company will be ready for larger awards of investment capital. In time, the company may go public or be purchased by a larger firm or competitor. In most cases, the firms have been purchased by a larger corporation, as has been the trend with a significant portion of biotechnology companies, particularly those related to the pharmaceuticals industry. In either case, the initial investors earn a return for their early financial support. MBRI receives value for its development role as determined by its equity agreement with the company, as well as from its share of CBI profits.

- o Reinvestment: MBRI reinvests its income in either basic research grants at Massachusetts universities or in support of bioscience skills training.

MBRI as an overall organization seeks to become financially self-sustaining. Currently it covers costs with assistance from the U.S. Small Business Administration, U.S. Dept. of Agriculture, U.S. Economic Development Administration, the Worcester Business Development Corporation, and the Fuller Foundation.

MBRI is unique within Massachusetts because it focuses on the mid-tier technology universities that do not have aggressive commercialization structures (i.e., Tufts University, Worcester Polytechnic Institute, Worcester State College, etc.). MBRI is unique nationally because only it and a small number of other organizations with similar resources take such an entrepreneurial and aggressive approach to seeking profit and building companies.

When MBRI began in 1984, Worcester had no biotechnology industry and few technology companies at all. Unemployment rates were over 11%. Yet today Worcester has successful bio-tech companies working on products ranging from carbohydrate-based drugs to cancer medications to biologically safe insecticides. One example is TSI Corp., a biological products and testing service that has $35 million in sales and 460 employees. CBI realized a tenfold profit on its $1.8 million investment when TSI went public. So successful was MBRI's first base of operation in Worcester, Massachusetts that it was recruited to set up a second base of operation in Boston.

Appendix 7. Federal Models that Support Innovation

The Advanced Technology Program

Not-yet-possible technologies are the domain of the NIST Advanced Technology Program. The new synthetic materials technology that might revolutionize the auto industry-if the processing variables can be identified and controlled. The new polymer that can be used as a drug, binding and neutralizing disease-causing pathogens-if the design and manufacturing issues can be overcome. The new concept in distributed information systems that could both cut costs and potentially save lives in the nation's hospitals-if the proper software tools can be developed to make it cost effective on a large scale.

The ATP is a unique partnership between the federal government and private industry to accelerate the development of high-risk technologies that promise significant commercial payoffs and widespread benefits for the economy. The ATP encourages a change in how industry approaches R&D, providing a mechanism for industry to extend its technological reach and push out the envelope of what can be attempted.

Critical features — the following features set ATP apart from other government R&D programs:

- The goal of the ATP is economic growth and the good jobs and quality of life that come with economic growth

- The ATP is industry driven, which keeps the program grounded in real-world needs. Research priorities for the ATP are set by industry: for-profit companies conceive, propose, co-fund, and execute ATP projects and programs based on their understanding of the marketplace and research opportunities.

- The ATP does not fund product development. It supports enabling technologies that are essential to the development of new products, processes, and services across diverse application areas. Private industry bears the costs of product development, production, marketing, sales, and distribution.

- ATP awards are made strictly on the basis of rigorous peer-reviewed competitions designed to select the proposals that are best qualified in terms of the technological ideas, the potential economic benefits to the nation (not just the applicant), and the strength of the plan for eventual commercialization of the results.

- The ATP has strict cost-sharing rules. Joint ventures must pay at least half of the project costs. Single companies working on ATP projects must pay all indirect costs associated with the project. (This provision encourages small companies, particularly start-ups that often have much lower overhead rates than large firms.)

- ATP support does not become a perpetual subsidy or entitlement-each project has goals, specific funding allocations, and completion dates established at the outset. Projects are monitored and can be terminated for cause before completion.

- The ATP benefits companies of all sizes. ATP funding stimulates companies of all sizes to take on greater technical challenges with larger, broader, and faster payoff potential for the nation-benefits that extend well beyond the innovators-than they could or would do alone. For smaller, start-up

firms, early support from the ATP can spell the difference between success and failure. To date, over half (53 percent) of the ATP awards have gone to individual small businesses or to joint ventures led by a small business. Large firms can work with the ATP, especially in joint ventures, to develop critical, high-risk technologies that would be difficult for any one company to justify because, for example, the benefits spread across the industry as a whole. Universities and nonprofit independent research organizations also play significant roles as participants in ATP projects. More than 100 different universities are involved in more than 180 ATP projects as either joint-venture participants or subcontractors.

- Since its inception, the ATP has made economic evaluation of the outcomes of ATP projects a central element of its operations. The ATP has developed and implemented a thorough measurement program that pushes the state of the art in evaluating the long-term outcomes of R&D investment.

Competitions — ATP uses general and focused program competitions. General competitions ensure that all good ideas receive consideration, no matter what the technology area. Focused programs create a mechanism to provide critical-mass support for high-risk, enabling technologies in particular technology areas identified by U.S. industry as offering especially important opportunities for economic growth.

Economic Returns — ATP projects are expected to make significant contributions to scientific and technical knowledge, produce new technologies that will be developed and introduced into the marketplace by the project awardees (using their own funds), and, in the long run, yield substantial benefits to the economy beyond those accruing directly to the award recipients. This is a lengthy process. ATP projects typically run from 2 to 5 years, the commercialization phase could add several more years, and the full economic impact may not be realized for some years after commercial introduction. It also is costly-companies must spend additional time, effort, and money on their own to pursue product development and marketing. Because of the risks involved-commercial as well as technical-some ATP projects will fail. Others may proceed faster than anticipated, and intermediate results may lead to marketable products even before the ATP project ends. Regardless of whether initial commercialization takes place before an ATP project ends, or long after, the company must invest its own money to design specific products incorporating the technology and to pay any other costs associated with commercialization.

Using a variety of analysis tools, including third-party surveys and statistical analyses, the ATP has documented several important near-term results of the program, including:

- The majority of companies receiving ATP awards would not have been able to pursue the technology at all without the ATP, and the balance would have been able to proceed only at a significantly smaller scale. The bottom line: U.S. industry today has important new technical capabilities that would not exist without the ATP.

- R&D on the high-risk, high-payoff technologies fostered by the ATP has been accelerated significantly, according to award winners, a large majority estimating that the award has put them ahead by 2 years or more. In today's marketplace, where product cycles are shorter, a lead time of only a few months can mean the difference between success and failure in time-critical markets.

- U.S. firms have found new commercial opportunities-and some early growth-based on these new technical capabilities.

- A new element in the R&D culture of U.S. business is emerging-one that emphasizes more high-risk, high-payoff, enabling R&D and greater use of cooperative research ventures and industrial alliances, and that views government and industry as partners rather than opponents.

The Small Business Research Innovation Program (SBIR)

SBIR is a highly competitive program that encourages small business to explore their technological potential and provides the incentive to profit from its commercialization. By including qualified small businesses in the nation's R&D arena, hi-tech innovation is stimulated and the United States gains the entrepreneurial spirit as it meets its specific research and development needs.

Competitive Opportunity for Small Business — SBIR targets the entrepreneurial sector because that is where most innovation and innovators thrive. However, the risk and expense of conducting serious R&D efforts are often beyond the means of many small businesses. By reserving a specific percentage of federal R&D funds for small business, SBIR protects the small business and enables it to compete on the same level as larger businesses. SBIR funds the critical start-up and development stages and it encourages the commercialization of the technology, product, or service, which, in turn, stimulates the U.S. economy.

Since its enactment in 1982, as part of the Small Business Innovation Development Act, SBIR has helped thousands of small businesses to compete for federal research and development awards. Their contributions have enhanced the nation's defense, protected our environment, advanced health care, and improved our ability to manage information and manipulate data.

SBIR Qualifications — Small businesses must meet certain eligibility criteria to participate in the SBIR program.

- American-owned and independently operated
- For-profit
- Principal researcher employed by business
- Company size limited to 500 employees

The SBIR System —Each year, ten federal departments and agencies are required by SBIR to reserve a portion of their R&D funds for award to small business.

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Education
- Department of Energy
- Department of Health and Human Services
- Department of Transportation
- Environmental Protection Agency
- National Aeronautics and Space Administration
- National Science Foundation

These agencies designate R&D topics and accept proposals.

Three-Phase Program — Following submission of proposals, agencies make SBIR awards based on small business qualification, degree of innovation, technical merit, and future market potential. Small businesses that receive awards or grants then begin a three-phase program.

- Phase I is the start-up phase. Awards of up to $100,000 for approximately 6 months support exploration of the technical merit or feasibility of an idea or technology.

- Phase II awards of up to $750,000, for as many as 2 years, expand Phase I results. During this time, the R&D work is performed and the developer evaluates commercialization potential. Only Phase I award winners are considered for Phase II.
- Phase III is the period during which Phase II innovation moves from the laboratory into the marketplace. No SBIR funds support this phase. The small business must find funding in the private sector or other non-SBIR federal agency funding

The General Accounting Office (GAO) conducted a 10-year evaluation of the SBIR in preparation for the program's congressional re-authorization in 1997. GAO's report confirmed its previous evaluation that SBIR is a very successful program and worthy of continued federal support. Specifically, GAO's analysis indicates that SBIR Phase I projects enjoy about a 33 percent chance of reaching the marketplace. This is an outstanding level of success.

Appendix 8. Participants during the development of this report

We wish to thank the following for their contribution to this report:

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- Tom Adams, Vortechnics, Environmental Sciences
- Jim Atwell, Sevee & Maher Engineers, Environmental Sciences
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