

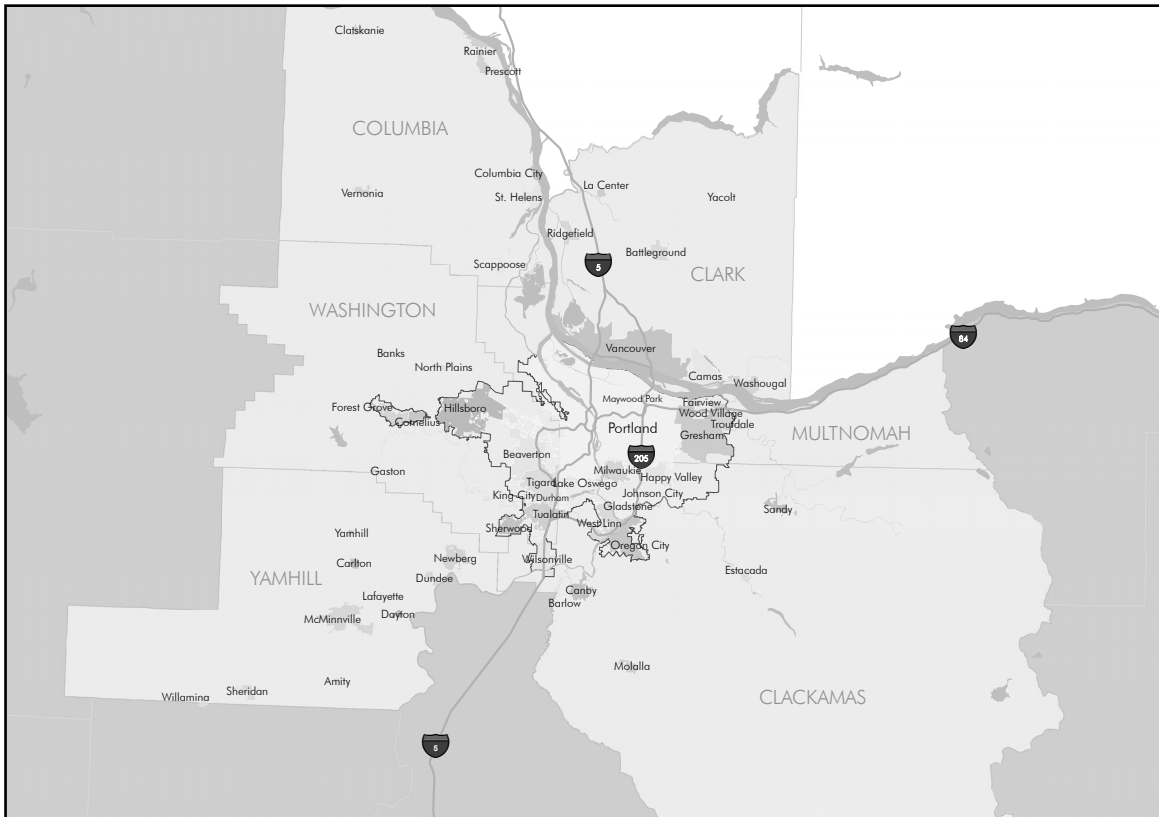
UNDERSTANDING THE ONAMI EXPERIENCE: SUCCESS FACTORS AND TRANSFERABILITY FINAL REPORT

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IMS Mission Statement

The Institute of Portland Metropolitan Studies is a service and research center located in the College of Urban and Public Affairs at Portland State University. The mission of the Institute is to serve the communities of the Portland-Vancouver metropolitan area and to further the urban mission of Portland State University by:

- Identifying the most pressing issues facing this metropolitan area and its communities, and developing the data and other information needed to fully communicate their scope and significance;
- Building capacity in the region to address critical metropolitan issues by:
 - Brokering partnerships among faculty, students, and area communities to foster new understanding of and/or new strategies for addressing those issues; and
 - Acting as a catalyst to bring elected officials, civic and business leaders together in a neutral and independent forum to discuss critical metropolitan issues and options for addressing them; and
 - Developing new resources to support research and service activities needed to meet those objectives.

By acting effectively on this mission statement, the Institute will enable the:

- University to help advance the economic, environmental, and social goals held by the communities of the region; and
- Communities of this region to act collectively to seek and secure a sustainable future for this metropolitan area.

Acknowledgements

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1 Introduction

In December of 2002, the Oregon Council for Knowledge and Economic Development (OCKED) issued its report to the Oregon Legislature. Established under Senate Bill 273 by the 2001 Oregon Legislature, OCKED was tasked with promoting knowledge-based economic development in Oregon. The report included a set of recommendations in three areas: research and technology transfer, capital and business formation, and workforce development. The recommendations included a \$35 million request for new initiatives from the general fund in the 2003-2005 biennium.

The primary recommendation for research and technology transfer was the creation of Signature Research Centers (SRC) to translate research into commercial applications. The pilot SRC was identified as The Center for Multiscale Materials and Devices (MMD). MMDs were described in the OCKED report as devices that “incorporate nanoscale materials into microscale structure to achieve smaller, faster, and better controlled processes for numerous applications” (p. 10-A). After a difficult 2003 legislative session, the SRC was funded with \$20 million in capital and \$1 million in operating funds. Thus, the state’s first SRC, later named the Oregon Nanoscience and Microtechnologies Institute (ONAMI) was born.

The State of Oregon has invested a total of \$12.75 million in operating funds and \$20 million in capital in ONAMI from the beginning of FY 2004 to the close of FY 2008. In addition, the state has committed \$4.5 million in FY 2009, bringing the state’s total investment in ONAMI to \$37.25 million by the end of the current biennium in June of 2009. During that time, ONAMI has broadened its scope, extended its network, and added new university and private sector partners.

The return on Oregon’s investment in ONAMI can be described, in part, by the following accomplishments:

- ONAMI’s initial capital investment has been leveraged by private-sector capital donations valued at \$9.4 million.
- The ONAMI network includes over 150 research affiliates at four universities and at the Pacific Northwest National Laboratory (PNNL).
- ONAMI’s university partners secured almost \$110 million in extramural nano- and microtechnology research awards from 2004 to 2008. On an annual basis, research awards in ONAMI-related technology have more than tripled since 2002.

- During this same period, the ONAMI partners have generated 135 invention disclosures, 120 patent applications, 13 patents awards, and 19 license agreements related to ONAMI research.
- ONAMI's members have earned over \$400,000 in ONAMI-related licensing revenue;
- Seven new companies have been created from ONAMI-related technology.

The most recent sign of ONAMI's success is the fiscal year 2009 defense appropriations bill, which includes 13.4 million in funding for ONAMI research projects.

A recent analysis of the economic impacts of ONAMI's activities estimates a benefit-cost ratio of 1.72, with a rate of return of 56% (O'Connor et al 2008). This is a remarkable accomplishment, especially given that ONAMI has only been operating for a few years. The greatest economic impact of technology development typically occurs in the longer term, as a broad range of industries adopt the technologies (Tassey 2003 p. 24). Furthermore, this rate of return exceeds what might be considered a favorable internal rate of return for most private-sector R&D investments (Tassey 2003, p. 47).

To what should we attribute ONAMI's success in these areas? Can the factors that have contributed to ONAMI's success be transferred to other Oregon Signature Research Centers? What can other states and nations learn from ONAMI's experience? This report investigates these questions.

Objectives and Methodology

The objective of this project was to answer the following questions:

- What aspects of ONAMI's development and institutional structure have contributed to its organizational effectiveness?
- What characteristics of the ONAMI design and experience can we transfer to other organizations as Oregon continues its development of signature research centers?

We pursued this objective by taking the following steps:

1. **Literature review.** We reviewed key literature on the effectiveness of technology-based economic development programs to extract key findings from earlier studies about what separates successful from unsuccessful programs.
2. **Develop Hypotheses.** After reviewing this literature, we formed several hypotheses about the factors that set ONAMI apart as a program with the potential for success.
3. **Test the hypotheses.** By reviewing ONAMI documents and interviewing ONAMI principal actors, we uncovered a number of key themes running throughout the ONAMI experience that either verified or refuted our hypotheses about the key factors in ONAMI's success.

Contents of this Report

This report includes three additional chapters and one appendix.

- The remainder of this chapter summarizes ONAMI's history and describes its general program activities.
- Chapter 2 provides background regarding the factors that improve the effectiveness of technology-based economic development programs. Reviewing these factors, we developed hypotheses regarding the key factors determining ONAMI's success.
- Chapter 3 lays out in detail factors that have contributed to ONAMI's success, based on a review of ONAMI documents and interviews with many of the principals of ONAMI.
- Chapter 4 draws conclusions about how applicable the ONAMI model is to other signature research centers.
- Appendix A contains a list of people who were interviewed and the references consulted.

ONAMI Programs

ONAMI is a multi-institutional, multidisciplinary program that also spans many stages of the research and development process—from research through application and commercialization. ONAMI contributes to Oregon's research in nanotechnology by providing incentives and mechanisms for cooperation among institutions and disciplines and between universities and the private sector. These incentives and mechanisms include the following:

- A network of shared user facilities that enable nanotechnology research,
- A pool of funding used for match on competitive extramural proposals,
- Funds that contribute to packages for recruiting signature researchers,
- Grants to researchers working with a company to advance the status of a university-developed technology to enable commercialization,
- Distribution of federal funding, and
- A variety of networking activities that encourage researchers to exchange research interests and ideas and to develop partnerships.

ONAMI also engages in outreach that increases recognition of ONAMI's capabilities among scientists, companies and potential funders within Oregon and around the nation.

Shared User Facilities

ONAMI has invested in a shared network of laboratories that enables nanotechnology researchers throughout Oregon to access sophisticated and expensive equipment that is essential to their research and therefore key to successful research proposals. ONAMI has invested \$990,000 to purchase new equipment and upgrade existing facilities. The shared user facilities are briefly described below. Additional detail about these facilities can be found on ONAMI's web site (www.onami.us).

The Center For Advanced Materials Characterization in Oregon (CAMCOR), is located at the University of Oregon in Eugene. The facility contains over 20 instruments with capabilities that include microanalysis, surface analysis, electron microscopy, nanofabrication, and traditional chemical characterization. The facility is located in a building that, through a combination of unique geological structure and advanced building engineering, is much quieter than a typical structure. As one of the quietest measurement structures in the world, the CAMCOR facility itself improves the precision of the measurements performed by the array of tools it houses (O'Connor et al 2008).

The Center for Electron Microscopy and Nanofabrication (CEMN) is located at Portland State University. CEMN offers imaging using a comprehensive set of electron microscopy tools. These tools can be used to image and analyze a variety of nano and micro structures. Researchers can access the CEMN by visiting the facility at PSU, or through remote-access high-speed Internet connections.

The Microproducts Breakthrough Institute (MBI), in Corvallis on the Hewlett-Packard campus is a nano-micro fabrication facility that is jointly operated by the OSU College of Engineering and the Pacific Northwest National Laboratory. The MBI has a comprehensive suite of tools for building prototypes of, fabricating and measuring micro devices. These tools are being used to develop, test, and create prototypes of microchannel devices that can be used in a variety of applications in distributed energy production, drug delivery, and other medical applications.

These facilities are available to all researchers in the ONAMI network as well as private-sector users. Not only do these facilities offer the researchers access to the facility and equipment, but they also offer users the expertise needed to operate the equipment safely and effectively.

However, this equipment must be maintained, and the facilities must be staffed. In order to provide an incentive for the facilities to make their equipment and services available to ONAMI researchers and the private sector, ONAMI matches the fees the facilities collect from users in order to subsidize these maintenance costs. Private sector users pay commercial rates to use the facilities. These matches have totaled \$610,000 through FY 2008.

Proposal Matches

One of ONAMI primary objectives is to accelerate the growth of federal and private awards to nanoscience and microtechnology researchers in the state of Oregon. Attracting extramural funding often requires an investment by the proposing institution to share in the costs. Even when match is not required by a funding agency, a proposal that includes matching funds, particularly cash match, can be more attractive to a potential funder because the resulting leverage increases the potential impact of the investment.

ONAMI offers matching funds for research, workforce development, and equipment purchases that support research and education in nanoscience and microtechnology. ONAMI provides a ten percent match for proposals that include faculty from one ONAMI-affiliated institution. For proposals submitted by a team that includes two or more ONAMI-affiliated institutions, the match rises to 15 percent. A proposal for

equipment that will be available for use in one of ONAMI's shared facilities is matched up to 33 percent. ONAMI will also match 33 percent of the value of a donated piece of equipment to facilitate installation and set-up if the equipment will be available to the ONAMI network.

ONAMI has invested about \$2.5 million in proposal matching funds. These funds have matched \$15.2 million in external funds. Thus, for every dollar ONAMI has committed as match, \$6.08 has been awarded in external funds. About 2/3 of these funds have been used to match grants for purchases or donations of equipment.

Signature Researchers

Although equipment and matching funds are important in competing for research funding, talent is the key ingredient for building Oregon's competitiveness in nanoscience and microtechnology. ONAMI co-invests up to \$500,000 with its member institutions to recruit researchers that are most likely to contribute to Oregon's ability to compete now and in the future. Attracting top talent requires a substantial investment, not only in salary and benefits, but also in the laboratories and equipment that will enable the scientist to conduct advanced research that will advance their career as well as Oregon's position in nanotechnology.

ONAMI has committed about \$3 million to the recruitment of the following signature researchers as well as four active searches:

- Mas Subramanian, OSU,
- Landis Kannberg, OSU and PNNL,
- John Conley, OSU,
- Andrea Goforth, PSU, and
- Drake Mitchell, PSU.

ONAMI's contributions to these recruitment packages have been instrumental in encouraging these scientists to accept offers to come to Oregon. These researchers are chosen for their ability to attract significant research funding to Oregon and to partner with existing faculty to complement existing technical strengths and build new programs. Some are established senior researchers with considerable accomplishments. Others are young researchers with great potential. The established, senior researchers can be very important in mentoring junior researchers and thereby building a foundation for future research and funding.

Federal funding

ONAMI has received about \$44.5 million in direct federal appropriations for research in areas of specific interest to the federal government. This funding has allowed ONAMI to build research capabilities in its four research thrust areas:

- Microtechnology-Based Energy and Chemical Systems (MECS)
- Safer Nanomaterials and Nanomanufacturing
- Nanoscale Metrology and Nanoelectronics
- Nanolaminates and Transparent Electronics

ONAMI has received a total of \$10.9 million from fiscal year 2005 to fiscal year 2009 for Miniature Tactical Energy Systems (TES) program through the Department of Defense. This funding has provided core support for the MECS thrust, which is led jointly by OSU and PNNL. The Department of Defense has also provided funding totaling \$13.7 million over five years to support the Safer Nanomaterials and Nanomanufacturing research program, which is led by the University of Oregon. Nanoscale Metrology and Nanoelectronics program, led by PSU, has received \$11 million over four years, beginning in 2006, from the Office of Naval Research. The Army Research Lab has provided over \$8 million to support ONAMI's thrust in Nanolaminates and Transparent Electronics.

The funding provided by these programs is generally awarded through a competitive process within the ONAMI network. Thus, rather than being distributed according to some formula that allows for a certain level of funding for each institution, teams of faculty submit white papers and compete for the funds. The ideas with the greatest promise for meeting the goals of the program are awarded funding.

Commercialization Gap Grants

ONAMI's second key objective, apart from increasing external funding for nano- and microtechnology research, is to increase the commercialization of nano- and microtechnologies. As Oregon companies adopt these technologies to develop products and improve processes, they will create industries, companies and jobs on the cutting edge of nanotechnology.

To facilitate the transfer of ONAMI technologies into the marketplace, ONAMI awards "proof of concept" grants to university researchers who are working directly with a private for-profit company. These grants fill the funding gap between university research and the availability of private funding for technology commercialization. The goal of these projects is to develop the technology to the point at which the technology is attractive to private investors. ONAMI looks for projects with the potential to attract private capital at least three times the gap fund award within 12 to 18 months.

ONAMI has awarded gap funds to ten projects totaling about \$2 million. Seven of these awards have gone to researchers at Oregon State University, while three have been awarded to researchers at the University of Oregon. Most of the companies working with these researchers have also received funding from other sources, such as the Small Business Innovation Research (SBIR) program. None has yet received private funding to commercialize the technology. One of the companies is no longer operating.

Networking

ONAMI sponsors a number of events that encourage the exchange of ideas and information among ONAMI members. Some of these events are formal, such as the annual Micro Nano Breakthrough Conference. Others are much less formal, such as social networking events and brown bag discussions of recent research results.

2 Key Success Factors

What makes science and technology programs—particularly those that are driven by university research—effective? For more than 20 years, states and regions have undertaken initiatives designed to promote the economic benefits of a knowledge-based economy. After decades of investment in science and technology programs of all types, it seems we should have learned a few lessons about what works and what doesn't.

State technology-based economic development programs have evolved a great deal since they first began appearing in the 1960s. States have a long history of supporting basic science through their state-supported universities. In some states, university extension services have included not only agricultural extension, but also technical assistance to manufacturing facilities. However, the linkage between science and economic development strategy and policy is a fairly recent phenomenon. Plosila (2004) notes that the linkage began in the 1960s and 1970s with the development of state science advisors and science advisory boards, and the development of state science and technology strategic plans. However, these efforts were not usually linked to economic development efforts, which at the time were primarily focused on industry recruitment and development of physical infrastructure (including industrial parks) that would assist in that recruitment.

By the 1980s, while the rust belt was suffering the decline of U.S. manufacturing, some regions were experiencing economic booms generated by the strength of their technology-based industries. Massachusetts' Route 128, California's Silicon Valley, and North Carolina's Research Triangle were illustrating the economic power of technology-based economies. Suddenly, science and technology began to draw the attention of economic development leaders. But these leaders were still accustomed to using the tools of industrial recruitment; thus, many focused on building physical infrastructure (research parks) and ignored many of the other key elements of a technology strategy. Only later did states begin to tie universities to their economic development strategies.

Today, state-level science and technology programs generally focus on one or more of four areas:

- Supporting research at the state's universities or in not-for profit institutes;
- Supporting the transfer of the resulting technology from the universities to industry;

- Encouraging the development and supporting the success of startup firms to capture locally the economic benefits of innovation;
- Facilitating access to capital for fledgling technology companies.

Most states employ a combination of all four of these strategies. ONAMI is an example of a state program that incorporates all of these elements. Although nanotechnology research is the main activity that has been supported by ONAMI so far, technology transfer, business formation, and the facilitation of capital for those companies are all part of the ONAMI program. ONAMI also contributes to the development of a workforce that is trained at many levels to contribute to the development and success of a nanotechnology industry in Oregon. By integrating these strategies into a single program focused on a general technology area, ONAMI illustrates the power of moving forward on each of these fronts.

This section reviews the experience of the past 40 years of state technology-based economic development policy and outlines the key factors that have distinguished successful from unsuccessful programs.

How is Success Defined?

Do we know what a successful technology-based economic development program looks like? While each program is established with its own specific objectives, they share a common goal: to improve the state economy. They also share an assumption: that thriving economies must be built on an economic base of firms that constantly innovate and maximize the use of technology in the workplace (SSTI, 2006).

This assumption is confirmed by volumes of evidence that technology-based firms contribute to the health of a local economy (Malecki, 1997; Jankowski, 1999), that technology is a key vehicle for economic growth and state competitiveness (Melkers, 2004), and that publicly supported research plays a key role in industrial innovations (Mansfield, 1997).

The Oregon Legislature’s specific objectives in establishing ONAMI can be found in the 2002 report of the OCKED. The Research and Technology Transfer committee of OCKED had three goals:

- Increase the state’s capacity for high-quality research and development;
- Facilitate the translation of research into commercial applications;
- Increase the value and economic benefit of research and technology transfer.

The spirit of these objectives is captured by a quote from the OCKED report: “Centers should be targeted on areas of expertise that have the greatest ability to translate research into business ventures by capitalizing on our R&D capacity while directly linking to Oregon’s knowledge-based and emerging industries (Page 6-A).”

A number of the ONAMI stakeholders interviewed for this project have emphasized the importance of these key goals. According to ONAMI’s President and Executive Director, Skip Rung, all of ONAMI’s expenditures are guided by two primary objectives:

- Accelerating the growth in federal and private research awards to nanoscience and microtechnology researchers in Oregon, and
- Accelerating growth in the commercialization of nano- and microtechnologies in Oregon.

Other, more detailed goals mentioned by stakeholders include

- Improving the quantity and quality of nanoscience and microtechnology research at Oregon universities;
- Increasing the number of faculty engaged in active research in the subjects they teach;
- Improving the success of young professors in acquiring external funding.

Each of these complementary objectives point to a shared understanding of what a successful ONAMI would accomplish: more nano- and microtechnology research, leading to the formation of new companies employing those technologies, and the creation of jobs filled by workers with the training necessary to contribute to the success of those young companies and to the growth of emerging industries.

How is Success Measured?

Measuring the impact of state investments and ensuring accountability to taxpayers is generally considered a very important factor in the success of these programs. Because state funds are often very limited, and because taxpayers are miserly, it is important to ensure that measures of success are developed and tracked. So how do state program stakeholders know if their investments are paying off?

Managers of state science and technology programs struggle to identify and apply appropriate measures of the outcomes of their efforts (Melkers, 2004). The most frequently used measures simply count inputs and activity; output and outcome measures are dominated by estimates of leverage and job creation. Although scholarly publications and collaboration are considered important interim measures of R&D success, they are used as metrics by fewer than 20 percent of state technology-focused economic development programs.

In the case of ONAMI, the overall performance measures include:

- Number of technologies or products developed in partnership with ONAMI affiliates that are commercialized by Oregon companies.
- Number of Oregon companies assisted by ONAMI to raise at least \$20 million in private capital.

Key ONAMI milestones are:

- By July 2009, hire between four and six world class researchers leveraged with contributions from ONAMI affiliates.
- Raise at least \$40 million in new federal and private funding by July 2009.
- Advance three to eight technologies, developed by companies assisted by ONAMI, to venture-ready stage by July 2009.

- Generate between \$200K and \$500K in technology licensing revenue and/or equity value growth in companies assisted by ONAMI by July 2009.

With the exception of the milestone related to venture-ready technologies, ONAMI has met each of these goals well before their July 2009 deadlines. Because the Commercialization Gap fund program is a relatively recently formed program, and because it represents a later stage in the research-to-commercialization cycle, it is not surprising that ONAMI is still working toward meeting this milestone

ONAMI also routinely reports on traditional metrics collected and reported by the Association of University Technology Managers (AUTM). These include:

- Technology disclosures,
- Patent applications,
- Patents issued,
- License agreements,
- Licensing expenditure,
- Revenue from licenses/royalties/capital gains,
- New companies created.

Finally, ONAMI reports on “return on investment” metrics such as

- Grant proposals submitted and awards made by source,
- Research dollars awarded and expended,
- Ratio of grant awards to state support (was 8.4 for FY 07).

What do we Know about Success Factors?

Several recent reports have summarized the nation’s experience with state-level innovation policy and developed a set of best practices and factors that differentiate successful state programs from less successful programs. Plosila (2004) identified several differentiators regarding how these programs are organized and run. The SSTI also identified the characteristics that seemed to differentiate universities that have been most effective in launching and supporting knowledge economies. Finally, the National Governors’ Association and the Pew Center on the States (2007) have developed a set of recommendations for state investments in innovation programs.

Although these studies have different areas of focus, there are a number of recurring themes regarding factors that differentiate successful programs. These include the following:

Choose a research focus that represents alignment between university capabilities and key regional industries. The research focus should build on existing strengths and offer market opportunities that fit well within the state’s existing industry clusters. Plosila recommends that the criteria for choosing a research focus should include filling private sector gaps to strengthen local industry. SSTI notes that successful programs are focused on areas that are drivers of national and regional clusters and knowledge sectors. Aside from its potential to benefit key industries, the

criteria for choosing a research focus might also include its potential for solving important social or technical problems facing the state and its key industries (swine flu in Iowa, pollution in California).

Choose a niche that allows the state to take a leadership position. It is also important to be realistic about the state's potential. As emphasized by the NGA/Pew report, a realistic assessment of the state's technology strengths—both university and private sector—is important. That assessment can identify a niche that will not only complement the state's research strengths and its economy, but also allow the state to excel. This kind of excellence in a technology niche can help a state compete for federal and industry funding—funding that often is awarded to the undisputed leaders in a scientific area.

This kind of specialization may compel the state to partner with others to compete for larger cross-disciplinary projects. These partnerships can be very beneficial. As the experience of ONAMI has shown, gaining attention in a small but significant research area can open doors to partnerships in significant research efforts.

Align key investments in an overall technology-based economic development strategy. The research focus of a university-industry partnership must be leveraged by complementary investments in other areas such as physical infrastructure (labs and other spaces that foster interaction), development of key talent, investment, and a culture of entrepreneurship.

While these strategies must be sufficiently flexible to adjust to feedback, states should avoid completely changing direction once the strategy is set. These programs can require significant investment and they take time to bear fruit. If the strategy is based on a realistic assessment of the state's strengths, market opportunities, and industry clusters, the public and their representatives must have the patience to stick with the strategy and allow it to work.

Emphasize leverage of state funding. Plosila points out that the most “successful” programs were those that leveraged state funds and made sure that private funds were committed first, with public funds following thereafter. As an example, he cites the Ben Franklin program in Pennsylvania, which required the commitment \$3 of private support for each \$1 of public support. This was important, according to Plosila, because the states were attempting to encourage long-term changes in private sector behavior and practice. This point of view is reinforced by SSTI which notes that “Requiring cash match is an essential component of successful centers.”

However, leverage can come from a variety of sources, and in the case of ONAMI, leverage has been obtained from federal grants and contracts, private contracts, and private donations of equipment and services. The private sector's role in ONAMI has been somewhat different than that its role in other successful centers. This reflects ONAMI's structural uniqueness and its limited responsibility for funding research projects. Private sector contributions to ONAMI's success are discussed in greater detail in Section 3.

Commit long-term funding subject to periodic review. As emphasized above, an innovation strategy may take more time to demonstrate success than more traditional economic development strategies such as industrial recruitment. University research

centers require multi-year funding to ensure the follow-through required for research to have economic development benefits. While these programs require patient investment, their funding should not be considered an entitlement.

Create an organization specifically focused on the center's mission. The most successful organizations, according to Plosila, created regional intermediary organizations that operated the program—usually a nonprofit corporation. The state economic development agency is generally not the best choice for managing these programs. Non-profit intermediaries are generally able to respond more quickly than public bureaucracy, can be more flexible and responsive in attitude, and can act as investors. In some states, these organizations have primary decision-making responsibilities, while the public sector acts primarily as a facilitator. While higher education is often an important partner, it is not the dominant player.

Involve industry in a number of ways. Some researchers have noted that in the late 1980s states developed innovation programs and policies without adequate consideration for the needs of industry. Focus has since shifted; SSTI points out that successful universities have leadership that is committed to partner with industry and that **successful centers are those that can bridge the gap between industry and university cultures.** This requires the commitment of senior industry leaders. Industry needs must drive the science; thus, senior industry representatives willing to share their understanding of the future course and context of the business must be involved.

Use experts – including industry leaders – to evaluate investments. Peer review of proposals can ensure good science while industry leaders can bring market knowledge to the table to assess the economic development potential of a project.

Invest in collaboration. University-industry collaborations have become routine, and scientists move between the academic and business environments throughout their careers. Give key roles to scientists who have worked in both worlds; it helps bridge the gap between industry and academic cultures. Collaboration among universities and among disciplines is also important. Investments should be structured to encourage them. Plosila suggests creating a structure that specifically facilitates these linkages.

Invest in the translation of research findings. A technology-based economic development program must not leave the job unfinished. It must support the translation of research findings into marketable products and processes, and the identification or formation of companies able to do so. This requires strong relationships between researchers and entrepreneurs and the development of networks of experts that may offer differing perspectives of the market potential and market positioning of a technology. It may also require investment in prototype development and proof of concept to take ideas to the point where they can be commercialized.

Identify and nurture key talent. There is a general recognition that a small number of “star” researchers will secure the majority of research grant awards. The SSTI points to the general rule that ten percent of the researchers will bring in 90 percent of external research funding. This emphasizes the importance of star researchers that have an orientation toward both fundamental science and real-world applications.

There are two approaches to capturing the benefits of star researchers: identifying young, promising scholars and nurturing them, or identifying established “star” researchers and aggressively recruiting them. The latter approach tends to have a more immediate impact and these faculty can play an important role in nurturing and retaining younger, promising talent. Regardless of the strategy chosen, these researchers must be committed to science that demonstrates both economic relevance and academic excellence.

A talented manager is key. Successful programs have a director with a unique combination of skills: entrepreneurial ability, credibility with faculty, the political skill to work with the university administration and elected leaders, and the ability to inspire the confidence of industry.

Require accountability and measure results. State innovation policies and programs are more likely to measure results than traditional economic development programs. Recommendations for ensuring accountability include the following:

- Measure indirect as well as direct benefits.
- Make sure measures reflect the specific needs of your state.
- Make the measures public—transparency is critical.
- Develop and report several measures of the degree to which research finds its way to the marketplace.
- Secure participation from all stakeholders when deciding what to measure.
- Produce measurements on a timely basis.
- Don’t hesitate to refine and change measures if necessary.
- Consider using an independent reviewer.

Observers of state innovation policy have argued that each of these success factors has a role in improving the likelihood that state investments in innovation will secure economic benefits for its citizens. In the following section, we describe how ONAMI has adhered to or diverged from these success factors.

3 ONAMI Success Factors

Section 2 reviewed the conventional wisdom about what makes technology-based economic development programs—particularly university-based programs—successful. We identified ten factors that seem to differentiate successful from unsuccessful programs. These factors include the following:

- Research focus: does the research focus fit with the region’s economy and with existing research capabilities?
- Alignment: is the strategy and focus of the program aligned with other economic development investments?
- Funding sources and leverage: is the state’s investment leveraged against other (private, federal, foundation) investments? Is funding contingent upon performance of key milestones?
- Organization and structure: is the program organized in a way that encourages collaboration and eliminates silos and turf?
- Role of industry: is industry used to evaluate the market potential of research? Do they participate in other ways? How does the program improve industry’s ability to turn the research emerging from the program into companies and jobs?
- Use of experts to evaluate projects: is project selection insulated from the political process? Are projects evaluated by experts both in the science and in the market potential of the technology?
- Collaboration and integrating frameworks: does the program offer incentives for collaboration among researchers, disciplines, institutions, and between the public and private sector?
- Translation of research findings: are resources devoted to the translation of research findings into products and processes? Are local companies formed that will provide and market those products and processes? Do these products and processes strengthen existing industry capabilities and clusters?
- Key talent: Does the program have access to talented, high performing faculty? Does it attract “star scientists” and nurture younger talent? Does the program’s director command the confidence of both faculty and industry?

- **Accountability:** what are the processes for reviewing the program’s progress toward desired outcomes? Are the funding, expenditures, and outputs of the program transparent?

Below, we review the ONAMI experience with respect to each of these factors and identify the specific aspects of the program that appear to contribute to its success. This section is derived largely from interviews with key informants—ONAMI founders, board members, staff, and key faculty, and from review of ONAMI documents.

3.1 Choosing a Research Focus for Oregon’s First Signature Research Center

Microtechnology and nanotechnology were chosen as the focus of Oregon’s first signature research center (SRC) for several reasons:

- It was consistent with industry’s strengths in the region and therefore a clear opportunity to create jobs.
- The program would build on compatible sets of capabilities already existing within Oregon’s universities.
- Collaboration at both the faculty and administrative levels was already occurring in the nano- and microtechnology areas.

Thus, rather than a top-down attempt to build a program from scratch, ONAMI provided energy, organization, and leverage to a strength that already existed both in industry and within Oregon’s universities. Furthermore, the seeds of collaboration had been planted prior to the formation of ONAMI.

Line of Sight to Industry

Industry leaders played a key role in the choice of micro- and nanotechnology as the focus of Oregon’s first SRC. The Technology Transfer/R&D Committee of OCKED was chaired by Jim Johnson, chair of the New Economy Coalition, and a retired Intel executive. Johnson insisted on three criteria for a signature research center:

- **Competitive research:** the focus represents an existing strength in Oregon’s universities and industries.
- **Emerging markets/future jobs:** the area has strong potential for market growth.
- **Line of sight to Oregon’s industries:** the technology area would be of direct and immediate benefit to Oregon’s primary industry clusters.

To assess these factors, the committee examined evidence gathered by two separate assessments of Oregon’s research capabilities: one conducted by the Oregon University System Chancellor’s office, and another conducted by OSU and PNNL. Skip Rung, then a retired Hewlett Packard executive, was hired by OSU to conduct an analysis of existing research capabilities. He was specifically looking for areas of intersection between university assets and industry strengths.

Skip Rung’s analysis quickly led him to small technology, especially on the industry side. Oregon is home to some of the world’s leading nano-and microtechnology

industry R&D, including Intel, Hewlett Packard, Electro Scientific Industries, FEI, Tektronix, Invitrogen, and others. Furthermore, the committee saw strong commercial market opportunities in key Oregon industries such as energy and natural resources, health care and bioscience, semiconductor manufacturing technology, fabrication and materials, process CAD, instruments and measurement, machinery and equipment, and sustainable technologies.

Institutional Capabilities and Collaboration

At the same time, there were some significant capabilities identified at the universities. The key capabilities included:

- U of O's capabilities in materials sciences, led by Jim Hutchinson and Dave Johnson at the Materials Science Institute;
- OSU's capabilities in microtechnology-based energy and chemical systems (MECS), which were strengthened when OSU hired Kevin Drost from PNNL in 2000.
- PNNL's capabilities in micro/mechanical systems.

These capabilities were strengthened by existing collaborations among the institutions.

- OSU and PNNL had developed a collaboration in microtechnologies that was strengthened by the movement of Kevin Drost from PNNL to OSU. Their collaboration was taking shape as the Microproducts Breakthrough Institute (MBI). The agreement between OSU and PNNL on the MBI was signed in 2002.
- Kevin Drost began to talk with Dave Johnson and Jim Hutchison at the U of O and they started collaborating. They slowly began to see how collaboration would lead to greater success than competition for grant funding.
- Collaboration among institutional leadership: Rich Linton, VP for Graduate studies and research at the U of O, and Ron Adams, Dean of Engineering at OSU, were already working to encourage collaboration among their faculty.

Complementarities among the universities' research strengths enabled inter-institutional collaboration. The lack of duplication of research areas among the universities discouraged researchers from feeling in competition with each other for national research funding. Instead, the ONAMI partners were able to combine their capabilities to strengthen their position relative to competitors in other states.

In some cases, the collaborations had been nurtured for a number of years prior to the establishment of ONAMI. These relationships strengthened the foundation on which ONAMI was built. For example, Dave Johnson at the University of Oregon and Kevin Drost at Oregon State University had been working on collaborating for several years before they met Skip Rung during the conception of ONAMI. They had already decided that collaboration was the only way they could succeed. ONAMI provided the support and infrastructure that enabled success, reinforced collaboration as a working model at ONAMI's member institutions.

The OCKED committee also considered sustainable technologies as an alternative potential focus area for the first SRC. An early white paper was written that described a center for sustainable development as an SRC. However, there was concern about the clarity of focus of such a center. Thus, the committee chose MMD as the preferred technology focus.

Thrust Areas within Micro and Nanotechnology

Within micro- and nano-technology, ONAMI's has chosen four thrust areas:

- Microtechnology-Based Energy and Chemical Systems,
- Safer Nanomaterials and Nanomanufacturing,
- Nanoscale Metrology and Nanoelectronics, and
- Nanolaminates and Transparent Electronics.

The choice of these research focus areas has been driven by three different factors:

- The availability of federal funding,
- Recognized strengths and unique capabilities in specific research areas, and
- The opportunity to fill market gaps.

Of course, these factors are somewhat interrelated. For example, the Miniature Tactical Energy Systems grant from the Department of Defense beginning in 2004 strengthened the thrust in microtechnology-based energy and chemical systems (MECS). However, it certainly helped that the collaboration between OSU and PNNL in microscale manufacturing of heat exchangers was considered to be one of the strongest microscale manufacturing groups in the country.

Similarly, the Safer Nano Materials and Nanomanufacturing (SSN) funding from the Department of Defense jumpstarted the safer Nanomaterials and Nanomanufacturing Initiative (SNNI). Although the universities had written proposals prior to ONAMI, those proposals were not successful. The collaboration and critical mass created by ONAMI put Oregon in a competitive position in a research area that at that time lacked a dominant leader.

Federal funding for Nanoelectronics and Nanoscale Metrology (NENM) came through the Office of Naval Research beginning in fiscal year 2006-2007. This proposal was stimulated by a suggestion from federal officials that the need for nanometrology was not being met by other universities, and that ONAMI had the capability to excel in that area.

3.2 Alignment With a Broader Strategy

ONAMI's alignment with a broader state technology strategy is the result of several different factors:

- Its genesis from a committee that considered not only research and technology transfer, but also capital availability and workforce training;

- The commitment of ONAMI’s leaders and signature researchers to offer students hands-on training that will make them very competitive in the job market;
- The commitment of private sector leaders to assess the marketability of technologies and the viability of companies built upon them.

ONAMI was developed as part of a statewide innovation and economic development strategy. This strategy, as articulated by OCKED and later refined by OCKED’s successor, the Oregon Innovation Council, included the three essential components of innovation strategy. The proposal to create a SRC (ONAMI) was paired with recommendations for improving the business environment by increasing the amount of capital and management talent available to emerging businesses, especially in technology sectors. The strategy also included recommendations for workforce development and improving the science and technology-based skills of Oregon’s students at both the K-12 and higher education level.

However, to get the greatest benefit from the alignment, these capital and workforce training efforts needed to focus on micro- and nanotechnology. And while the OCKED recommendations were not focused on the small technology area, ONAMI has emerged as a microcosm of a complete innovation strategy for a single technology area. ONAMI focuses not only on increasing the volume of research in micro- and nanoscale areas, but also on technology transfer, business and capital development, and training of professionals to work in industry. For example, the U of O’s MBA entrepreneurship program evaluates ONAMI-related technologies as a teaching tool and as a service to gap-fund companies. This provides valuable experience for the students working with real technologies and it provides a service to the ONAMI researchers trying to commercialize their technologies. ONAMI even includes an educational component for young (pre-college-aged) scientists.

The integration of these key elements—university research capability, industry commercialization, and the development of a talented workforce—is illustrated in the work of Mas Subramanian, ONAMI’s first key signature researcher. Dr. Subramanian has decades of experience in the private sector and understands the difficulty of bringing new ideas to the marketplace. He is passionate about involving students and post-doctoral researchers in the process of working with industry to find a path to commercialization. He understands that the researchers trained in this way will be very valuable to industry and therefore very competitive in the job market.

3.3 ONAMI’s Funding Sources and their Influence on Research

ONAMI funding from the State of Oregon is highly leveraged in a formula that provides high returns because:

- Only 11 percent of the funds awarded to ONAMI by the State of Oregon are used for staff and administrative expenses, including marketing and outreach.
- ONAMI funds allocated for the recruitment of signature researchers can comprise a maximum of 50% of the total startup package, up to \$500,000.

- The shared facilities are encouraged to market their facilities to external users for a market-rate fee. These fees are matched one to one with ONAMI funds until a cap is reached.
- Funds distributed to the universities from ONAMI are normally not subject to the university's usual indirect costs. This represents a considerable increase in the leverage available and represents an investment by the universities.
- ONAMI match for extramural funding is only expended if the proposal is funded. An unsuccessful extramural research proposal releases the ONAMI match for other proposals.
- ONAMI proposal matching funds increase the probability of success with extramural funders because they provide validation for the proposals to external funders; it is a sign that the state is co-investing.
- Proposal matching funds have generated \$5.30 for every dollar that ONAMI has invested in match.
- The ONAMI proposal match is highest for purchases of equipment in the shared facilities. This funding lays the groundwork for greater success in future extramural funding for all of the researchers in the network.
- The funds from federal earmarks are not considered an entitlement. Each researcher must compete with others within Oregon; the best proposals are awarded.

The private sector has also increased the leverage of ONAMI funds up by providing:

- space (Hewlett Packard provides the space for the MBI);
- free or reduced price equipment;
- Pro-bono legal, due diligence and other services.

The significant leverage applied to ONAMI funding has succeeded in focusing a considerable amount of resources—capital and talent—toward improving Oregon's capabilities in nanoscience and microtechnology. The funding formulas encourage co-investment among industry, universities, the state, and the federal government. Although each co-investor may have different specific motivations, they each contribute to a common result. The resulting collaboration creates the level of effort necessary for a small state such as Oregon to achieve credibility and capability in a technology area that requires expensive equipment and talent.

3.4 Organization and Structure

Several aspects of ONAMI's organization and structure contribute to its success by encouraging collaboration. In particular:

- ONAMI has no research staff of its own; it is not seeking to build research capacity or research infrastructure already available at the universities. This means that ONAMI adds value to the universities' research efforts rather than competing with them. ONAMI acts as a connector and facilitator that increases the success of the universities.

The universities view ONAMI as a resource rather than a competitor or threat.

- Because ONAMI is a 501c3 nonprofit organization housed outside of any of the existing institutions, it has the flexibility to accept charitable contributions and is also free from some of the organizational constraints of the universities. This flexibility increases its effectiveness as a connector among universities and between universities and industry.
- ONAMI's Leadership Team models, encourages, and facilitates collaboration. Leadership team members act as liaisons among the institutions by learning about the capabilities of faculty and helping to make connections with faculty on other campuses.
- Decisions about the distribution of funds are shared by each of the co-investors through the ONAMI board and the ONAMI Operations Council. Rather than allocating according to a formula that ensures a percentage for each campus or each technical area, funds are awarded competitively. Because collaboration is often required to meet the needs of a complex technical problem, the competitive process encourages collaboration among faculty and institutions.

As noted in Chapter 2, collaboration is essential to advancing science in emerging areas such as nanotechnology. The collaboration encouraged by the ONAMI structure contributes to its success in attracting extramural funds and advancing technologies to commercialization.

3.5 The Role of Industry in ONAMI

Although the private sector has played an important role in the development of ONAMI, its participation is different from that of the private sector in many other state-based innovation organizations.

- The private sector is not expected to provide direct funding of ONAMI research activities. However, considerable effort is made to encourage collaboration between industry and university researchers.
- ONAMI provides services to the private sector through shared research facilities.
- ONAMI's Commercialization Advisory Council consists primarily of venture capital partners active in Oregon. They evaluate the short-term (12 to 18 months) market potential of gap-fund proposals. This is viewed as one of the most significant contributions the private sector can make to ONAMI's success.
- Companies participating with ONAMI researchers through the Commercialization Gap Fund credit ONAMI with encouraging greater interaction between Oregon university researchers and businesses active in micro- and nanoscale research (O'Connor et al 2008).
- The private sector also contributes in other ways, including, as described above, space, equipment, and pro-bono services.

As explained above, ONAMI was proposed by industry leaders in large part because of the strong industry capabilities in this area. Aside from participation in OCKED, one of industry's earliest involvements in the project was the donation by Hewlett Packard, rent-free, of the building that houses the MBI.

ONAMI did not ask for, nor did the state require, initial private sector funding for ONAMI's startup. Instead, the private sector contributes equipment, services, and their expertise regarding what technologies are ready for the market. ONAMI's structure as a 501c3 organization separate from either state government or the universities enables this involvement by the private sector.

ONAMI encourages the shared user facilities to cultivate private sector clients in order to develop long-term operating revenue and to bring more private sector companies into the ONAMI network. Private sector partnerships may begin with the use of a shared facility and build into a longer-term partnership as university and private sector researchers work side by side at the facilities.

3.6 Use of Experts and Project Evaluation

ONAMI's process for choosing investments is designed to ensure that research with both market value and technical merit is chosen. The factors contributing to this are:

- Competition and collaboration. Competition and collaboration are both important parts of the ONAMI process. This combination leads to proposals that are technically strong.
- Leverage: ONAMI never invests in a project without a partner that has also evaluated the investment and decided that it makes sense.
- Volunteer experts: ONAMI uses existing review processes as well as their own advisory councils to evaluate projects.

ONAMI has different procedures in place for evaluating its four different types of investments. The matching grant awards take advantage of the evaluation process of the external funding agency. Because ONAMI's goal is to increase research volume, they put very few barriers in place and approve most matching funds for extramural research. If the external funder awards the grant, that means they consider the project of value to their program. This external evaluation process ensures that ONAMI is not arbitrarily weeding out projects that could be successful for external funding.

The higher match for grant proposals that feature collaboration among the institutions (15 percent versus 10 percent for single institution proposals) provides an incentive for multi-institutional proposals. This provides an additional screen that ensures that more than one institution appreciates the merits of the proposal.

ONAMI provides match for shared user facility operating support only when private sector users are billed for their use of the facility. Thus, if a piece of equipment is not of value to the private sector, ONAMI does not invest in its upkeep. This offers a screen for the investments that ensures they are consistent with private-sector needs.

Signature researcher recruiting requires that both the universities and the ONAMI board appreciate the importance of the investment in the researcher being recruited. Because ONAMI will provide at most 50 percent of the value of the startup package, the university making the hire is a co-investor that will use its own evaluation process for determining the potential value of its investment. This ensures that the signature researcher is a good fit for the university while meeting the goals of ONAMI.

3.7 Collaboration and Integrating Frameworks

ONAMI has invested a great deal in collaboration. The need for collaboration among the disciplines and among the universities was evident to ONAMI's founders:

- Oregon is too small to fund any one institution at the level that would enable them to take a leadership position in the micro- and nanotechnology space.
- The universities on their own did not have the capability to exert a leadership position in any one of the four thrust areas. However, by combining their intellectual and physical assets, they had a chance to lead in these areas.
- The thrust areas require interdisciplinary efforts; the faculty that lead each of the thrust areas are interested in crossing and combining disciplines to further discovery.
- Politically, a joint SRC has a better chance of funding than any individual university's request.

The mandate for collaboration was clear from the beginning. Nanotechnology requires a convergence between organic chemistry, life sciences, and physical sciences. Strengths in each of these areas exist within the Oregon University System, but not within any single institution.

The political benefits of collaboration also eventually became clear. University presidents aligned their requests for state and federal funds for ONAMI and agreed to develop the process for distributing the funding later. This collaborative request for funds was very well received both in Salem and in Washington, DC.

ONAMI has been successful at creating collaboration because:

- The executive director has made it a priority. He sees his job as being a matchmaker among faculty from different institutions.
- The leadership team principals, comprised of the lead faculty for each of the thrust areas, take the lead at their home institutions in identifying, encouraging and leading research collaborations in Oregon.
- ONAMI's matching fund program provides incentives for interinstitutional collaboration.
- There is very little duplication of expertise among the institutions.

- The shared facilities put researchers side by side within laboratories. This physical co-location promotes communication and collaboration.
- Being a tenant at the MBI requires that a researcher actively be a collaborator or at least have interest and potential in becoming a collaborator.
- Collaboration was already occurring among many of the faculty and at the leadership level prior to ONAMI. ONAMI's success has strengthened this commitment.

It may seem paradoxical to assert that competition leads to collaboration. However, as noted above, there was very little duplication of expertise across the universities. Furthermore, although each of the universities excelled in specific niches of nanoscience or microtechnology, a competitive proposal often requires combining expertise in one more specific areas to form a team that can address a complex problem more completely. Thus, the faculty had an incentive to form interinstitutional teams to compete effectively for ONAMI funding.

This collaboration has been cited as the key factor in many of ONAMI's successes. The benefits flowing from the collaboration include:

- the opportunity to share physical facilities, increasing the research infrastructure available to every researcher in the network;
- the active engagement of entrepreneurs in ONAMI research, improving its commercial orientation;
- enhanced reputation and name recognition, which improves success with funding and with recruiting signature researchers;
- a more stimulating research environment in which researchers challenge each other and raise expectations for the quality of research;
- a bridge between academic and private sector cultures.

Collaboration between OSU and PNNL required that the two cultures—academic and federal lab contractor—be bridged. Each brought unique assets to the table, with the universities offering a long-term perspective on discovery and exploration, and PNNL offering an understanding of emerging market opportunities. This leads to research that is both inventive and of immediate interest to industry. It clears the path from academic research to commercialization and reinforces industry's sense that ONAMI is worth engaging.

However, collaboration takes time and can be challenging. Some of the key challenges faced by ONAMI researchers engaged in collaborative research projects include:

- the need to eliminate the thinking that funding is a zero-sum game;
- licensing and intellectual property issues;

- the initial impression that researchers would only pay lip service to collaboration in order to gain funding;
- the clash of cultures, which manifests itself in different attitudes about intellectual property and commercialization; and
- the need to break new ground in administrative and legal areas, such as dealing with multiple funding sources and blended intellectual property.

Although collaboration begins with human relationships, the institutional relationships become more important to a long-term collaboration. As the new ground is broken in working out these institutional relationships, the costs of collaboration fall; the “hassle factor” of working among institutions lessens.

3.8 Translation and Commercialization

ONAMI has, by all accounts, had a significant impact on the translation and commercialization of research at Oregon’s universities. The number of invention disclosures, patent applications, patents awarded, and license agreements has increased at all of the universities within the small technology area. According to ONAMI reporting metrics, annual invention disclosures have grown from 16 in fiscal year 2002 to 30 in fiscal year 2008. Patent applications have more than tripled, from nine in fiscal year 2002 to 34 in fiscal year 2008. ONAMI researchers have been awarded 14 patents since its initiation, and their member institutions have developed 20 licensing agreements that have earned them over \$550,000 thousand in licensing revenue.

The culture within the universities is slowly evolving toward a better appreciation for the commercial applications of research and the market relevance of a scientist’s education. Several factors have contributed to this change:

- ONAMI provides funding to the technology transfer offices at the institutions to assist with the IP protection of technologies that are being used in gap-fund projects.
- ONAMI assists the university technology transfer offices in focusing their patenting efforts on commercially relevant areas likely to generate revenues. For gap-fund projects, the partnership with a company significantly reduces the risk that the money spent on patenting will be wasted.
- The signature researchers that have been recruited through ONAMI are very focused on applications of their research, and they are training their students to understand the market as well.
- Skip Rung’s experience in the private sector offers a natural orientation to private sector applications of the technology.
- The participation of PNNL has also encouraged a transfer of the culture of commercialization to other members of ONAMI.
- Several of the signature researchers recruited with ONAMI participation have private sector experience and orientation toward the market as well as an appreciation for the benefits of the academic setting.

It is worth noting that although this better understanding of the market potential for nanoscience and microtechnology is important to meeting the goals of ONAMI, the academic orientation of ONAMI's university researchers also brings important benefits to the ONAMI partnership. Private sector members appreciate the longer-term orientation toward science and discovery that academic scientists offer. Rather than undermining the culture of academia, the ONAMI partnership is about bridging the cultures of academia and the private sector to create a "line of sight" between university research and technology commercialization in Oregon industry.

3.9 Key Talent

ONAMI is creating an attractive and productive research environment for nano- and microtechnology researchers. The enriched environment includes:

- A statewide virtual campus of shared laboratory facilities,
- ONAMI's growing reputation in nanoscience and microtechnology,
- Attractive startup packages enabled by the signature researcher recruitment program,
- An environment that encourages signature researchers to collaborate with and to mentor younger faculty, and
- The culture of collaboration that makes the research more fun and rewarding.

ONAMI's shared laboratory facilities allow researchers access to a more valuable set of equipment than would otherwise be possible. This facilitates their research and assists them in writing successful grant proposals. ONAMI's growing reputation as a leader in its thrust areas also attracts and retains faculty, because it sparks their interest and improves their success with grant proposals. For established faculty courted by multiple institutions, the signature research program assists in developing attractive startup packages. These star faculty are also eager to collaborate and mentor young faculty. For young faculty with promising futures, the opportunity to work with star researchers with strong track records and innovative ideas creates a strong pull. And many of the researchers are drawn to and nurtured by the growing culture of collaboration that ONAMI is cultivating.

Aside from the faculty, ONAMI's other key talent is its President and Executive Director, Skip Rung. Many of the ONAMI partners interviewed for this report mentioned his direct interest in faculty research, his skill at marketing, his ability to bring faculty together, and his credentials with both the academic and private sector as a key factor in the success of ONAMI. This is consistent with the literature that notes that a very dedicated individual with a unique set of skills and credentials is required to drive the success of programs such as ONAMI

3.9 Accountability

Transparency and accountability are considered critical to the success of an innovation program for several reasons:

- Because they show stakeholders that their money is being well spent;

- Because they ensure that nobody takes public funding for granted and understand that results are expected.
- Measuring results tends to focus people on achieving those results.

ONAMI has developed a very transparent and accountable culture. Each ONAMI partner submits quarterly reports of the value of research proposals, grant and contract awards, and research expenditures for each ONAMI-related project and for total ONAMI-related activity. In turn, ONAMI monitors progress toward its key benchmarks in quarterly reports that it submits to its board, to the Oregon Innovation Council and to the OECDD.

As explained earlier, the only benchmark that ONAMI has failed to meet up to this point is the attainment of the private sector funding for companies funded by ONAMI's commercialization gap fund. ONAMI fully admits that the commercialization gap-fund process lags the other accomplishments

3.10 Summary

ONAMI's apparent success, as measured by metrics related to research activity, external funding, and the creation of intellectual property, can be attributed to a number of factors. Some of these resulted from conscious decisions about ONAMI's initial design. Others were the result of political and financial realities facing ONAMI's architects. Other factors are the result of careful program decisions made by ONAMI's advisory board over the past four years. Still others are due to fortunate accidents and opportunities that have worked out favorably.

Many of these factors are consistent with the advice of observers of state innovation policy. The main factors that seem to be contributing to ONAMI's success are the following:

- **Orientation toward problems and solutions of interest to Oregon industry.** This orientation has gained the attention and participation of the private sector and capitalized on their market knowledge and expertise. Although this market orientation has required some shift in perspective at the research universities, many of ONAMI's key participants have industry experience and a natural orientation toward understanding the marketable applications of a discovery. However, as explained in the next section, the longer-term perspective of the university research culture will be important to ONAMI's continued success.
- **An organization that enables, rather than competing with, existing research institutions.** ONAMI's minimal structure, with no research staff, laboratories, or intellectual property of its own, has prevented university researchers and administrators from viewing ONAMI as a competitor. Without the fear that ONAMI is a threat to its own ambitions, the universities are better able to work with ONAMI and the other ONAMI partners to promote their research areas.

- **A combination of competition and collaboration that enables a small state with limited funding for innovation to choose an area and excel.** Rather than allocating research resources according to some predetermined, politically expedient formula, ONAMI has competed the funds made awards to research teams with the best ideas. Often, building a credible proposal requires collaboration. In the case of the matching grant program, collaboration is explicitly given preference. The shared user facilities encourage collaboration while reducing the cost of access to important facilities for all ONAMI partners. This combination of competition and collaboration brings the best ideas forward and strengthens each team's ability to deliver effective results.
- **A low overhead, highly leveraged structure that allowed ONAMI to begin and continue operations with low overhead and high accountability.** ONAMI began operating with only \$1 million in operating funds for its first two years of operation. This forced ONAMI to adopt a lean structure and today it uses only 11 percent of state funds for staff, administrative, and marketing expenses. This structure has contributed its reputation as a catalyst and enabler rather than a resource drain.
- **A focus on developing and combining complementary talent to create new opportunities.** ONAMI's efforts have led to alliances among researchers from different disciplines, different institutions, and different sectors. It has matched entrepreneurs with technical experts and helped them learn to work together. It has facilitated the bridging of private sector and university cultures to the benefit
- **A pre-existing collaborative attitude.** ONAMI has benefited also from the seeds of collaboration that were planted long before ONAMI became a legal entity. The early recognition among key university leaders of the benefits of collaboration paved the way for ONAMI's explicit promotion of inter-institutional research.

4 Model Transferability

This report has documented some of the factors that have shaped ONAMI and contributed to its success in increasing research volume and intellectual property generation in nanoscience and microtechnology in Oregon. While ONAMI's successful start is notable, it represents only one of three existing signature research centers in Oregon. The other two centers, The Bio-Economy and Sustainable Technologies (BEST) Center and the Oregon Translational Research and Drug Development Institute (OTRADI), have benefited from Oregon's experience with ONAMI.

However, it is not clear that each of the factors that have led to success for ONAMI will also offer success for these other centers. It is worth examining these factors and sorting through which are unique to the ONAMI situation and which are transferable to other technologies and markets.

4.1 Replicable Conditions and Success Factors

Orienting to the Market and finding the "Line of Sight" to Oregon Industry

The creation of ONAMI as Oregon's first SRC was based on three criteria laid out by OCKED for a signature research center. One of those was a clear line of sight to Oregon's industries. That criterion was a key factor in gaining industry support and participation in ONAMI and enabling research teams to gain a market orientation as they worked with industry. Without local industry engaged in similar research and commercialization, ONAMI might not have received donations of equipment or benefited from the market knowledge of the local venture capital community. Finally, the tie to local businesses offers a rich pool of talent, as many researchers and executives from industry have become involved in ONAMI in a number of ways. Clearly, a tie to local industry strengths can improve the resources available to an SRC as well as increasing their ultimate economic impact.

Identifying a Niche in which Oregon can lead

By almost any measure of R&D activity, Oregon is a minor contributor. Total state R&D performance in 2004, according to the National Science Foundation, was \$3.7 billion—about the same as Arizona, but about half of the R&D performed in North Carolina, and less than one-third that of Washington State. Federal R&D obligations to Oregon totaled only \$449 million in 2004, compared to \$2.2 billion in Arizona, \$1.6 billion in North Carolina, and \$2.1 billion in Washington State.

These statistics point to the need for Oregon’s innovation strategy to focus on niche areas in which the state can build on existing research strengths to lead a technical area. While nanotechnology is a broad area of research, ONAMI’s choice of four thrust areas allowed it to build a record of accomplishment—and thus a strong reputation—over time. Similarly, other SRCs should choose areas of focus in which the key researchers’ records can substantiate a claim of leadership and build a portfolio of accomplishment.

Building Capability through Collaboration

Oregon’s relatively small volume of research calls for building collaboration where it serves to increase the state’s claim on a leadership position in a technical area important to Oregon’s economy. Collaborations can be especially important when solving complex problems requires expensive research infrastructure and/or interdisciplinary research teams. For ONAMI, the construction of a virtual statewide laboratory contributed to the recruitment of star researchers as well as the competitiveness of research proposals.

New discoveries often emerge from the convergence of previously distinct technical areas. Because the research capabilities of Oregon’s universities are relatively specialized (e.g. there is not significant duplication of effort), interinstitutional collaboration may be essential to the exploration of these new opportunities. For example, ONAMI is beginning to increase its exploration into the emerging field of nanomedicine as Oregon Health Sciences University increases its role in ONAMI.

Building on Existing Research Strengths

Given Oregon’s limited public investment in innovation, it is unrealistic to imagine that public funds can be used to create technical capability in areas in which it does not currently exist. While larger states with richer treasuries may attempt to build critical mass simply by buying capability and facilities, that is not an option in Oregon. The key to a successful SRC will be to add value to the existing capabilities by providing the catalyst for collaboration among existing resources, and marketing those capabilities to potential funders and partners.

Using Competition to Build Collaboration

While capability in a given research area can be built by encouraging collaboration, collaboration can be encouraged through competition. This will be most productive in technical areas in which Oregon has little duplication across intuitions. The competition will encourage researchers with complementary skills to search for their colleagues with the technical skills required to meet the needs to solve a complex problem with practical applications of interest to government and private funders.

ONAMI’s competitive formula for disbursing research funds has also encouraged researchers to submit their best ideas. They are motivated by the knowledge that proposals will get funded based on the technical merit and market potential, not on some predetermined formula.

4.2 Exceptional Conditions

Federal Earmark Funding

ONAMI's four thrust areas were built, at least in part, through the investment of the federal government in noncompetitive research awards. That investment may not be forthcoming in other technical areas that meet the criteria for investment in a signature research center. In this case, other sources of funding may be needed to seed specific research areas. This source of funding could be a foundation, a consortium of private companies, or a significant competitive federal program.

The Availability of Unique Talent

The literature on best practices for state innovation policy clearly points to the importance of a talented executive director with credibility in both the academic and business world and a dedication to the mission of the organization. While ONAMI has benefited from a unique and talented executive director, other signature research centers may have difficulty finding the right person to lead. The chances of finding this person are best in technical areas with strong industry research presence in Oregon.

Collaborative Attitude Among Faculty and Leaders

ONAMI's culture of collaboration began at two levels: at the faculty level, and with the academic and administrative leadership. We can assume that the leadership's positive experience with ONAMI will encourage them to accept similar collaborations in other technical areas. But we don't know whether the key faculty in other technical areas—particularly the established faculty with hefty research records—will be willing to collaborate with younger faculty and faculty from other disciplines and institutions.

Collaboration is not always an even exchange. Some faculty or institutional leaders may not perceive the benefits of lending their time, talent, equipment, facilities, resources, and credibility to a project in which they will have to share the credit and the financial rewards.

However, ONAMI's accomplishments may serve to encourage this collaboration in other areas because it has clearly demonstrated the potential benefits. ONAMI and its partners have also cleared some of the administrative hurdles, which might make collaboration less frustrating.

History and Alignment of Circumstances

ONAMI's success at catalyzing growth in micro- and nanotechnology research was built on a long history of research and partnerships. This history includes the formation of the Materials Science Institute at the University of Oregon in 1985 and the industry collaborations arising from its internship program. Another key relationship was the partnership between Doug Keszler at OSU and Dave Johnson at the University of Oregon, which eventually led to the thrust area in nanolaminates

and transparent electronics. OSU's strengths in chemical, industrial, and mechanical engineering, PNNL's strong portfolio of intellectual property in micro-materials, and the history of exchange between the two institutions led to the formation of the Microproducts Breakthrough Institute, which predated ONAMI.

Each of these technical areas and partnerships had time to germinate prior to the establishment of ONAMI. ONAMI's formation resulted from an alignment of opinion about the potential of these parallel but related efforts and their implications for Oregon's potential competitiveness in micro- and nanotechnology. ONAMI provided the fuel, leverage, and connections to integrate these efforts and bring them to critical mass. However, this would not have been possible without the history, technical foundation, and hard work that preceded its formation. This points to the importance of long-term support for research that creates the foundation for commercial success.

4.3 Factors Important to ONAMI's Long-Term Success

ONAMI's long-term success depends on a strategy that builds a pipeline of research results and nanotechnology researchers. A pipeline of research results applicable to a variety of Oregon's key industries is essential to the long-term success of the program. ONAMI's gap fund program is currently commercializing technologies that, for the most part, take advantage of research results that have been available, but not ready for commercialization, for a number of years. To continue the process of commercialization, ONAMI must build a pipeline of results that will offer a steady supply of new discoveries over time. This is possible because of the longer-term perspective offered by the university approach to research and discovery combined with an understanding of the market potential of these discoveries. This strategy has the private sector, university researchers, and students excited about the future of ONAMI's thrust areas.

This strategy requires continued public investment. ONAMI's board of advisors must continuously examine the long-term usefulness of ONAMI's research results to industry and insist on transparency and accountability. But the early estimates of the economic performance of investments in ONAMI indicate that these investments are paying off. With a 56 percent internal rate of return and a benefit-cost ratio of 1.72 (O'Connor et al 2008), the state's investment in ONAMI is reaping strong returns for Oregon's taxpayers.

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¹ This study also benefited from the transcripts of additional interviews conducted by Alan O'Connor of the Research Triangle Institute as documented in O'Connor et al 2008.