Report on High Technology/Education Cooperation

City Club of Portland (Portland, Or.)
REPORT ON

HIGH TECHNOLOGY INDUSTRY/EDUCATION COOPERATION
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REPORT ON
HIGH TECHNOLOGY INDUSTRY/EDUCATION COOPERATION

To the Board of Governors,
City Club of Portland:

I. INTRODUCTION AND SCOPE

The Research Committee was charged to:

"Determine the form and composition of a long-range institutional arrangement among education, business, labor, and government in the Portland area, the purpose of which is to: (1) analyze current relationships and problems among these groups; (2) provide ongoing coordination among these groups; and (3) facilitate economic diversification and growth by promoting the development of technological research facilities and post-secondary education."

This charge was proposed in August 1982 by the Special Economic Development Subcommittee of the Education Standing Committee. It was part of a broader effort by the Club to study the relationship between higher education and economic development. This broader effort also included a series of City Club programs and a forum panel of City Club members who directly discussed the subject with other interested groups (see Appendix A).

The charge was drawn from conclusions reached from many sources, including City Club studies, speakers, the May 1982 Governor's Economic Recovery Council Report, and the July 1982 SRI International report on Strengths and Weaknesses of the Portland Area as an Industrial Location. Behind the charge was the fact that, for nearly 20 years, City Club research reports have shown concern for the state's economy and its relationship to the higher education system. To sharpen the focus of committee research, the charge includes a specific premise:

"Economic diversification would be beneficial for Oregon's economy. Improved technological research capabilities, making use of post-secondary education, will help lead to economic diversification."

The premise led us to ask the following questions:

- What is high technology?
- What kinds of high technology industries are likely to locate in Oregon? What kinds do we want?
- What is the relative role of high technology industry in Oregon's economic development?
- How important is post-secondary education in Oregon for the attraction and growth of desired high technology industry?

Our research addressed each of these questions but returned to the central issue - coordination. We examined past and present coordinating mechanisms in Oregon and looked for useful examples in other states.

II. SUMMARY OF REPORT

The term "high technology" as used in this report means the application of new technical knowledge in our society. Thus, the definition goes beyond electronics, optics and robotics to include segments of forestry, ag-
riculture and other traditional Oregon industries which incorporate state-of-the-art technology. Businesses applying recent advances in science and technology are a small (50,000 employment) but important sector of Oregon's economy. Such businesses rely on post-secondary education in several ways:

- Manufacturing businesses expanding in or opening a facility in Oregon need a trained production workforce. We believe this need is adequately addressed by Oregon community colleges.

- Businesses dependent on research and development rely on local undergraduate and graduate schools for new engineers and scientists, for continuing education of their existing staff, and for supporting research and access to expertise. Oregon's private and state universities, like others nationwide, fall short of training the needed numbers of scientists and engineers. Also, Oregon's capacity for providing continuing education is not located in the part of the state (metropolitan Portland) where the need is greatest. Finally, lack of priorities prevents focusing resources to support a small number of nationally recognized research programs necessary to support high technology economic growth.

Research and development-oriented companies are likely to produce more benefits to Oregon than manufacturing facilities because they offer higher paying jobs, are more likely to generate spin-off companies, and are less likely to be lost by relocation to lower labor cost areas.

New startups and businesses depending on research and development acquire technology and expertise from a variety of sources. These include national laboratories, defense contractors, and universities. Oregon does not have a national laboratory or a large defense industry to attract related research and development activity. Yet, your Committee believes that research and development activity is crucial to accelerating the growth of business startups in Oregon. As a result, we must rely on higher education to meet this need. Two possible approaches for improving Oregon's research and development activity have been explored:

- Creation of university/industry coordinating bodies to improve the flow of information and resources between higher education and industry.

- A sharper focusing of effort in our existing higher education systems to better concentrate our resources.

Your Committee considered many examples of coordinating bodies nationally and found that the Minnesota Business Partnership and associated programs represented a good model for Portland and Oregon. The Minnesota program is designed to coordinate services not only in technical research, but also in financing, management assistance, education, and training and marketing. However, regardless of structure or form, the distinguishing factor in successful coordinating bodies is the leadership from and smooth working relations within each component of the partnership — viz. higher education and industry.

Oregon has a history of successful single purpose coordinating bodies between higher education and business but no central coordinating body serving new technology business and education. Oregon State University's relationships have been in agricultural and forestry fields. More recently, OSU has been involved in providing continuing post-graduate education to
employees of electronics companies. While not a part of the State's System of Higher Education, the community colleges have helped train production personnel. Private universities and the Oregon Graduate Center have also worked with various industries to assist in research and instructional efforts. For the most part, however, these cooperative efforts have been on an ad hoc basis without long range coordination or planning.

In 1982, the Oregon legislature created the Oregon Consortium for High Technology Education which allocated $1 million through the Educational Coordinating Commission to various private and public institutions to further science and engineering education. The funds came equally from the state budget and industry, and the largest allocation benefited Portland State University's programs in response to electronics industry demands. Two central coordinating bodies to replace the Consortium were also proposed within the last year:

- The Science and Engineering Board for Education and Research (SEBER) was recommended by the Governor's Economic Recovery Council. This Board would be private industry-based and report directly to the Governor. It would be charge with raising and distributing funds through the Governor's Office to particular educational programs, securing relevant information and promoting cooperative efforts among industry, government and educational institutions.

- The Council for Advanced Science and Engineering Education/Research for Industry (CASEERI) was recommended by the Chancellor of Higher Education to allocate program development funds available via the legislature. This group, chaired by university leaders but with private industry membership, would advise the Chancellor.

After studying models elsewhere, your Committee recommends that the Governor adopt the recommendation of his Economic Recovery Council and establish SEBER, the coordinating body organized outside the higher education system, with broader representation and decision-making powers.

In studying examples of cooperation between post-secondary education and high technology industry, we repeatedly were confronted with perceived deficiencies in Oregon's State System of Higher Education. As reported to us, these deficiencies would restrict Oregon schools from being an effective partner in encouraging new industry growth. Such deficiencies included:

- Lack of flexibility in program funding and in allocation of resources among the several State System campuses.

- Destructive competition among State System schools evidenced by needless duplication of some programs and artificial definition of new degree programs to enable teaching similar advanced courses at several schools.

- Lack of a strategic plan which successfully differentiates and makes corresponding allocation of resources among programs important for Oregon's economic health. We believe that the appropriate strategy for supporting high technology economic development includes these key elements:

  —providing competent and adequate instructional programs across the board,
funding a small number of "pinnacles of excellence" for research programs selected to support emerging high technology firms, and

—providing both instructional and research programs to parts of the state where the economic impact would be greatest.

- Lack of policies and an infrastructure which encourages frequent communication and technology transfer among disciplines and between State System schools and high technology industry.

- A management system very protective of status quo conditions through emphasis on bureaucratic procedures, committees and extensive reviews of even small changes.

These deficiencies, reported to us by knowledgeable persons in industry and higher education, seem so serious that they demand solution before any new education/industry coordinating body can be fully effective. However, your Committee recognizes that their solution goes well beyond the study charge and well beyond the scope of our efforts.

Other actions needed to determine how best to proceed in improving higher education support for high technology economic development include:

- A professional study to evaluate Oregon's public higher education system and to suggest changes within the state system to facilitate cooperative education/industry program development and technology transfer.

- A revision of the recent Strategic Plan for the Oregon State System of Higher Education to identify "pinnacles of excellence" in research that Oregon will develop and fund.

- A comprehensive study of administrative consolidation for the System of Higher Education, to determine whether a single State University of Oregon - with major campuses at Eugene, Corvallis and Portland - can break down some of the barriers to badly needed cooperative program efforts.

III. BACKGROUND

A. High Technology Industry in Oregon

There are a number of alternative definitions of high technology, ranging from lists of academic disciplines to the following Standard Industrial Code (SIC) grouping used by the U.S. Department of Commerce and referenced in national studies on economic development (18):

- Chemicals and Allied Products (SIC 28)
- Machinery, except electric (SIC 35)
- Electrical and Electronic Machinery (SIC 36)
- Transportation Equipment (SIC 37)
- Measuring, Analyzing, and Controlling Instruments; Photographic, Medical, and Optical Goods; Watches and Clocks (SIC 38)
A narrower list has recently been used by the Western Interstate Commission for Higher Education in examining manpower needs over the next decade (20):

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Aerospace</td>
<td>-Computer and information sciences</td>
</tr>
<tr>
<td>-Bioengineering</td>
<td>-Information sciences and systems</td>
</tr>
<tr>
<td>-Computer</td>
<td>-Data processing</td>
</tr>
<tr>
<td>-Electrical</td>
<td>-Computer programming</td>
</tr>
<tr>
<td></td>
<td>-Systems analysis</td>
</tr>
</tbody>
</table>

The latter listing does not include the traditional physical and biological sciences in which rapid changes occur and on which many other commercial ventures depend.

Often the term high technology is used without any clear notion of the specific industries or technologies involved. For example, John Naisbitt, in Megatrends, leaves the definition to the reader's intuition. In our research we have relied on data using definitions that more closely relate to the Oregon experience. In that context, we take "high technology" to mean "new technology" — simply the application of new technical knowledge in our society. The implication for Oregon, of course, is that forestry, agriculture, fishing, and other established industries all have elements of "high technology" and are subject to associated growth and productivity improvements.

High technology industry as defined by the Oregon Department of Economic Development (SIC Codes 35, 36, and 38) constitutes a small percentage of total employment in Oregon but has grown rapidly over the past two decades (Figure 1).

Figure 2 shows that Oregon has experienced a growth rate in its high technology labor force that is among the highest in the western states. In California, it has been estimated (2) that high technology jobs, which comprise only 4.5% of the state labor force, contribute directly or indirectly some 23% of all new jobs. We conclude that high technology industry is an important source of new employment in Oregon even though it is not currently the major contributor to new employment.

High technology business ventures in Oregon occur either by attracting external companies that are expanding or moving, or by creating an environment which encourages the formation of new local ventures. Post-secondary education plays different roles in these two situations.

1. **Factors That Attract External Industry** — Major plant additions have been characterized by a large manufacturing percentage of the work force as opposed to management or research percentages. A primary requirement is a trained or trainable production work force. This requirement currently is met quite satisfactorily by coordination with local community colleges. City Club speakers have testified to the adequacy of a range of cooperative programs between community colleges and industry, both nationally and locally. This is understandable, given the community college charge and relatively short term (2-year) programs of these schools.
Table 1 presents the results of a recent congressional study of the factors that influence the decisions of existing companies on the location of new plants. It is noteworthy that in choosing a (multi-state) region, the availability of post-secondary academic institutions ranked fourth among twelve factors (18).
<table>
<thead>
<tr>
<th>Rank</th>
<th>Attribute</th>
<th>Percent of Respondents Indicating &quot;Significant&quot; or &quot;Very Significant&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Labor skills/availability</td>
<td>89.3</td>
</tr>
<tr>
<td>2</td>
<td>Labor costs</td>
<td>72.2</td>
</tr>
<tr>
<td>3</td>
<td>Tax climate within the region</td>
<td>67.2</td>
</tr>
<tr>
<td>4</td>
<td>Academic institutions</td>
<td>58.7</td>
</tr>
<tr>
<td>5</td>
<td>Cost of living</td>
<td>58.5</td>
</tr>
<tr>
<td>6</td>
<td>Transportation</td>
<td>58.4</td>
</tr>
<tr>
<td>7</td>
<td>Access to markets</td>
<td>58.1</td>
</tr>
<tr>
<td>8</td>
<td>Regional regulatory practices</td>
<td>49.0</td>
</tr>
<tr>
<td>9</td>
<td>Energy costs/availability</td>
<td>41.4</td>
</tr>
<tr>
<td>10</td>
<td>Cultural amenities</td>
<td>36.8</td>
</tr>
<tr>
<td>11</td>
<td>Climate</td>
<td>35.8</td>
</tr>
<tr>
<td>12</td>
<td>Access to raw material</td>
<td>27.6</td>
</tr>
</tbody>
</table>

The top-ranked attribute, labor skills/availability, implies some kind of education level for the work force. Discussion with the congressional study's author indicates that labor skills/availability refers to skilled craftsmen. It is ranked higher than the availability of academic institutions because professional labor is more mobile than skilled craftsmen, e.g. machinists, welders and computer programmers.

In Table 2 it can be seen that when locating within a region, proximity to good schools was ranked below more traditional business expense factors.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Attribute</th>
<th>Percent of Respondents Indicating &quot;Significant&quot; or &quot;Very Significant&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Availability of workers</td>
<td>96.1</td>
</tr>
<tr>
<td>2</td>
<td>State/local tax structure</td>
<td>85.5</td>
</tr>
<tr>
<td>3</td>
<td>Community attitudes toward business</td>
<td>81.9</td>
</tr>
<tr>
<td>4</td>
<td>Cost of property and construction</td>
<td>78.8</td>
</tr>
<tr>
<td>5</td>
<td>Good transportation for people</td>
<td>76.1</td>
</tr>
<tr>
<td>6</td>
<td>Ample area for expansion</td>
<td>75.4</td>
</tr>
<tr>
<td>7</td>
<td>Proximity to good schools</td>
<td>70.8</td>
</tr>
<tr>
<td>8</td>
<td>Proximity to recreational/cultural opportunities</td>
<td>61.1</td>
</tr>
<tr>
<td>9</td>
<td>Good materials/products transportation</td>
<td>56.9</td>
</tr>
<tr>
<td>10</td>
<td>Proximity to customers</td>
<td>46.8</td>
</tr>
<tr>
<td>11</td>
<td>Availability of energy supplies</td>
<td>45.6</td>
</tr>
<tr>
<td>12</td>
<td>Proximity to materials/components supplies</td>
<td>35.7</td>
</tr>
</tbody>
</table>

In this same study, the availability of 1) degree programs and 2) information resources were cited as "most important" among those companies for which a university was important.
2. **Factors Influencing New Business Formations** - New business formations, in contrast to relocations or expansions, are composed of a high percentage of management and research employees. These new jobs often depend upon prior graduate level education, but in early years do not substantially rely directly on the local post-secondary education system for staff development. As a venture capital firm representative stated to us, "the last thing I look for in choosing to back a new high technology venture is the existence or adequacy of nearby post-secondary education - the staff of our ventures don't have time for that."

Startup businesses typically rely on the founders' former employers for the technological germ of their product ideas. Founders will be inclined to rely on known good resources to decrease their likelihood of failure. In so doing, they will hire previous comrades, whose work they respect to be team members. The usual source of these experienced early employees is industry. A recent notable exception is in the biotechnology industry, where many startups were launched directly from university laboratories. In either case, it is only after the new venture has navigated past early critical obstacles, that founders consider recruiting inexperienced, untried college graduates.

But while startup business do not rely on higher education institutions for employee education or training, they often require help from experts at the cutting edge of technological development. While they often reach outside the local region to centers of national excellence for such help, proximity offers an obvious competitive advantage. Oregon startup companies, lacking local access to a national research laboratory or a concentration of research-intensive industry, see research laboratories in higher education institutions as the most promising local source for such expertise.

Local examples of startup companies include:

- **Metheus**, whose founders and most early employees were all from Tektronix. Recently, they have recruited several employees from Intel in Hillsboro.

- **Mentor Graphics**, whose founders were all from Tektronix, as were the majority of their 30+ employees.

- **Graphic Software Systems**, whose founders and key employees were all from Tektronix.

- **Sequel Computer Systems**, which recently started with 16 Intel employees.

- **Star Technologies**, which was staffed with former Floating Point managers, technologists, and executives.

- **Servio**, who recruited their technical leadership for data base computer products from Tektronix and Floating Point.

- **Intellidex**, a Corvallis robotics firm whose dozen initial employees came from Hewlett-Packard.
With the exception of Metheus and Intellidex, these companies have no direct dependence on local universities. (Metheus has close ties with OGC, Intellidex with OSU.)

B. Post-Secondary Technical Education in Oregon

Oregon has eight public colleges/universities and ten private institutions which provide baccalaureate and post graduate degrees in science and technology disciplines. In addition, all 15 community colleges and a majority of the 150 private vocational schools operating in Oregon offer training programs in support of high technology industry. Figure 3 portrays this technical enrollment for 1981-1982.

Figure 3

OREGON POST-SECONDARY SCIENCE/ENGINEERING PROGRAM ENROLLMENT (1982-82 ESTIMATED DATA)

Although directly comparable data are not available, spot checks indicate that the Oregon participation rates in technical programs follow national trends for total post-secondary education and are well ahead of national averages (Table 3).
Table 3
OREGON TOTAL POST-SECONDARY ENROLLMENTS PER 1,000 POPULATION COMPARED WITH NATIONAL AVERAGES (FALL 1980) (19)

<table>
<thead>
<tr>
<th></th>
<th>Oregon Participation Rate</th>
<th>US Average Participation Rate</th>
<th>Oregon/US Participation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undergraduates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community Colleges</td>
<td>14.35</td>
<td>9.65</td>
<td>148.70</td>
</tr>
<tr>
<td>Public Universities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(classification includes only UO and OSU)</td>
<td>9.80</td>
<td>6.36</td>
<td>154.10</td>
</tr>
<tr>
<td>Public Four-Year Colleges</td>
<td>6.76</td>
<td>8.37</td>
<td>80.80</td>
</tr>
<tr>
<td>Independent Colleges</td>
<td>4.32</td>
<td>7.33</td>
<td>58.90</td>
</tr>
<tr>
<td>Total Undergraduate</td>
<td>35.23</td>
<td>31.70</td>
<td>111.10</td>
</tr>
<tr>
<td><strong>Graduate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>6.20</td>
<td>4.42</td>
<td>140.30</td>
</tr>
<tr>
<td>Independent</td>
<td>1.34</td>
<td>2.05</td>
<td>65.40</td>
</tr>
<tr>
<td>Total Graduate</td>
<td>7.54</td>
<td>6.47</td>
<td>116.50</td>
</tr>
</tbody>
</table>

The predominance of public post-secondary education is evident. Table 4, below, compares Oregon with national average appropriations per capita, percent allocation to public higher education, and appropriations per full-time equivalent student (FTE). Clearly, Oregon allocates more on a per capita (resident) basis and targets more dollars for post-secondary education than the national average and falls below the national average in dollars spent per student.

Table 4
FUNDING LEVELS IN POST-SECONDARY EDUCATION 1981-1982 (19)

<table>
<thead>
<tr>
<th></th>
<th>Oregon Appropriations Per Capita</th>
<th>Oregon Appropriations Per FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Allocation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Public Higher Education</td>
<td>12.9</td>
<td>$3,285</td>
</tr>
</tbody>
</table>

Appendix B provides recent summary budget and enrollment data for Oregon higher education.

The constriction in enrollment and the tight fiscal condition of the state have meant that public institution budgets were decreased in the last biennium. Indeed, Oregon received national press attention last October (48) when we were ranked 50th among the states in percentage increase of education budgets over the previous biennium. It is little comfort to know that Washington ranked 42nd and California ranked 47th in this same survey (all three states were above the national per capita funding averages at the beginning of the biennium), as such policies can not be sustained for long without permanent effect. Table 5 demonstrates that individual post-secondary schools shared the budget constriction almost evenly.
Table 5

COLLEGE/UNIVERSITY GENERAL FUND BUDGET ALLOCATIONS
1982-1983 (28)

<table>
<thead>
<tr>
<th></th>
<th>1982-1983 Appropriations (Millions)*</th>
<th>Percentage Change From Prior Two Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon State University</td>
<td>$56</td>
<td>-1</td>
</tr>
<tr>
<td>University of Oregon</td>
<td>32</td>
<td>+1</td>
</tr>
<tr>
<td>Oregon Health Sciences University</td>
<td>43</td>
<td>+4</td>
</tr>
<tr>
<td>Portland State University</td>
<td>22</td>
<td>-4</td>
</tr>
<tr>
<td>Southern Oregon State College</td>
<td>8</td>
<td>-6</td>
</tr>
<tr>
<td>Western Oregon State College</td>
<td>7</td>
<td>+1</td>
</tr>
<tr>
<td>Oregon Institute of Technology</td>
<td>7</td>
<td>+5</td>
</tr>
<tr>
<td>Eastern Oregon State College</td>
<td>5</td>
<td>+5</td>
</tr>
<tr>
<td>Community College Support</td>
<td>47</td>
<td>-8</td>
</tr>
<tr>
<td>Student Aid</td>
<td>8</td>
<td>+17</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>$241</td>
<td>-4</td>
</tr>
</tbody>
</table>

The state fiscal crunch and dropping enrollment have had their effect. Over the past two years, the presidents of Western Oregon, Eastern Oregon, and Oregon Institute of Technology have resigned, each citing inadequate state support as the primary reason. Faculty salaries have been frozen at levels approximating the 1981-1982 national average (full professor, $33,000). At the University of Oregon, where normally 15-20 faculty resign each year, this past year 43 faculty left. The morale of remaining faculty has been adversely affected.

When one looks only at science and technology disciplines, however, the enrollment and funding picture is not quite so grim. Programs in electrical engineering and computer science, for example, have expanded some 30 percent over the past three years (in both funding and enrollment). The current upper division enrollments (Table 6) seem large, but nationally enrollments in these fields represent only 32 percent of the need over the next three years as judged by the industry (American Electronics Association).

Table 6

ELECTRICAL ENGINEERING/COMPUTER SCIENCE (EE/CS) STUDENTS
1981-1982 (16)

<table>
<thead>
<tr>
<th></th>
<th>BS/BA</th>
<th>MS</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Oregon</td>
<td>130</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>Oregon State University</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Science</td>
<td>181</td>
<td>41</td>
<td>15</td>
</tr>
<tr>
<td>Electrical/Computer Engineering (EE/CS)</td>
<td>359</td>
<td>77</td>
<td>30</td>
</tr>
<tr>
<td>Portland State University</td>
<td>293</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oregon Graduate Center</td>
<td>0</td>
<td>19</td>
<td>19</td>
</tr>
</tbody>
</table>

*Source: Private communication from Lawrence Murr, Oregon Graduate Center.
Baccalaureate graduates of Oregon schools tend to seek employment here. For example, in 1982, 13 of the top 20 baccalaureate students (EE/CS) from OSU were employed by Oregon electronic firms. On the other hand, graduate students in Oregon public universities are increasingly of foreign citizenship (50 percent) and at the doctoral level, foreign nationals have recently obtained 85 percent of the PhD's awarded in science and technology disciplines. These students generally return home, and do not contribute to Oregon's professional work force.

State System schools respond to the changing education needs of society only slowly. The response time depends upon the number of qualified faculty already on campus, the amount of resources needed, the support provided by the community for the new program, and the number of other institutions having an interest in the program. The preparation and internal review by an institution of a proposal for a new program can take an entire year. One major concern to be addressed at the institutional level relates to the resources (money, space, library additions, etc.) needed for the program. Other state institutions review the program, ostensibly to help avoid duplication of programs. Finally, the program is reviewed by the Chancellor's office and acted upon by the State Board of Higher Education. Two years to complete the process is not uncommon. In an exception, the establishment of the computer science department at PSU, was processed in four months. This was probably because it had strong support from local industry which felt that the Portland area would benefit from a more visible program. Incentives among schools of the State System to work cooperatively to offer a better "product" to industry are nonexistent. Funding for each school is based on the number of full-time equivalent (FTE) students enrolled. If a cooperative effort requires that a UO professor spend time at PSU, it implies that he will be able to teach fewer UO students and this result leads to a reduction of UO funding.

These examples of problems encountered in establishing cooperative ventures should not cause us to overlook some of the severe problems at Portland's local school, PSU. PSU is the only one of the three major schools which is unionized at the professor level; the resulting adversarial relations between faculty and administrators detracts from the university's flexibility to respond quickly and effectively. The administrative structure at PSU has repeatedly hampered development of new programs and external agreements. With more than 45 faculty committees having acknowledged authority over school affairs, change is slow. This diffuse structure also reduces leadership opportunities for the truly excellent innovator or administrator. Department chairmen are elected by their respective faculty members for only three-year terms; less productive faculty are likely to vote for a protective chairman. Department-specific tenure rules are set by that chairman. We believe that a dilution of standards can be expected with such structure.

Duplication of programs has been a public concern among Oregon state system schools. Two distinct problems have been identified:

1. At the baccalaureate and graduate levels, we observe that each school seeks a full complement of programs in order to compete nationally for top level faculty. This flies in the face of state policy that ostensibly prohibits program duplication and is reportedly resolved by a university artificially defining a new degree program not claimed by other schools but requiring a wide range of common supporting courses and research support facilities. When total statewide funds for a program are reported, the number of dollars does not re-
fleet the diffusion of effort. Oregon has four universities serving our population of 2.6 million which grant doctoral degrees, while Washington has three similar universities serving 4.1 million and California has twelve similar universities serving more than 20 million citizens. University faculty and administrators have reported to us that the duplication illustrated by maintaining two separate marine science graduate schools exists less visibly in other disciplines. The complete matrix of doctoral programs at Oregon public universities and the Oregon Graduate Center is provided in Appendix C.

2. In the Portland area, the duplication between community colleges and four-year schools creates a special impact on PSU. The large base of lower division university students which supports graduate teaching assistants and provides training ground for new staff is reduced at PSU because many of these lower division students attend a community college here.

The new Chancellor's "Strategic Plan for the Oregon State System of Higher Education" (15) has recently attempted to clarify State System priorities, thereby reducing unproductive program competition and enhancing high technology economic development. The plan recommends a wide range of changes to improve access to State System programs, to improve the quality of programs, to strengthen programs that will contribute to the economic development of the state, and to improve the efficiency of State System institutions. The recommendations dealing with Oregon's economy (Draft 2, February 24, 1983) are included as Appendix D.

C. University-Based Research and Development in Oregon

If Oregon's post-secondary schools are to contribute to economic growth in the region, your Committee believes, based on national examples, that much of the contribution will be associated with research. Oregon universities are not associated with large national laboratories nor do they receive major defense industry contracts which have provided a research base for new industries elsewhere. For example, among the 50 states, Oregon is at the median with $5.6 million in university military contracts per year; we are far behind our neighbors, Washington with $51.3 million and California with $98.3 million. The sum of high technology research contracts and grants associated with major Oregon universities is not well known because of a number of definitional questions and because there is no requirement for uniform reporting. Our individual inquiries indicate that more than $80 million of research work is done annually (Table 7).
<table>
<thead>
<tr>
<th>State System</th>
<th>Total Contracts</th>
<th>Science/Technology Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon State University</td>
<td>62.5</td>
<td>51.0</td>
</tr>
<tr>
<td>University of Oregon</td>
<td>20.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Oregon Health Sciences University</td>
<td>12.3</td>
<td>12.0</td>
</tr>
<tr>
<td>Portland State University</td>
<td>2.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Oregon Regional Primate Research Center</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Oregon Graduate Center</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Reed College</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Linfield</td>
<td>.08</td>
<td>.05</td>
</tr>
<tr>
<td>Lewis and Clark</td>
<td>.05</td>
<td>.03</td>
</tr>
<tr>
<td>University of Portland</td>
<td>.03</td>
<td>.02</td>
</tr>
</tbody>
</table>

The large research budget at OSU includes agriculture and forestry research, which is funded in part by dedicated Oregon taxes and administered jointly by industry and OSU. All other funds (all schools) come from a variety of federal agencies (50 to 90 percent) and private industry. Corresponding information on research in Oregon private industry is even more difficult to obtain because the facilities are distributed across state lines and proprietary interests are involved. It is believed that the amount spent in Oregon by private industry on research and development approximates twice the total numbers above. In addition, Oregon industries contribute millions through consortia and industry associations to research in other states (e.g., Electric Power Research Institute in Palo Alto, California).

Current research efforts in Oregon appear to lack effective linkages for the transfer and commercialization of new technology. "Incubation centers" of various sorts have been suggested to your Committee, and the word "collaboration" has been frequently used to suggest the need to establish a variety of opportunities for informal communication between university and industry. These suggestions ranged from "more exchange via coffee breaks" to "ride sharing" to "an organized periodical on research and development." Within each discipline, considerable familiarity and sharing of knowledge seem the rule, but almost no organized communication seems to exist across discipline lines. Individual efforts to improve communication have been made in the last year. For example, the Oregon Health Sciences University (OHSU) conducted its first public "Research Symposium" last fall to display its work to the Portland community.

The national literature suggests that the following tensions exist between industry and academia:
- Publication rights by university staff,
- Patent agreements,
- Accountability for university research work, and
- Attitudes regarding role of in-house industrial staff or academic freedom at universities.
The present policies of the State Board of Higher Education regarding patents, inventions and copyrights are contained in Oregon Administrative Rules (OAR) and in Internal Management Directives (IMD) of the State Board. The objectives of these policies are to provide a means of bringing inventions, technological improvements and materials into the public domain; to encourage the development of new knowledge; and to provide for equitably sharing net royalty income with employees:

"As a condition of employment, all Board and institution employees shall agree to assign to the Board rights to any invention or improvement in technology conceived or developed using institutional facilities, personnel, information or other resources." (OAR 580-43-011)

"Employees shall be eligible to share in net royalty income from each invention or separate improvement thereof, an amount not to exceed 40% of the first $50,000, 35% of the next $50,000 and 30% of all additional net royalty income received by the Board for inventions and technological improvements." (OAR 580-43-011)

"In accepting grant and research funds from governmental, nonprofit and commercial agencies, the institution and researcher shall agree to the conditions in the agreement with the sponsoring agency pertaining to licensing, patent policies, and ownership of all copyrightable material conceived and developed in the course of work required by the agreement. Such agreements shall normally include provisions enabling the institution to publish the findings of research and rights to take title to patentable inventions, discoveries, and educational and professional materials arising from the work performed. In the absence of such agreement or terms, the products shall be the property of the institution and Board." (OSBHE IMD 6.220)

Nationally there have been numerous efforts to reduce these tensions surrounding publication, patents, and multi-company sponsorship of research. Such efforts have at their root tough international competition where cartels and other cooperative arrangements are allowed. The U.S. government, recognizing peril to U.S. balance of payments and defense vulnerabilities, has endorsed new industry cooperative research programs. Several years ago, the Department of Defense launched the VHSIC (very high speed integrated circuit) effort, in which a network of university and industry contractors perform research and routinely exchange results. More recently, the federal government went further in endorsing formation of the Semiconductor Research Cooperative (SRC) in North Carolina and the Microelectronics and Computer Technology Corporation (MCC) in Minnesota. Such national changes suggest the need for upgrading Oregon State System policies.

D. Cooperation Between High Technology Industry and Education in Oregon

Oregon's state and local economic development efforts in the past have been marked both by "turf battles" between political entities and by the lack of a coordinated strategy and marketing plan. In recent years, however, Oregon has worked hard to eliminate its negative business climate image and to advertise existing resources such as livability, productive labor force, moderate costs of living and housing, lower energy costs, and adequate transportation infrastructure. With a few exceptions, Oregon's post-secondary education systems have not contributed significantly to the attraction or creation of new industry in the state.
The City of Portland's effort to attract Wacker Siltronic Corporation is one of the exceptions. Besides providing the company with plant site infrastructure, the City and Portland Community College (PCC) worked together to develop a work force training program.

The general failure of public higher education to meet industry's needs is one of this state's recognized weaknesses (16) and is particularly evident in Portland. Oregon has a history of successful single purpose coordinating bodies between higher education and business but no central coordinating body serving new technology business and education. For the most part, however, these cooperative efforts have been on an ad hoc basis without long range coordination or planning. Table 8 and the following brief review of past and present linkages between academia and industry in Oregon is not intended to be exhaustive, but merely illustrative. Most of the linkages deal with the electronics industry.

1. Oregon State University. Following World War II, the Division of Continuing Education (DCE), using OSU and UO staff, provided higher education to World War II veterans in their Portland workplace. In the late 1960s, OSU provided a master's degree program in engineering in Portland through the DCE. From a peak enrollment of 700 part time students (1965), DCE programs were reduced to zero by 1970, after the legislature required such off-campus programs to be fully self-supporting. Somewhat later, OSU was "contracted" to provide graduate education programs at Tektronix facilities in Beaverton. OSU is presently operating under a five-year contract to provide post-graduate courses in electrical engineering and computer science for Tektronix employees. OSU recovers costs and overhead from Tektronix. Some courses are taught by affiliate faculty who are industry personnel. In support of OSU's commitment to respond to Tektronix' training and technical assistance requirements, Tektronix has funded two chairs at OSU in electrical engineering and in computer science. The incumbents incidentally, are now chairmen of their respective departments at OSU.

2. University of Oregon. In 1973, an Innovation Center was established at the UO in Eugene to assist independent inventors and innovators. Funded through the National Science Foundation, the Center could not develop external funding at the local/state level. The Center closed its doors in 1980, and the director has since initiated similar work on a private consulting basis. Some staff have initiated a similar project in Wisconsin with different federal funding.

3. Portland State University. Cooperation of Portland State University (PSU) with high-technology industry has been limited historically because of its restriction on offering technical programs pursuant to policy of the State Board of Higher Education. In 1965, PSU obtained authorization for several master's degree programs, and in 1969, after a strenuous campaign by Portland area constituents, it obtained limited doctoral program authority. With continued industrial growth in the area, PSU attracted private foundation support for the purchase of computer equipment in 1982. Additional financial support for computer sciences was recently obtained from the Oregon Consortium for High Technology Education (described below). In January 1983, the City of Portland offered the interim use of the City's former Water Bureau Building to PSU to house parts of its Electrical Engineering and Computer Science Departments.
### Table 6

**OREGON BUSINESS/EDUCATION COORDINATION EFFORTS FOR HIGH TECHNOLOGY**

<table>
<thead>
<tr>
<th>Name</th>
<th>Time</th>
<th>Purpose</th>
<th>Governance</th>
<th>Funding</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Extension Service</td>
<td>1880s to present</td>
<td>Transfer new farming knowledge to practicing farmers; more recently extended to forestry and fishery practices</td>
<td>OSU, state director advised by a council of farmers</td>
<td>$13 million/year</td>
<td>Improved productivity, better markets, improved conservation practices</td>
</tr>
<tr>
<td>Agricultural Experiment Station</td>
<td>1880s to present</td>
<td>Develop new knowledge to improve farm practices and products</td>
<td>OSU, with aid of various commodity boards</td>
<td>$15 million/year</td>
<td>New crops, disease-resistant varieties, effects of pesticides and herbicides</td>
</tr>
<tr>
<td>OSU Forest Research Laboratory</td>
<td>1941 to present</td>
<td>Oregon forest product and forest management, research</td>
<td>Fifteen-member industry/university advisory committee</td>
<td>$4 million/year</td>
<td>Building code changes, product design standards (eg, laminated beams), forest practice rule changes, process change studies (eg, plywood trimming)</td>
</tr>
<tr>
<td>Division of Continuing Education</td>
<td>1946 to 1970</td>
<td>Guide working veterans toward college degrees - off-campus education meeting business needs</td>
<td>State Board of Higher Education</td>
<td>General fund budget, tuition, veterans benefits</td>
<td>Peak enrollment approximately 800 in 1965, state funding for off-campus instruction withdrawn 1969</td>
</tr>
<tr>
<td>Science, Engineering, and New Technologies Commission</td>
<td>1955 to 1965</td>
<td>Create Oregon environment for space-age industries (focus on materials)</td>
<td>Governor-appointed commission, staffed by departments of economic development</td>
<td>Minimal</td>
<td>1965 proposal for publicly funded graduate school in Portland - not funded by legislature; need met privately by Oregon Graduate Center</td>
</tr>
<tr>
<td>Portland Advisory Committee for Engineering Education (PACEE)</td>
<td>1966 to present</td>
<td>Assist industry and education in collectively meeting mutual needs</td>
<td>Volunteer - industry and education representatives</td>
<td></td>
<td>Assisted PSU and University of Portland in developing engineering programs; raised $60,000 in 1977 for PSU mechanical engineering labs; launching forgivable loan program for future engineering teachers</td>
</tr>
<tr>
<td>CASEERI (Council for Advanced Science and Engineering Education/Research for Industry)</td>
<td>1982 to present</td>
<td>Identify research needs; strengthen education programs; advocate necessary funding</td>
<td>Industry/educators advisory council, staffed by assistant to chancellor</td>
<td>Presumably at or greater than $1.5 million/year</td>
<td>1982 ad hoc consortium created several new joint ventures among schools and stimulated matching funds from electronics/computer industry</td>
</tr>
<tr>
<td>Oregon Consortium for High Technology Education (OCHTE)</td>
<td>Proposed</td>
<td>Allocate legislative funds to education centers to serve Oregon high-technology industry, a continuation of 1982 legislative directive</td>
<td>Education coordinating commission appointments from industry, education, legislature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEBER (Science and Engineering Board for Education and Research)</td>
<td>Proposed</td>
<td>Advocate education/research programs and funding to promote economic development in technology fields</td>
<td>Governor-appointed commission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Oregon Health Sciences University. The Oregon Health Sciences University has long had a large research program, but with only limited application in Oregon industry. OHSU recently has been successful in obtaining a federal grant of approximately $21 million for construction of a facility for an Institute for Advanced Bio-Medical Research. The university has been the recipient of a private anonymous gift of $5 million to assist in the creation of the Institute. OHSU President Leonard Laster believes that such an institute can be a catalyst for the attraction and creation of bio-medical industries. In the past, important technical developments at OHSU have been commercialized in other states but that should no longer be necessary.

5. Oregon Graduate Center. The Oregon Graduate Center, a private, independent research and graduate educational institution in Beaverton, was founded in 1963. OGC was formed, using private sector resources, in response to the failure of the State System to provide post-graduate training in the Portland area (i.e., at PSU) relevant to the needs of Oregon's emerging science-based industries. OGC offers programs in applied physics, electrical engineering, chemistry, biochemical sciences, computer sciences engineering, environmental science, and materials science and engineering. OGC operates on an annual budget of less than $5 million. Because it has small faculty and can serve relatively few students, OGC cannot meet all the education and research needs of high technology industries in the Portland metropolitan area. OGC uses adjunct faculty drawn from local industry, and former faculty have moved to industry in important roles. OGC is developing a science park adjacent to its campus, hoping to attract research divisions of high technology companies.

Current tax laws have stimulated research partnerships. Through research partnerships, enterprising universities have developed new sources of nonfederal funds to underwrite research projects. Stanford and, locally, OGC have developed the practice of searching out industry needs, and then locating tax-burdened investors to finance the necessary research and development. The interested company advances seed money (a small fraction of the funds actually required to conduct the research) and sells development/royalty rights to the university, which arranges for the remainder of research funds from investors. The investors gain immediate tax benefits and look forward to a royalty stream paid by the user company through the university. The universities typically provide attractive rewards to researchers who organize and execute such work. The investors are drawn to the arrangement by the tax benefits and by the knowledge that the commercialization of research work will be done by the interested company.

6. Community Colleges. Oregon's community colleges have developed progressively closer ties to industry as sources of post-secondary education. PCC has worked with Intel, Tektronix, and FMC, among others, providing vocational skills for employees and potential employees. PCC's successful effort in training the initial work force for Wacker Siltronic Corporation is well known. Chemeketa Community College has recently trained a work force for Siltec, a silicon wafer manufacturer interested in a Salem location.

7. Industry Initiatives. In November 1982, Tektronix and the Tektronix Foundation pledged $3.5 million to Oregon colleges and universities to upgrade instructional equipment in electrical engineering and computer science programs. The gift also is intended to develop research in
new semiconductor materials. The gift is to be phased over five years and will involve $2.5 million in grants from Tektronix Foundation and $1 million in equipment from Tektronix. This commitment of money and equipment to Oregon universities and colleges reflect Tektronix' continuing support and encouragement of research programs relevant to its business.

8. Other Efforts to Coordinate High Technology Industry and Education in Oregon. In addition to the bilateral types of relations between industry and academia described above, there have been continuing efforts to organize the relationship between high technology companies and higher education. In the late 1950s, Governor Hatfield formed the Science, Engineering, and New Technologies Commission (SENT) to make Oregon's system of higher education more responsive to space-age industries. However, the state legislature failed to approve SENT's recommendation for creation of a graduate center in the Portland area, and industry interest dissipated. The 1963 City Club report, making similar recommendations, did not generate major changes. Ultimately, PSU did obtain some graduate degree programs by repeated appeals to the Board of Higher Education, but not in areas of primary interest to local industry.

The Portland Advisory Committee for Engineering Education (PACEE) was established in 1966 as a nonprofit, volunteer group of industry and educational representatives from Oregon and southwestern Washington to meet mutual needs. It assisted PSU and the University of Portland (UP) in developing engineering programs and worked with community colleges, OSU, and Klamath Falls' Oregon Institute of Technology (OIT) in similar program design work. In 1977, PACEE secured over $60,000 in contributions from industrial organizations to assist in accreditation of PSU's mechanical engineering program. PACEE continues to assess continuing education in the Portland area. Its latest project, to raise $240,000 to launch a forgivable loan program for future engineering faculty, has been nationally recognized as unusually innovative. PACEE's project was undertaken because of the recognized shortage of qualified engineering faculty; its members hope to begin supporting faculty positions on a limited basis.

Based on interested individuals, the Task Force for Enhanced Education Delivery in Oregon was formed over the past two years among Oregon schools and industry to review the technology available for novel delivery systems to industry. Lane Community College has shown particular initiative in proceeding with an experimental interactive video program. Students using this program in a distant classroom can interact directly with the professor, who remains in a campus instructional center. Teleconferencing systems of this kind have been used at Stanford University for several years to provide continuing education to off-campus electronics industry personnel.

- Oregon Consortium for High Technology Education. In 1982, the Oregon Council of the American Electronics Association directed new attention to the need for quality post-graduate education. The Council pointed out that while most of the growth of the electronics industry in Oregon occurred in the Portland metropolitan area, there was a lack of corresponding growth of science and technology instruction and research in the area. Because of limited responses by the Oregon State Board of Higher Education, the Oregon Legislature responded by creating the Oregon Consortium for High Technology Education. This Consortium was
charged with allocating $1 million, through the Educational Coordinating Commission (ECC), to various private and public education institutions to further science and engineering education. Funds came equally from the state budget and matching grants from industry. The Consortium consists of four representatives from electronics companies, three members from the public higher education sector, and one member from private higher education. Proposals were received from the Oregon State System of Higher Education, the University of Portland (UP), OGC, and the community colleges. As a result of the proposals, the Consortium distributed $400,000 to PSU for faculty, $150,000 to UP for faculty, $100,000 to OGC for faculty, $275,000 to OSU to release faculty for support of PSU program improvement, and $75,000 for community college special projects to be approved by the Consortium. The Consortium, in making its report to the ECC, recognized the need for a long-term research and training program for high technology industry in Portland. It concluded that an effective program must:

- Have strong leadership with authority,
- Involve the Oregon State System of Higher Education,
- Be responsive to industry's needs, and
- Be managed for the long term with a structure which funds, directs, and measures program performance.

The Consortium recommended the establishment of an Oregon Commission for High Technology Education (OCHTE), appointed by the governor, with equal representation from industry and education. OCHTE, with the assistance of an advisory committee, could assist with the coordination of educational programs, contribute to the development of science and technology policy, and make funding recommendations to the ECC. The Consortium's report indicated that the ECC would request a base budget of $1 million from the general fund for the 1983-85 biennium to continue the matching grant program. All agreed that this amount was tiny compared to existing budgets and industry's need. It was also generally agreed that in 1982-83 this tiny effort has stimulated significant program coordination and joint ventures among schools.

In the current legislature, the governor's proposed budget for 1983-85 includes $4 million for improvement in high technology education programs. One third will be distributed by Consortium recommendation, and two thirds by the State Board of Higher Education to state schools through a system of competitive "program improvement" allocations.

- The CASEERI Proposal. During the Consortium's deliberations in 1982, a Council for Advanced Science and Engineering Education/Research for Industry (CASEERI) was proposed to advise the Chancellor of Higher Education and the State Board of Higher Education on coordination of science and engineering education programs with industry (30). From the beginning, it was recognized that the initial thrust of CASEERI would be to meet the needs of high-technology industry in the Portland area, although its stated charge is both geographically and industrially broader. CASEERI was designed to have representatives from the three public universities, the OGC, UP, and Portland-area industries. The director for CASEERI has been hired, but the organization is not yet functional. There is a perception among both industry and independent colleges and universities that CASEERI was formed in an attempt to control the allocation of the Consortium grant funds and that its future is limited.
- **The SEBER Approach.** Preceding the proposal for CASEERI in 1982, the Governor's Economic Recovery Council recommended appointment of a Science and Engineering Board for Education and Research (SEBER), to report directly to the Governor (4). It was proposed that SEBER operate in much the same way as the North Carolina Board of Science and Technology (discussed below) and that SEBER be given authority to administer grants and disburse special funds through the Office of the Governor. SEBER would be composed of representatives from industry, public and private post-secondary education, the legislature, and the private sector. SEBER would also be charged with securing relevant information, promoting programs, and developing cooperative ventures among industry, government, and educational institutions. The Governor has not acted on the recommendation of the Economic Recovery Council. The Economic Recovery Council's recommendations are included in Appendix E.

E. **National Models of High Technology Industry/Education Coordination**

Oregon's effort to promote economic development by making better use of post-secondary scientific and technical education is obviously not unique. A summary list of these efforts with some annotation is provided in Appendix F. Examination of that list will show a diversity of efforts highly dependent on local situations.

The key factors which led to development of some well-known centers of high technology seem not directly applicable to Oregon today. Three examples illustrate this situation:

- **Silicon Valley - California**

The existence of Stanford University and the University of California appears crucial to recent spectacular growth. Although a nascent electronics industry was in place as early as 1917, the $35 billion spent by the federal government in California during World War II led to the area's emergence (including the aviation industry) as a nationally recognized technology community. Even in the 1960s, 40 percent of U.S. space and defense work was performed in California.

- **Route 128 - Massachusetts**

As in California, the pre-existence of excellent universities attracted defense spending (vacuum tubes, radar) to Boston in World War II. The continued growth of the last decade has been more diversified, including consumer and industrial goods, but is not the creature of any overall planning effort. Beginning in the 1950s, individual promotional efforts by Boston financial houses and suburban land developers pioneered the "industrial park" idea along Route 128.

- **Research Triangle Park - North Carolina**

In contrast to the above examples, this development was a conscious effort of state leaders, beginning in the 1940s with research (not manufacturing) as a goal for economic development. The Research Triangle Institute (Duke University, University of North Carolina, and North Carolina State University) and associated committees opened Research Triangle Park in 1959 but for seven years had only one substantial tenant, Monsanto. Then IBM and the Environmental Protection Agency moved major research facilities to the Research Triangle in 1965. Their presence led to the in-migration of seven other major research labora-
tories, each employing over 200 persons. Current planning, done state-
wide, is headed by the 15-member North Carolina Board of Science and
Technology — a governor-appointed group of industry and education lead-
ers.

1. **Key Factors for an Oregon Model.** The examples where planning was
not the dominant development force were long in coming — both Califor-
nia and Massachusetts have long traditions of excellent universities.
In North Carolina, the development time was shortened to some two de-
cades. This is why we find that an Oregon planning effort is worth-
while.

In searching for models of coordination in other regions that might be
applicable to the Portland metropolitan area, we first looked for com-
munities and states with characteristics relevant to effective interac-
tion between high technology industry and higher education. We noted
the following distinguishing features of Portland and Oregon.

- Considerable geographic distribution of state universities with
  considerable distance from the population centers to major na-
tional centers of technical excellence.

- Domination of a few firms in high technology employment.

- A tradition of an activist legislature.

- Relatively high priority for education among its populace.

- Lack of a major defense-related installation or national research
  laboratory with attendant high technology base of personnel.

- Generally attractive living conditions.

- Moderate-to-high wage rates with a significant role played by or-
  ganized labor.


In searching for models of cooperation, we further looked for situa-
tions with a variety of university-industry relationships, because we
believe there is strength in that kind of diversity. A reasonable
range of such relationships was judged by the Committee to include:

- Corporate contributions to university,
- Procurement of services,
- Cooperative research, and
- Research partnerships.

Past coordination models are obviously not completely appropriate for
the future. From our review of industry trends, it is plausible to
postulate that some increase in industry-university cooperative re-
search is almost inevitable. This is so for three reasons: (1) the
outlook for increased federal research funding is not favorable; (2)
industrially-funded research and development is on an established up-
ward trend, and (3) university researchers will inevitably be drawn to
the available sources of funds.
2. The Minnesota Business Partnership — A Model for Portland and Oregon. With the above considerations in mind, the Committee examined other state and local efforts with goals similar to those of Portland and Oregon. The Minnesota Business Partnership and associated programs appeared to be the best external model for Portland and Oregon to draw from in stimulating new high technology business (6). The Minnesota Business Partnership is a private organization with chartered responsibilities broader than high technology industry/education cooperation. It has many of the characteristics of Governor Atiyeh's Economic Recovery Council but operates on a sustained basis. Its broader charter appears necessary for carrying an innovation from university inception to sustained commercial operation and real economic growth. Programs of the Minnesota Business Partnership are focused on new small business development, creating a small business "chain of success," including the following elements:

- **Technology:** Micro-Electronics and Information Sciences Center (MEIS) is a cooperative venture among several Minnesota companies and the University of Minnesota. Facilities, personnel, and research activities are shared by the university and participating businesses. Although most of the industry funding is provided by big business, the results of the research are made available to all companies regardless of size with special emphasis on small enterprises. Within the last six months, the Minnesota High Technology Council (previously existing only as a university advisory committee) has been formed with encouragement of the Minnesota Business Partnership to give high technology firms a separate voice in educational budget reviews, to promote professor internships, and to plan and implement new education delivery systems.

- **Financing:** Minnesota Seed Capital Fund (MSCF) was incorporated in July 1980 to serve small business needs for start-up money. A for-profit venture capitalized at $10 million, the MSCF fills a critical financing gap by investing in companies which have the potential to grow and create a substantial number of new jobs within the community. Typical MSCF investments range from $50,000 to $250,000. Investors include Honeywell, 3M, Northern States Power, Control Data Corporation, The Minneapolis Star and Tribune Company, and the Minnesota Teacher Retirement Fund.

- **Management Assistance:** Minnesota Cooperation Office (MCO) was founded in 1979 to provide small business with management assistance. A community-based nonprofit organization, it is being financed during its early years by contributions and grants. It is intended to become self-supporting through a combination of client fees and funds generated by equity investments in client companies. MCO consists of a board of directors drawn from major sectors of society, a small permanent staff, and a volunteer Client Advisory Board of engineers, scientists, financial specialists, and executives. MCO takes an entrepreneur with an idea for a new product or service through development of a five-year business plan.

- **Education and Training:** Existing institutions perform their traditional function of offering high-quality, affordable, and accessible education and training services. Minnesota Wellspring focuses public attention on the linkages needed to create jobs and encourage the growth of local companies (e.g., conferences and public information). A recent initiative seeks a business tax credit or university equity
position for donated "ideas" which are transferred to new small busi-
nesses through a system administered by the Business Partnership and
Wellspring.

- **Marketing:** Mid-American International Trading Company (MITCO) fur-
nishes market analysis, project management, product and service qual-
ification, financial services, brokering, oversees training, and pro-
motional and consulting assistance. It has the full support of state
and federal agencies, local chambers of commerce, and the local world
trade association.

- **Efficient access to facilities and services:** Business and Technology
Centers (BTC) gather physical facilities, e.g., office space, fabrica-
cation, warehouse space, and business services at one place and offer
a package at a reasonable cost to new small businesses.

The scope of the Minnesota Business Partnership is broader than that of
the North Carolina Board of Science and Technology (NCBST), which has
been widely acclaimed as a model for state use of technological re-
sources for economic development (41). However, the NCBST has a longer
record of accomplishment worth noting. The NCBST was originally estab-
lished in 1963 by legislative action but downgraded by state adminis-
trations through much of the 1970s. New legislation in 1979 reorga-
nized the Board and enhanced its central role. The Governor now
serves as chairman. The Board points to its following accomplishments:

- Published a full report of research and development in the state bud-
get, to be updated biennially.

- Published an inventory of scientific equipment and its availability
in the state with a view to proper allocation of state funds among
universities and private research institutes.

- Published a roster of retired scientists, engineers, and other pro-
fessionals wishing to remain active in their technical fields.

- Published an analysis of needs and opportunities for faculty of non-
research schools to maintain academic currency through industry re-
search involvement.

- Fostered industry and state government support of the several cooper-
ative research and training institutes located in North Carolina.

- Stimulated and integrated efforts of government and industry to man-
age environmental resources consistent with balanced growth objec-
tives.

- Initiated research in state human service delivery systems using sci-
entific and technological expertise.

The NCBST consists of 15 members drawn from public and private univer-
sities, state and local government, and industry. Because of generally
reduced federal support, a broader group, the Governor's Task Force on
Science and Technology, was formed in 1982 to include representation
from labor, primary/secondary education, and social service agencies in
planning scientific and technological advances consistent with the
goals of all state citizens. This broader effort more closely resem-
bles the network effort of the Minnesota Business Partnership.
IV. DISCUSSION

A. Importance of New High Technology Industry to Oregon

Regardless of whether new manufacturing plants or start-up companies are involved, the importance of each job created may be considerable. However, the impact of technological progress is not always in the direction of creating more jobs. For example, increases in automation, have always reduced manual labor demand. But failure to take advantage of technological developments to save an existing job may be equivalent to relinquishing one's market to competitors, national or foreign, and losing not a few but all of the work opportunities involved.

The application of "state of the art" high technology developments to old Oregon industries such as lumber, fisheries, agriculture, or even services and trade, should pay high dividends if pursued aggressively. Such improvements can never account for many jobs in these sectors, but they can increase productivity and allow the industry as a whole to prosper. In forest industries, for instance, laser instruments have made the sawing operation more efficient, and high technology is playing a role in the development of new strains of trees and methods of drying lumber. Unless Oregon industries and universities actively explore all avenues to improve production and reduce overall costs, others will do it at the expense of Oregon's workers.

1. Higher Education Key in Attracting High Technology Industry. With over 50,000 workers in high technology industry today, the addition of several hundred new jobs per year for new plant startups should not disrupt present Oregon employment patterns. Present employers already accommodate a 14 percent annual turnover rate. Looking at national data regarding the location of new high technology (manufacturing) plants, we conclude that Oregon can attract additional high technology industry for the near-term.

The bulk of new employees from relocated or attracted high technology manufacturing industries earn wages of $4-$5 per hour for production work. Production labor in several of Oregon's traditional but increasingly non-competitive industries garner more than twice this hourly rate. Oregon's choice in this matter is to lose the traditional jobs or offset loss of some higher paying craft jobs in traditional fields with these lower-paying high technology production jobs. The benefit of these new industries is the net increase in total number of Oregon jobs.

Interestingly, several older cities, such as Lowell, Massachusetts, have revitalized their economies by changing from a former textile manufacturing center to a regional support center for high technology electronics companies. And in Portland, local government encouragement of high technology companies has also helped to achieve social objectives. Providing Wacker Siltronic Corporation with plant site infrastructure allowed the City of Portland to obtain an agreement with Wacker to employ hard-core unemployed citizens of the city.

Table 1 of this report (see Background) identifies factors that influence the regional location choices of high technology companies. It might appear that our educational infrastructure is of relatively little significance. Academic institutions rate fourth. Above this level are labor skills/availability, labor costs, and tax climate within the
region. However, factor number one, —labor skills/availability— directly relates to the existence of educational facilities to train labor, from factory line workers through skilled labor to professionals and management. Additionally, of the first five factors, only academic institutions require directed funding commitments from the taxpayer and only academic institutions require a long lead time to develop to a level at which they become an attraction for the location of high technology companies. With the small numerical difference between factors ranked first and fourth, we feel that the premise regarding the importance of education for high technology business growth is supportable for high technology manufacturing industries.

In Table 2, relating to location within a region, the factor first ranked, availability of workers, again relates directly to post-secondary education. Seventy-one percent of the respondents indicated that proximity to schools was a significant or very significant factor. Of the first seven factors, good transportation (number 5) and good schools (number 7, presumably including post-secondary) are the two requiring the most direct monetary and longest time commitments to develop.

Finally, it is important to note that after availability of college graduates, continuing education for employees is the most important contribution of universities to high technology companies. Simply, Oregon can increase its attractiveness if we can improve available education systems without gross increases in the state tax burden.

From these data, we conclude that the proximity of post-secondary education institutions is not only of relatively high importance to the attraction of high technology manufacturing companies, but also that the costs and long lead time required to build quality post-secondary educational institutions make them a key target in actions to improve Oregon's future.

2. The University Role in New Business Formations. We believe that even though high technology manufacturing industry will be valuable to Oregon, it is the creation of a research and development industry that will have the greatest positive impact on the long-term economic health of our state and community. To encourage this kind of industry, we must create an atmosphere in which research and innovation at our universities and in our industries can move quickly to commercialization with a minimum of interference.

New startups and the commercialization of new products or services do not directly use higher education but they rely on higher education in more subtle ways. The principals in such activities are often at the forefront of technical knowledge. Startups often rely on collaboration with other persons in related fields. Since new startups usually occur where the principals are already living, nearby universities can and do provide this collaboration opportunity. Even though a person's professional training is often obtained far from one's place of employment, business collaboration is more likely to be local in nature. Collaboration can also come from association with national research laboratories or defense research and development work, but Oregon is not strong in either of these dimensions. For the long-term, then, Oregon has a special need to rely on its higher education system to provide the arena for collaboration and innovation.
B. Evaluation of Post-Secondary Education in Oregon

1. Oregon's Competitive Position Weak. The 1980s have created a sense of urgency about our national stature in science and technology, reminiscent of the period some 25 years ago when the Soviets jolted this nation out of its complacency with Sputnik I. Competition is the key word for the 1980s. We compete externally with Japan, West Germany, and France for market share of a variety of high technology goods; and we compete internally, state by state and city by city, for the location of high technology industry.

Congress is responding to the cry for a competitive edge with almost 50 separate legislative proposals to put this nation's technological capacity and accomplishments ahead of the competition. Even President Reagan, who began his administration in opposition to federal support for science education, has begun to see the connection between science and engineering education and our ability to compete.

Oregon's competitive position is not strong. In fields other than electrical engineering and computer science decreasing enrollments, shrinking financial support and the loss of experienced administrators and staff are associated with an active deterioration of our educational capability.

Portland's competitive position is weakened by the lack of highly qualified faculty in the several technologies emphasized by local industries. In turn, the ability of our education institutions to attract highly qualified faculty is weakened by the lack of funded graduate programs.

2. Turf Battles, Duplication Hamper Productivity. The Oregon State System of Higher Education has been widely criticized (28, 34, 48). Primarily, the attack upon the present system of management centers around the competition among higher education institutions' protection of "turf," lack of flexibility, and lack of motivation to change. In addition, the concept of tenure and the method of funding higher education institutions based on full time equivalent (FTE) students have been criticized. Your Committee believes that the two specific areas most in need of improvement are:

- Cooperative work among campuses of the State System.

- Clarification of the roles of different post-secondary schools.

Streamlining the university administration could yield significant increases in productivity. Improved transfer of ideas and research among campuses, a more rational allocation of resources, and less counterproductive competition among institutions could result. Your Committee believes that much of the debate regarding location of State System facilities is not based on the issues of real concern to industry and the people of Oregon, but rather revolves around the protection of settled professorial careers at present campuses. With three independent university administrations, we believe there are important barriers to assigning faculty to provide regular services elsewhere.

FTE-based funding in the State System limits the ability of engineering and science programs to respond to demand. FTE-based funding makes these programs noncompetitive because they often require more expensive
equipment per student than other courses of instruction and the distribution of available funds to several campuses results in none of the schools being able to purchase more specialized equipment.

While tenure provides protection of academic freedom, it results in waste. Scarce resources are allocated to faculty or programs for which there is no longer a demand.

While we could not prove that other models of university administration have been responsible for high technology industrial growth, we conclude that efficiencies gained by State System streamlining could provide additional and sorely needed funding in Oregon.

Over the past several decades, other efforts have intermittently been made to streamline Oregon's higher education system. The current legislature has bills before it which are intended to "coordinate" Oregon's post-secondary education systems. Senate Bill 20, originally the continuing authorization bill for the Educational Coordinating Committee (ECC), has been substantially amended by Senator L. B. Day to establish a "Board of Regents" to develop state education policy and set priorities for expenditures among the segments of public education (K-12, community colleges, and the State System of Higher Education) (31). The K-12 and State System segments would remain governed much as they are today; a new "Board of Community Colleges and Employment Training" would be established to coordinate the approximate 30 percent of funding to community colleges which the state provides. The supervising Board of Regents would be composed of six gubernatorial appointees and, as ex officio members, the Chairman of the State Board of Education, the Chairman of the Board of Community Colleges and Employment Training, and the President of the State Board of Higher Education. The chairmanship would rotate among these three leaders, and the staff of the Board of Regents would be that of the present ECC. Such Board of Regents would analyze, consolidate, and coordinate state education budgets for the legislature. However, such coordination among education segments is not, in the opinion of your Committee, the most critical factor in improving higher education support of new high technology industry. Instead, the most critical factor is coordination within the State System of Higher Education.

In contrast to these State System problems, Oregon community colleges are competitive with those of other locales because of their simpler role, local focus, and more applied program content. Only to the extent that streamlining the State System may suggest a closer relationship between community college and State System university staff (e.g. use of graduate assistants in community college teaching) would your Committee suggest changes to this popular lower division program.

3. Commitment to Technology Transfer Essential. We have pointed out that nationally recognized researchers are a strong attraction for high technology research and development companies. The synergy between these researchers and their colleagues in industrial laboratories often results in accomplishments that could not have happened otherwise. We have also recognized the importance of access to university intellect and facilities for the resolution of technical problems. We have not discussed the potential impact of university research spinoffs that could be commercialized through an active technology transfer program.
Your Committee recognizes that not every research project will generate marketable or even usable technology. However, the modest research effort in Oregon's public universities still amounts to more than $70 million per year. Even this relatively limited amount of science has the potential to produce a significant amount of new usable technology. This technology represents a resource that could be used to:

- Provide lower cost research to industry;
- Create marketable products or services usable by industry;
- Solve industries' problems in design, manufacture, or marketing of new products;
- Encourage and support the development of new companies; and
- Help universities supplement faculty salaries and expand research facilities.

But before any of these events can occur, there must be a commitment on the part of the Oregon State Board of Higher Education (OSBHE) to a policy of active technology transfer. This commitment to technology transfer is already a policy of the federal government and our state legislature. The OSBHE, on the other hand, says the following to our universities, in an Internal Management Directive (IMD):

"The board encourages the president to assist the invention commercialization process to the extent that the invention contributes towards fulfillment of the institution's mission. Resource allocation for licensing, patenting, and technology transfer, however, is the responsibility of the president."

In other words, they give the presidents the option of supporting technology transfer. The result of providing this option at OSU, our leading research institution, is summarized in a recent scathing memorandum of resignation by Bill Lovell, OSU Patent Manager (38). Lovell mentions "30 inventions originating at OSU for which no attempt at commercialization has been made". He says, "that fact derives from the philosophy of 'Well, we can't really be out selling things - our business here is research, not technology transfer'. Furthermore, Lovell points out the results of having taken the option to "sit" on all inventions:

"In all fairness, one would think that if we are not going to pursue commercialization of an invention, we ought to give it back to the faculty member. However, the same IMD's, in 6.215(5), preclude that as follows: '. . . The president or designee will normally recommend the execution of a limited release only after the institution has exhausted efforts to license or patent the invention.' (Emphasis added.) Taken together, these policies then have two effects. The first is to lock up in bureaucratic limbo the intellectual products of our faculty members, products which I am sure our legislators and fellow citizens assume are being applied to the economic welfare of the people in this state. Secondly, it puts me in the position of having to explain to faculty members why I am not out looking for those royalties that they thought they were going to get."

Your Committee believes the above points have merit. Clearly, until the Oregon State Board of Higher Education establishes a technology transfer policy for all of our state universities or permits delegation of the responsibility to an external entity, we will not see the
creation of the necessary infrastructure nor the allocation of resources. We believe that the details of a preferred technology transfer mechanism could be learned from the experience of other state universities.

4. Changing University/Industry Relationships. While no persons interviewed locally expressed any significant concern about industry and universities becoming too close because of research relationships, the national literature has consistently raised issues relating to conflicts of interest over the past year (29, 32, 33, 40). Much of this literature relates to genetic engineering, a field in which some faculty from prominent institutions have become equity owners in development companies. Other faculty have signed exclusive research agreements with various industries.

a) Conflicts of Interest
One of the primary conflicts mentioned is the philosophical difference between business, which is looking for a short-term return on investment, and the university, which is presumably committed to the search for and distribution of knowledge and truth, regardless of commercial application. Other objections involve academic freedom and restrictive communications as a result of industry-university research ties. Stanford University President Donald Kennedy has noted that commercial rivalries are beginning to invade academic laboratories and are hampering communications. He suggests that some commercial difficulties have driven a wedge between different research groups.

University presidents seem to feel they can control the negative aspects of these problems. In Beyond the Ivory Tower, Harvard President Derek Bok points out that basic research at the university level has traditionally been funded primarily through federal sources. While this worked to the benefit of universities, it reduced communication between university and industry researchers. Bok believes that in an era of reduced federal funding, the increased communication between industry and university researchers would help the country in its international economic competition.

Because of the potential profit from application of research, currently reduced federal funding, competitive research costs, and industry equipment subsidies to universities, university administrators seem relatively receptive to the new role the institutions are being asked to play in high technology economic development. New Oregon administrative and coordination arrangements should be sensitive to problems associated with these new collaborative relationships between business and education.

b) Emerging Coalitions
In the last five years, the U.S. government, recognizing peril to U.S. balance of payments and defense vulnerabilities in a high technology leadership shift, has endorsed new industry cooperative research programs. The emergence of such research consortia and their potential importance to Oregon high technology industry and post-secondary education should be recognized in Oregon planning.

The urgency felt by startup companies is also felt by these national coalitions of firms embarking upon collaborative research programs. They have little patience for the gradual development of expertise at a given research institution. They are likely to base their judgment of
university research partners on the established expertise of faculty and research personnel already affiliated or easily recruitable by those universities.

The science and technology programs with the greatest potential for consortium participation in the Portland area are found at Oregon Graduate Center and at the Oregon Health Sciences University. OGC research expertise and facilities (materials science, computer sciences) could be of interest to existing coalitions. OHSU has a window of opportunity in the biomedical technologies because research consortia in this field are only now emerging.

5. **Oregon Needs Strategic Plan for Higher Education.** Your Committee believes that Oregon needs a well-thought out plan for higher education which includes a plan for the role of education in economic development. Recent drafts of such a plan are an important start but fall short of the need.

The closest Oregon has come to having a real plan is the Chancellor's four-year Strategic Plan for the Oregon State System of Higher Education. This plan has been widely criticized (48) as merely planning for the extension of present programs, as lacking vision, and as reacting to "perceived economic realities" rather than charting a course for the future of Oregon's higher education.

The Chancellor's plan was reviewed by members of your Committee and by planners interviewed by your Committee. On the basis of this review, your Committee believes that it falls short of Oregon's needs in three major areas:

1. The plan defines too broadly the niche that higher education fills in helping Oregon economic development. This may well stem from lack of clarity on Oregon's economic development priorities, a function of the state's executive and legislative leadership. If so, your Committee's concern is directed at such leadership.

2. The plan views strategic planning as forecasting the future rather than as a process of setting goals and determining strategies to reach them. The plan states, "... strategic planning, at its very best, is only as good as our ability to forecast the future ... strategic planning, in other words, is more a matter of perspective than a planning technique." (15)

   If planning is seen as a means of predicting the future, it has little utility. If, however, planning is viewed as the development of strategies to reach well-thought out goals, it becomes a tool for shaping the future.

3. The plan does not tackle the most urgent major problems. For example, it states that its authors "... decided to address only those problems that could be solved." One problem apparently viewed as "unsolvable" is the development of graduate programs in electrical engineering and other selected high technology areas at Portland State University. The plan states that "there is a strong need for ... (a graduate program in electrical engineering) ... in the Portland area." It further states that such a program needs "a sound undergraduate program, highly qualified faculty in selected and related areas, and sufficient resources."
It also states that current financial conditions are a major constraint. With no further reported analysis or development, the plan then concludes that no graduate program in electrical engineering can be developed in Portland because it "would be unwise to duplicate additional graduate and research programs that are now available and operating well at ... the other universities."

To improve programs in electronics that serve the high technology industries in the Portland metropolitan area, the plan outlines the establishment of "CASEERI." The plan states a purpose and some goals for CASEERI, but it does not state measurable objectives nor does it state strategies to reach the goals.

C. Allocation of Resources: Pinnacles of Excellence

As a result of Oregon's present budget limitations, it is unrealistic to expect that this state can develop the across-the-board excellence in science and engineering education which Stanford, MIT, University of California-Berkeley, and others have developed over a great number of years and with much greater financial resources. Nonetheless, additional resources focused in a planned and well targeted manner can produce several "pinnacles of excellence" that will be competitive in the world market. At issue is a very basic choice facing the state - allocate more funds to selected programs or simply accept that Oregon's high technology future will be limited to manufacturing industries. Your Committee is convinced that a combination of these two alternatives is best for Oregon and for Portland citizens.

In suggesting more funds for higher education, your Committee believes it is not necessary to develop the breadth of a Stanford University or MIT in order to provide for most educational needs of high technology companies. For example, in the Silicon Valley south of San Francisco, it is not Stanford that is the major supplier of engineers with bachelor's degrees, but rather San Jose State University.

Therefore it appears that the appropriate strategy for higher education in Oregon is to provide plateaus of adequate instructional programs across the broad range of disciplines, pinnacles of research excellence in a limited number of fields carefully selected to support emerging high technology firms, and delivery of services to areas in the state where private sector demand exists.

Beyond this, what local higher education institutions lack in original research capabilities and in a capacity to teach at the cutting edge of science or technology, they must make up by becoming a link between local users and national centers of research/education leadership. Portland State University and the OGC must develop associate relations with MIT, Stanford, University of California-Berkeley, and others to channel needed knowledge to Oregon users. All parties to such cooperation benefit. Local firms receive access to advanced knowledge that is economical in terms of time and money. Local universities develop relations with leading education/research institutions for knowledge and technology transfer. The service providing institutions gain access to new corporate clients.

1. Program Funding: Emphasize Prominence. The attraction of research funds and coordinated research activities between industry and educational institutions will depend upon applying more resources to those programs and utilizing researchers in both public and private in-
stitutions that have achieved, or are capable of achieving, national prominence. Oregon State's Agriculture and Forestry Departments and Marine Science Center fit this category, as do the University of Oregon's Institute of Molecular Biology, various programs at the Oregon Graduate Center, and the Oregon Health Sciences University's Institute.

We believe that, after an appropriate survey of Oregon's academic strengths, only such areas of potential national prominence should be given financial support to the limit of available resources. Given the reality of this state's economy, and the fact that there is an existing high technology electronics industry, it makes sense to focus on this area first.

Even with this slight advantage, unless all involved parties, whether state or local, public or private, academic or industrial, commit sufficient resources in a coordinated manner, the effort may well fail. The competition in this arena is intense. For example, Arizona is developing a Center of Excellence in Engineering at Arizona State University, committing approximately $35 million to the task. Stanford University is developing a new Center for Integrated Systems as a result of the receipt of approximately $12 million in funding from 17 microelectronics firms for constructing and equipping a new building. Additional funding for research support is being negotiated. There are many other examples across the country of multimillion-dollar commitments to education in electronics, bioengineering, robotics, and optics (University of California-Berkeley, University of Illinois, University of Texas).

2. Funding Campuses: The Synergy of Proximity. We have reviewed several studies which suggest that proximity of colleges and universities is not the most critical factor in moving a new production facility to a community. Your Committee believes that the location of research and development divisions of high technology companies will be determined less by availability of manpower and more by ease of access to the special talents and facilities found in colleges and universities. Companies must consider the synergy that this proximity produces. The opportunity to discuss ideas, explore new directions, and engage in cooperative research with leading researchers on topics of common interest can be rewarding to both parties. Within Oregon, the priority for making new investments at different State System campuses should be a response to this need. Your Committee agrees with the logic of the recent Consortium report (45) which stated:

"They [the Consortium recommendations] are made in full recognition of the desirability ultimately to achieve a Willamette Valley High Technology Corridor. However, the urgent need is to achieve a more equitable high technology educational balance, recognizing the current distribution of education and industry in the Corridor. As soon as significant progress in developing outstanding educational institutions in the Portland metropolitan area is occurring, the Consortium recommends similar support to other excellent areas and institutions, such as Eugene and the University of Oregon."

Further, as noted in national survey data (see Background), continuing education is of key importance to high technology industries. Obvious-
ly an industry is better served if continuing education can be provided within commuting distance, so employees may obtain further training while continuing on their jobs.

D. New Strategies for Industry/Education Coordination: The Importance of Leadership

1. Nationally — Systems Follow Ideas. Some other states and communities appear to have clear lines of organization to achieve their goals of using higher education in economic development. Simple questioning, however, reveals much more dependence on individual leadership than on any particular structure. Control Data's William Norris in Minneapolis seems to have inspired large numbers of businessmen and academics to cooperate in the network described as the Minnesota Business Partnership. Governor James D. Hunt of North Carolina personally heads the North Carolina Board of Science and Technology. This kind of leadership and the cooperation that it inspires is not apparent in Oregon, although the bad economic times of the past year apparently have been the factor spurring cooperation among colleges and universities who otherwise would have even fewer or no resources for high technology instruction and research.

The usefulness of industry-education models appears to be in individual ideas for action rather than creation of administrative systems. With this qualification, there appear to be two kinds of new activities needed as a result of our review: (1) strengthened coordination within the Oregon State System of Higher Education (State System Administration) (discussed in C., 2.) and (2) improved communication between industry (high technology users of Oregon post-secondary systems) and the entire range of post-secondary schools (industry/education coordination).

2. Locally — Governor's Leadership Vital. The coordination problems relating to turf duplication and FTE-based funding may appear to have little to do with scientific training and research, but in fact they dilute available resources and limit cooperative ventures which could stimulate and support commercialization of new products and processes. Because of these handicaps, your Committee has concluded that the present administrative system is not capable of competing effectively against public university systems in other states. The solutions to these problems are not going to be easy to find nor are they likely to be received with universal good will. In any case, we are hopeful that the work can begin soon. Delaying the process must surely further decrease our ability to compete for high technology industry.

Your Committee views coordination between industry and Oregon institutions of higher education as an issue of crucial importance to the overall economic health of our state. This is an issue that cuts across the entire spectrum of interests to reflect the needs, not only of the key players in industry and higher education, but also of our state and local governments, community development interests, and local school boards.

We believe that leadership for this effort should come from the Governor as the chief elected official of this state. We are aware that there is a tendency on the part of many people to assume that omnipotent powers and unlimited resources accrue to the Office of the Governor, so that there often are unrealistic demands placed on that office.
However, we are operating under no such illusions. We view the need for gubernatorial leadership on this issue to be vital because:

- No one else in industry or government has the visibility and political clout;
- No one else in government has as extensive cross-cutting responsibility or authority;
- No one else can force the issue by "going to the people;" and
- No one else can send as strong a signal to national and international business interests that Oregon higher education can and will be responsive to industry.

During the past year, two distinctly different organizations were proposed to accomplish the coordination task:

- The Council for Advanced Science and Engineering Education/Research for Industry (CASEERI) would be subject to the approval and control of the Chancellor of Higher Education and the State Board of Higher Education. Both North Carolina and Minnesota have research councils that coordinate research activities at state and private universities and, perhaps, this ought to be the function of CASEERI.

- Science and Engineering Board for Education and Research (SEBER) was proposed by the Governor's Economic Recovery Council in 1982. SEBER would have representation from appropriate industries, both public and private post-secondary education, the Legislature (ex officio) and the private sector. Besides being an advocate for cooperation and high technology industrial development, the Board would have the power to administer grants and disburse special funds through the Office of the Governor. Because it would not be part of the administration of higher education, SEBER would tend to be less affected by the biases of higher education staff. Your Committee believes SEBER is the better alternative for these reasons.

E. Important Considerations Beyond the Premise

Your Committee discovered inherent limitations in the charge and premise we faced. We did no substantive research in these areas but we know they are matters of general interest to the City Club.

The research premise included in the charge implies a priority of technical education over other post-secondary education, including the liberal arts. It makes sense to your Committee that underlying any need for improved technical education is the need for improved quality in all educational efforts. Our focus on education for jobs should include the broader education that defines a career.

The premise does not recognize the nature of Oregon's competition. We not only compete with other states, but also in the international arena. In other countries, the central government often plays a more directive role in education. Standards for entering a science or engineering education track are set at higher levels. The public demand for universal access does not dominate, as it does in the United States. Students who do not meet the standards are directed elsewhere, and as a result, higher education becomes more effective in use of money, people, and time.
Our research indicates that in Oregon the population at large—including our business leaders—may not have a strong enough desire or long enough view to compete with other locales that have committed themselves to a high technology future. For example, adult education, whether job-oriented or personal-development oriented, is much more the norm in California than in Oregon. Similarly, the idea, stated by a few business leaders, that we can "recruit" all the technology we need from nationally recognized schools in other states is dangerous. At best, this attitude will keep our enterprises a step behind others. More likely, it will result in the out-migration of commercially viable ideas and people. Oregon cannot simply "harvest" high technology industry when the competition maintains its position by investing.

The premise does not recognize the impact of primary and secondary education on higher education efforts. Our interviews with college educators confirmed our sense of inadequate preparation in Grades K-12. In part, this seems to stem from inadequate time devoted in early years to arithmetic and science, in part due to long neglect of the task of educating teachers in these disciplines, and in part, on the low level of expectation society has for our students in public schools. We can support local and state efforts to:

- Raise, publicize, and enforce K-12 graduation standards.
- Upgrade technical education through business/school cooperative ventures and teacher development programs.
- Invest in programs to increase the productivity of our schools (improvements in technology and institutional/labor arrangements).

Finally, we recognize that in the areas used as examples of economic development resulting from high technology/higher education cooperation, other important factors exist: social, economic, tax structure, urban proximity, and cultural. The relationships among high technology, higher education, and economic development is a complex equation. It is difficult to establish a direct cause/effect relationship through a review of the existing models; it is easier to infer a symbiotic relationship. In Portland, a significant national and international high technology industry has developed without a close link to a major university-based engineering research program. Where economic development has prospered around universities, the interaction has a dual structure involving both organizations and individual or informal aspects. Which of these contributes most significantly is not clearly demonstrated.
V. CONCLUSIONS

Existing Industry

1. It is just as important for Oregon's economic health to increase the productivity and competitive edge of existing major industries as it is to attract and develop new high technology industries in Oregon. Research and instructional programs at higher educational institutions will continue to play an important role in the application of new technologies by existing industries.

New High Technology Industry

2. For the startup of new high technology companies, important business factors include: a) the availability of educated engineering/research personnel who are likely to be already employed in nearby industries and b) access to national expertise in the technology of interest, whether found in government laboratories, industry or universities.

3. For attracting manufacturing plants in high technology industry, the most important factor is the availability of a skilled production labor force. In Oregon, especially in the Portland area, there is an adequate labor supply to assimilate new industry.

Oregon Post-Secondary Education

4. Most of Oregon's graduate research technology programs cannot compete on the national level.

a. These programs are essential for research and startup of high technology ventures.

b. The State System's programs that are competitive do not serve the Portland area where most of Oregon's high technology industries are located.

5. The current organization and management of the Oregon State System of Higher Education fosters unproductive competition and duplication of programs among schools. This results in diffusion of resources, inhibition of program excellence, and limits the potential for high technology economic development.

6. Regarding Oregon's community colleges, they are satisfactorily meeting the needs placed on them by high technology industry through cooperative local college/industry programs.

7. There is a trend for major high technology research and development programs to be conducted through multi-company and multi-university efforts. For Portland to compete successfully as a potential location for such programs, active and continuing cooperation among all major Oregon universities and industries is necessary.
8. If a university is to aid industrial development in areas such as joint research, technical and business consulting, and on-the-job training, the university must both:

1) make current knowledge financially and geographically accessible, and
2) create and simplify opportunities for industry to enter into working relationships with members of the academic community.

Industry and Higher Education

9. Various obstacles restrict the transfer of ideas within the State System of Higher Education and industry:

a. Lack of mechanisms to encourage and support the communication of research and development activities among various academic disciplines as well as among schools and industry.

b. Lack of financial incentives within the university system for staff to experiment and develop their own ideas, inventions, or patents.

c. Delays in development of new ideas due to inflexible bureaucratic procedures that inhibit creativity and the development of closer relationships between faculty and industry.

Allocation of Resources

10. The current strategic planning efforts in the Oregon State System of Higher Education are important for resource allocation. These efforts do not adequately reallocate the limited money available, nor do they focus on only a few outstanding programs.

11. To meet most needs of existing high technology companies, it is not necessary for Oregon to have nationally prominent science/engineering schools across the board, if there are at least several specialties with nationally prominent programs and individuals. This seems possible in Oregon with some changes in State System priorities.

Other Models

12. Nationally, effective coordinating organizations between high technology industry and post-secondary education are dominated by industry representatives. Among models surveyed, the Minnesota Business Partnership model most comprehensively and directly serves the economic development needs of Portland and Oregon.
VI. RECOMMENDATIONS

1. We recommend that Oregon's goals for high technology education be more narrowly defined in the current State System's strategic plan to concentrate funds and programs where there is substantial industrial support, and where national excellence in university staff exists or where there is a high potential for development of such a staff.

2. We recommend that the governor establish a review panel of nationally prominent university administrators to evaluate Oregon's public higher education system and suggest changes within the State System to facilitate cooperative university/industry program development and technology transfer.

3. The legislature should promptly mandate and fund a comprehensive study of administrative consolidation for the system of higher education. Based on our study of higher education resource use and high technology industry needs, we support the concept of a single State University in Oregon, with major campuses at Eugene, Corvallis and Portland. This may result in one single department for a given technical field, with staff and resources shared among the 3 campuses. However, since our examination necessarily has been limited, we feel that a more intensive study is needed.

4. We endorse the interim use of an industry consortium to direct incremental public funds to high technology education. We support the initial recommendations (1982) of the Oregon Consortium for High Technology Education regarding near-term focus on Portland for electrical engineering/computer science enhancements.

5. We endorse the establishment of a long-term coordinating mechanism between high-technology industry and higher education in Oregon. The proposed Science and Engineering Board for Education and Research (SEBER) is the preferred mechanism because it has a broader membership base than other alternatives, has a private orientation, and reports directly to the Governor. Membership on SEBER should include representation from the Economic Development Commission and State Board of Higher Education or its successor policy board.

6. Important early issues for SEBER work (beyond the recommendations of the Economic Recovery Council) should include:

   - Transfer of research and development information across academic disciplines and between academia and industry.
   - Development of career retraining programs with enhanced support from industry.
   - Elimination of current state administrative restrictions on program development and joint industry/education efforts such as common laboratory use, off-campus instruction, and joint assignments.
   - Funding of individual initiatives in other cooperative efforts (e.g., Portland Advisory Committee for Engineering Education (PACEE)).
- Revision at all levels, graduate and undergraduate, of the faculty compensation system to allow differentiation—to develop and support "pinnacles of excellence" and enable new split-career arrangements for faculty with industry.

- Encourage, facilitate, and support the commercialization of university faculty research projects by creating an aggressive technology transfer policy. Eliminate burdensome state rules, regulations, and restrictions.

Respectfully submitted,

Patrick Borunda
Craig M. Chisholm
Nathan Cogan
Jean Delord
Ronald F. Ennis
Stephen H. Feinstein
Rhona Wolfe Friedman
Becky Gardner
Greg Hutchins
Frank V. Langfitt
Paul C. Magnusson
Linda E. Moore
R. Stephen Nicholson
William E. Paudler
Myra N. Rose
Richard P. Smith
Carol N. Stone
John L. Frewing, Chairman

Approved by the Research Board and the Board of Governors on May 5, 1983 and ordered published and distributed to the membership for consideration and action on May 27, 1983.
APPENDIX A

PERSONS INTERVIEWED

John Anderson, President, Oregon-Pacific Economic Development Corporation, Eugene
Robert Baugh, Secretary-Treasurer, Oregon AFL-CIO
Robert Berdahl, Dean, College of Arts and Sciences, University of Oregon
Dr. Joseph Blumel, President, Portland State University
Thomas Bruggere, President, Mentor Graphics Corporation
Fred Burgess, Dean, School of Engineering, Oregon State University
Richard Carlson, SRI International
Dr. F. Paul Carlson, President, Oregon Graduate Center
Doug Carter, Director, Oregon Department of Economic Development
Gene Chao, President, Methus Corporation
Dr. Amo DeBernardis, Former President, Portland Community College
Dr. Chik Erzurumlu, Dean of Engineering and Applied Science, Portland State University
James Gardner, Oregon State Senator, District 10
Larry Gibney, President, Omega Securities
John Gray, Chairman, Omark Industries
David Hathaway, Venrock Associates/Rockefeller Family & Associates
William Haynes, Division of Human Resources, Wacker Siltronic Corp.
Dr. Richard Hersh, Graduate Dean, University of Oregon
Clifford Hudspick, Manager, Economic Services Division, Port of Portland
Ed Jensen, Portland Chamber of Commerce
Barbara Karmel, President, The Reed Company
Vera Katz, Oregon House of Representatives, District 8
Dr. Kevin Kelly, Vice President and Economist, US Bancorp
Robert Kleinert, Senior Vice President, Commercial Credit Corporation/Control Data, Baltimore
Dr. Leonard Laster, President, Oregon Health Sciences University
Paul Linntner, President, Electro Scientific Industries
Tom Long, Vice President, Communications Division, Tektronix
Sandra Lowe, Chairman, Multnomah/Washington Private Industry Council
Kathy Mass, Human Resources Division, Intel Corporation
Don Miller, Portland Advisory Committee on Engineering Education
Kathleen Murphy, Oregon Legislative Research
Lawrence Murr, Vice President for Academic Affairs and Research, Oregon Graduate Center
Tom Nelson, Dean, Multnomah School of Engineering, University of Portland
Jacques Nichols, Attorney
Aaron Novick, Chairman, Biology Department, University of Oregon
Dr. T. K. Olson, Executive Director, Oregon Educational Coordinating Commission
Steve Peterson, Director of Economic Development, Portland Development Commission
Angelica Pilato, Manager, Corporate Education, Tektronix
Dr. Carl Stoltenberg, Dean, School of Forestry, Oregon State University
Loren Wyss, member, Oregon State Board of Higher Education
City Club Forum Panel Discussions*

Representatives of:
Oregon Community Foundation
The Jackson Foundation
Portland Chamber of Commerce
Portland State University Faculty Senate
Oregon Community Colleges Association
Oregon Health Sciences University Faculty
Oregon Educational Coordinating Commission
Oregon Educational Coordinating Council Consortium Advisory Committee
City of Salem
Willamette University
Marion County Education Service District
Audubon Society
Sierra Club


Group discussions were solicited but could not be arranged with State Board of Higher Education, Oregon Economic Development Commission, Oregon Labor Groups, Salem Economic Development Commission.

City Club Speakers

John Anthony, President, Portland Community College
Governor Victor Atiyeh
Ray Broughton, Vice President and Chief Economist, First Interstate Bank of Oregon
Paul Carlson, President, Oregon Graduate Center
Richard C. Carlson, Senior Regional Economist, SRI International
William E. Davis, Chancellor, Oregon State System of Higher Education
John Elkins, Vice President, Western Region, The Naisbitt Group
Mary Futrell, Secretary-Treasurer, National Education Association
James A. Gardner, President, Lewis & Clark College
Dan Goldy, Consulting Economist
Kevin Kelly, Vice President and Chief Economist, U.S. Bancorp
Roy Lieuallen, former Chancellor, Oregon State System of Higher Education
William Little, University Distinguished Professor, University of North Carolina and Director, Research Triangle Institute
Ralph R. Shaw, President, Shaw Management Company
Douglas C. Strain, Chairman of the Board, Electro Scientific Industries, Inc.
C. Norman Winningstad, Chairman and Chief Executive Officer, Floating Point Systems, Inc.
Loren Wyss, Investment Economist and member, Oregon State Board of Higher Education
References


Papers, Articles, Memos, Etc.


48. The Oregonian, articles cited below:


The Oregonian articles, continued:


"Eroding Graduate Education Muddies Oregon's Job Waters" by Don S. Willner (Forum) 3-7-82.


50. "Q & A with Dr. Donald Kennedy, on Professors as Entrepreneurs," Venture, August 1982.


### General Fund Appropriations for Education 1981-1983*

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<tr>
<td>Student Loans</td>
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<td>Tuition Support</td>
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<td>Arts Comm., ECC, Historical Society, Library, Public Broadcasting</td>
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* Includes 1982 and March, June 1982 special legislative session reductions.

**Includes new $500,000 pass through grant program to Oregon ECC to improve higher education/new technology quality and coordination.
Preliminary Full Time Equivalent Enrollment Estimates and Projections 1982-1983

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<td>University of Oregon</td>
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<td>Oregon State University</td>
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<td>Portland State University</td>
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<td>Southern Oregon State College</td>
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<td>Clackamas</td>
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<td>Clatsop</td>
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<td>Lane</td>
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<td>Linn-Benton</td>
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<td>Mt. Hood</td>
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<td>Portland</td>
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<td>Rogue</td>
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<td>Tillamook Bay</td>
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<td>Treaty Oak</td>
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<td>George Fox</td>
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<td>Lewis and Clark</td>
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<td>Reed</td>
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<td>University of Portland</td>
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<td>Willamette University</td>
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## APPENDIX C
### DOCTORAL PROGRAMS AT OREGON PUBLIC UNIVERSITIES AND OGC (13)

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<td>Applied Physics and Electrical Engineering</td>
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<td>x</td>
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<tr>
<td>Anatomy</td>
<td>x</td>
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<td>Biochemistry</td>
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<tr>
<td>Biology</td>
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<tr>
<td>Biophysics</td>
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<td>Botany and Plant Pathology</td>
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<td>Chemistry and Biochemical Sciences</td>
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<td>x</td>
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<tr>
<td>Computer and Information Science</td>
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<td>Computer Science and Engineering</td>
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<td>Education (subdivisions)</td>
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<td>Entomology</td>
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<td>Environmental Science</td>
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<td>Fine Arts (history, music, theatre)</td>
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<td>Materials Science and Engineering</td>
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<tr>
<td>Mathematics</td>
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<tr>
<td>Medicine</td>
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<tr>
<td>Geophysics</td>
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<td>Physics</td>
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<td>Social Sciences</td>
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<td>Criminal Justice</td>
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<td>Recreation and Park Management</td>
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<td>Anthropology</td>
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<td>Resource Economics</td>
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<td>Urban Studies</td>
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APPENDIX D

SELECTED RECOMMENDATIONS OF THE STATE SYSTEM STRATEGIC PLAN (15)

41. The State System should continue the development of the Council for Advanced Science and Engineering Education/Research for Industry (CASEERI) consisting of representatives of post-secondary public institutions, private educational institutions, and business. The Council should provide a direct liaison between education, government, and business and should make higher education more responsive to the state's need for economic development.

42. CASEERI should collect and analyze data on future requirements for education programs to train workers for new science-related industries. CASEERI should work with other state agencies in identifying which government body should be responsible for collecting and providing data on employment and training and for making the data available statewide. These data are essential in planning educational programs to meet the educational and training needs of the state.

43. The State System should continue to strengthen the electrical engineering and computer science programs at Portland State University to serve the educational and research requirements of high-technology industries in that area.

44. The State System should determine the need for engineering technology programs in the Portland area and develop cost-effective programs to meet the need.

45. Knowledge of computers and computer science is becoming a basic skill requirement for many occupations. State System colleges and universities must continue to reallocate resources and seek new funds to meet student demand for computer science courses. The State System should also request additional funds from both the state and the private sector for the purchase of modern computing equipment, for related instructional software, and for the technical personnel to operate and maintain the equipment.

46. Micro-electronics is not the only area in which there is considerable industry-university cooperation. High-technology industries are also looking to the academic community for knowledge in the areas of genetic engineering, biomedicine, and other biotechnology areas. Our state universities have considerable expertise in these biologically-related, high-technology fields, and specific state funds should be requested to assist researchers in transferring their knowledge to those who can use it commercially.

49. CASEERI, in cooperation with the State Department of Economic Development, the Department of Commerce, and the graduate research deans at the state's universities, should develop and maintain an inventory of existing research activities in the state and should assess the need for additional research which would facilitate economic development in Oregon.

50. After identifying the research needs that are not being met, the State System should request funds from the Legislature to support a competitive grant program to fund priority basic and applied research projects needed for the diversification of the state's economy. This state-
supported research program would be more limited in scope and focus than the traditional research mission of a research university. It would not replace traditional research activities but would provide "seed money" and "cost sharing money" to help attract research grants that have potential benefits for Oregon industry. Once the research has proven to be useful, continued support would be sought from private as well as public sources.

51. The State System, in cooperation with educational, political, and business leaders in the state, should examine the feasibility of establishing a University Research Institute in Oregon. Modeled after the Research Institute in North Carolina's Research Triangle, the University Research Institute would seek public and private funds to conduct research which would encourage new research and high-technology industries to locate in Oregon.

52. Both the University of Oregon and Oregon State University are engaged in marine-oriented research. The Legislature should consider providing support for one or more marine experiment stations which would focus ongoing research at the two research universities on Oregon-related problems just as the Agricultural Experiment Stations do for agricultural interests in the state.

54. CASEERI, in cooperation with State System institutions, should determine the need for public service programs that share research results and existing knowledge with those in the state who can benefit from that knowledge in the course of their work. CASEERI should also assess the need for professional services that State System faculty could provide to small businesses and labor organizations, state and local governments, and other public and private agencies.
APPENDIX E

RECOMMENDATIONS OF THE EDUCATION TASK FORCE*
OREGON ECONOMIC RECOVERY COUNCIL
1982

In order to strengthen and more effectively utilize our higher education system and its unique assets in fostering industrial economic development, it is now apparent that a clear sense of advocacy is needed at the highest level of state government. An advocacy agent can facilitate the interplay between the academic and industrial sectors through the creation of effective communication channels, incentives, and opportunities for joint activities of many types. In particular, it can provide a rationale for fostering federated, as well as consolidated, relationships between community colleges, private institutions, colleges, and universities that stimulate industrial vitality and growth both in a research as well as educational sense.

Therefore, it is recommended that the Governor appoint a Science and Engineering Board for Education and Research (SEBER) that reports directly to the chief executive. It is the intent that this board and its operating structure be similar to the North Carolina Science and Engineering Board (sic), and that its advocacy role be strengthened and affirmed with powers to administer grants and disburse special funds through the office of the Governor.

The SEBER shall have representation of appropriate qualification from industry, both public and private postsecondary education, the legislature (ex officio), and the private sector. It shall elect its own chairman and shall meet as required to perform its designated charter and other duties. Its responsibilities shall include, but not be limited to, the following:

A. Initiate and conduct appropriate activities in concert with industry and postsecondary educational institutions that will advance science and engineering programs in education and research, to meet Oregon's economic development and other technological needs and opportunities. The scope of such efforts might include the following:

1. Secure information on the status and operation of engineering and science programs in the state of Oregon.

2. Consult with appropriate educational boards and commissions, university presidents, etc, to discuss and promote specific needs for programs, expansions, and reorientation. Advise such groups about opportunities.

3. Develop as a cooperative venture with industry and state government a program to stimulate teaching and research through special funding, coordination of which might include:

   a. Activities that will enhance the attraction and retention of top-quality faculty.

   b. Starter grants for new faculty members, to help them early-on to become competitive for national awards.

   c. "Seed" grants for projects specifically relevant to Oregon's economic development.
d. "Seed" grants for new facilities and equipment which have a multi-institutional shared-use aspect to them.

B. Examine new and emerging areas of science and technology and advise the Governor on potential opportunities offered for economic development in Oregon. Such studies and advice should stimulate actions needed to take advantage of opportunities (i.e., actions involving education, research, industrial accommodation, etc).

C. Examine barriers that:

1. Inhibit the most effective and productive use of education talents on a statewide basis in the area of the board's concern.

2. Inhibit the development of productive relationships between both public and private educational institutions and industry. Some areas to be examined are:
   b. Restrictions on proprietary research.
   c. Purchasing regulations.
   d. Allowance for joint venture programs and construction of facilities with industry and institutional resources.

D. Encourage the development and operation of delivery systems (coalitions, networks, new media technology, etc) that extend educational services and opportunities from wherever the specific talent exists to the points that identified public, private, or industrial needs are and can be economically justified.

*Chairman, Robert Ingalls; members, Fred Burgess, Paul Carlson, Richard Hersh, Henry Hewitt, Vera Katz, Rex Kruger, Leonard Laster, Tom Long, T.K. Olson, William Paudler, Loren Wyss*
APPENDIX F

BUSINESS-UNIVERSITY COOPERATIVE EFFORTS FOR ECONOMIC DEVELOPMENT

Alaska
. Alaska Renewable Resources Corporation

Arizona
. Center of Excellence in Engineering (ASU)

Arkansas
. Arkansas University Industrial Experimental Center for Small Manufacturers
. Arkansas State Science, Engineering, and Technology Program

California
. California Commission on Industrial Innovation (CCII)
  The CCII, established by Governor Edmond G. Brown in 1982, consisted of a review by university and industry leaders of ways to maintain California's leadership in technological innovation. It concluded that California's prosperity depended on innovation itself - not innovation in electronics, biology, material sciences, or any other particular technology, but across-the-board rapid identification of new public needs, new ways to meet needs, and early adoption of associated production activities.
  . Center for Integrated Systems - Stanford
  . California Engineering Foundation
  . Microelectronics Innovation and Computer Science Research Opportunities (MICRO)
  . Innovation Development Loan Program
  . Stanford/University of Santa Clara Early Bird Engineering Program (television instruction)
  . Investment in People Program (labor training)

Colorado
. Colorado Advanced Technology Institute

Connecticut
. Connecticut Product Development Corporation

Georgia
. Advanced Technology Development Center
. Small Business Development Center (University of Georgia)

Indiana
. Corporation for Innovation Development
. Indiana Center for Advanced Research, Inc.

Maine
. Maine Capital Corporation
. University of Maine/Orono Technology Transfer/Services Program

Maryland
. University Research Foundation
. Maryland Center for Productivity and Quality of Working Life
Massachusetts

- Massachusetts High Technology Council
- MIT Lifelong Cooperative Education Program
  As part of its centennial celebration in 1982, MIT created a faculty study committee to consider present educational needs in the broad fields of electrical engineering and computer science. This committee focused its attention on post-graduate education and professional development as problem areas because of the rapid rate of technological and scientific innovation.
- MIT Innovation Center/Co-Op
- Massachusetts Community Development Finance Corporation
- Massachusetts Technology Development Corporation
- MIT Center for Information Systems Research

Michigan

- Innovation Center at the University of Michigan
- Technology-Based Innovation and Development Fund
- Michigan Business and Development Corporation

Minnesota

- Minnesota Business Partnership
- Minnesota Wellspring
- University of Minnesota Institute of Technology

New Jersey

- New Jersey Office for Promoting Technical Information
- Princeton University Forrestal Center Research Park

New Mexico

- New Mexico Technological Innovation Program

New York

- New York State Science and Technology Foundation
- RPI Center for Industrial Innovation
- RPI Incubator Space Project
- RPI Center for Manufacturing Productivity and Technology Transfer
- Capital Park (RPI)

North Carolina

- Research Triangle Park/Foundation/Institute
- North Carolina Board of Science and Technology
- MICRO Electronics Center of North Carolina

Ohio

- Ohio Technology Transfer Organization
- Ohio Development Financing Commission/Industrial Technology and Enterprise Board

Pennsylvania

- Ben Franklin Partnership
- Carnegie Mellon Robotics Institute
- Carnegie Mellon Center for Entrepreneurial Development, Inc.
- Pennsylvania Technical Assistance Program

Tennessee

- Technology Corridor - Governor's Task Force
- Innovation Center for Enterprise Development in Appalachia
Texas
  . Institute for Ventures in New Technology (Texas A&M)
  . Gulf Universities Research Consortium
  . Balcones Research Center (UT)

Washington
  . Washington Research Foundation

Wisconsin
  . University/Industry Research Program (UW)

Others
  . National Science Foundation
  . University/Industry Cooperative Research Centers Program
  . Business-Higher Education Forum
  . Semiconductor Research Cooperative
  . National Center for Higher Education Management Systems
  . Western Interstate Commission for Higher Education (WICHE)

WICHE has conducted an ongoing study aimed at cooperation between business and higher education in Western states. A special "Western Technical Manpower Council," chaired by Hewlett-Packard's John Young and Oregon's Victor Atiyeh recently published a "Fact Book on High Technology and Energy-Related Higher Education in the West" and associated "Strategies for Action."