GRADUATE EDUCATION AND ECONOMIC DEVELOPMENT

Report and Recommendations by the
Florida Postsecondary Education Planning Commission

February 1999

POSTSECONDARY EDUCATION PLANNING COMMISSION

Graduate Education and Economic Development

Prepared in Response to Specific Appropriation 176
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EXECUTIVE SUMMARY

The Commission was directed by the 1998 Legislature too "examine the relationship between graduate education and state economic development/ workforce needs of Florida, including academic degree programs necessary to strengthen the state's economy." This charge came about in part due to concerns raised in ***Challenges and Choices: The Master Plan for Florida Postsecondary Education***, that despite the positive impact of graduate education on the state's economy, Florida's universities awarded less than the national average of master's, doctoral and professional degrees. Of particular concern was Florida's production of Ph.D. scientists and engineers (less than one-half the national average) and the dearth of minority graduate recipients in the sciences and engineering.

Although the emphasis on graduate education varies among Florida's universities, the state had the ninth highest overall graduate student enrollment in the nation (1995) and was seventh in graduate enrollment among public institutions. The proportion of graduate students enrolled in disciplines in Florida institutions that are deemed by business and industry to be most geared to their workforce and development needs is comparable to graduate student enrollment in states identified as the most "economically sound" in the 1998 ***Master Plan***. The Commission found that while graduate enrollment may need to increase in certain disciplines, and most assuredly among minority students, those increases should take place at Research I and II institutions whose missions include graduate education and research. While the Commission concluded that with adequate state support future expansion in some areas of graduate education is warranted, there is no evidence that a strict accountability between graduate education and economic development is desirable or indeed even possible. It is imperative however, that students are prepared to meet Florida's future workforce needs, particularly in areas that will help drive the state's high technology based economy. Toward that end, university/industry partnerships must be strengthened, universities must practice effective enrollment planning, and the state must provide adequate funding for graduate education, including fee waivers and stipends, in order to attract and retain the best graduate students available.

Directly related to the analysis of graduate education and economic development for this study was the role of university research and development in fostering economic growth through scientific discovery and technology transfer. The Commission found that university research, a natural outgrowth of graduate education, has made viable contributions to the state's economic development. The transfer of university resources both human and material from the laboratory into the larger community benefits the state's economy and enhances the reputation of Florida's universities. Partnerships with business and industry that foster such interaction need to be expanded and the state's research infrastructure that begets discovery and its application needs to be strengthened. At

the same time, a long-term plan to increase Florida's share of federal and private research dollars and to increase private investment in high-potential businesses in Florida should be developed. Toward achieving these ends, the Commission makes the following recommendations:

Recommendations:

1. ***The Legislature should provide adequate funding to SUS institutions for graduate stipends and fee waivers to ensure Florida's competitiveness with out-of-state institutions. The universities should ensure that those funds are effectively managed with outside grants to maximize available resources for supporting graduate incentive packages. Complete information on the sources of all graduate waivers and stipends should be routinely provided by the universities to the BOR to be used in budget planning and development.***

2. ***The BOR, in conjunction with the Council of Graduate Deans, should develop a systemwide method for tracking the career success of its institutions' advanced degree holders.***

3. ***The Council of Graduate Deans should work closely with Enterprise Florida and industry leaders in Florida to determine if additional graduate programs need to be created or if existing programs should be expanded and/or restructured to prepare students for the 21st century workforce and to meet existing unmet needs in industry throughout the state. Graduate enrollment increases should be limited to those institutions whose mission encompasses graduate education and research.***

4. ***The State University System should establish a web-based site to link graduate students with internship opportunities in government, business, and industry.***

5. ***The Board of Regents, in consultation with the Council of Graduate Deans, should identify strategies, including financial incentives, for increasing the number of minorities enrolling in and receiving M.A.s and Ph.D.s in the sciences and engineering. The Board should set a policy goal that includes the recruitment of minority students into graduate level science and engineering programs that meets or exceeds the national average of minority enrollments in these programs.***

6. ***The Board of Regents should identify specific new strategies by which the universities can participate in enhancing the economic growth of the state. Such strategies should include: identifying and strengthening interactions that are being taken or can be taken by university-industry partnerships; identifying***

areas of research excellence that will allow the universities to more successfully compete for federal and private research funds; providing a web-based site for information on research activities within the SUS; matching needs and resources for developing cooperative research programs; developing actions designed to strengthen the transfer of university ideas and products to the marketplace; stimulating the establishment of businesses by professors; and, developing other actions necessary to bring the universities' research programs into the deliberations of Enterprise Florida.

7. ***The Board of Regents should reactivate the Chancellor's Research Alliance composed of the SUS Vice Presidents for Research and provide staffing for that body. The Alliance should be charged with, but not limited to, developing research strategies for the SUS such as: increasing the amount of government and private industry support for university research and development; maintaining communication between the Board and the universities on government and industry issues affecting university research and development; initiating collaborations for increasing the state's research infrastructure and resources; establishing roundtable discussions and fostering interaction with Enterprise Florida, the Leadership Board for Applied Research and Public Service, and other business, industry and government leaders; and, making recommendations to the Legislature for enhancing the state's economic well-being.***

8. ***The Chancellor's Research Alliance, in conjunction with Enterprise Florida, should review existing laws, rules, and policies affecting economic development and university/industry partnerships and recommend the deletion or substitution of any regulations or requirements that are impediments to enhancing or strengthening the state's research and development infrastructure including securing venture capital from private and public sources.***

9. ***The Legislature should provide additional incentives to attract new high technology industry to Florida. Potential strategies include: extending the silicon technology research and development sales tax exemptions to other or all areas of university/industry research; providing incentive funds to the universities to develop collaborative research strategies related to the main geographic corridors within Florida; providing an incentive fund composed of new money that would be accessible by SUS institutions collaboratively engaged in research partnerships with industry; and, providing funds earmarked for matching support of proposals to win federal research funds and /or centers.***

INTRODUCTION

The 1998 Legislature directed the Commission to "examine the relationship between graduate education and state economic development/ workforce needs of Florida, including academic degree programs necessary to strengthen the state's economy." As part of this analysis, Commission staff collected data on graduate funding, enrollment, completions, and employment, university research and development activities and expenditures, university/government/industry research partnerships, and economic development strategies in Florida and in other states. Staff sent three separate surveys, one to State University System (SUS) graduate deans, one to SUS vice presidents of research and one to select State Higher Education Executive Officers (SHEEO) to help determine what, if any, changes in policies, focus, and planning are needed to enhance graduate education in Florida, provide employment opportunities for advanced degree holders, guard against a "brain drain" of Florida's best and brightest graduates, foster economic development and expansion, strengthen the state's research infrastructure, and attract investment to Florida's high-potential businesses and industries.

This study contains an issues section divided into two related areas of discussion, graduate education and research and development. A summary and recommendations section is included along with an appendices to support study findings and recommendations.

The Commission Chairman assigned this study of graduate education and economic development to the Program Committee chaired by Mrs. Inez Bailey. Other members were Dr. Robert Bryan, Mr. Ivie Burch, Mr. Ed Tolle and Mr. Clyde Hobby. The Committee held a series of public meetings between August 1998 and February 1999 which included testimony from business and industry, legislative, and education spokespersons.

ISSUES

Graduate education is an integral component of the State University System's mission of providing quality higher education opportunities that are responsive to the needs of the citizens of Florida. In ***Challenges and Choices: the Master Plan for Florida Postsecondary Education***, the Commission stated:

The role of graduate education in Florida is to produce the intellectual leadership for the next century. Students with graduate degrees help create and impart valuable knowledge, attract high technology industry and businesses, contribute to the health of the state economy, and enhance the reputation of Florida's universities.

Advanced degree recipients are an important component of the state's workforce, filling the positions created by high technology/high wage businesses and industries and contributing to the economy through increased earning power. Graduate programs produce the scientists and engineers who conduct the nation's research and development, provide solutions to complex societal problems, attract millions of dollars in outside research funding, and help lure new high technology businesses and industries to the state.

As part of the Commission's review of the relationship between graduate education and state economic development/workforce needs of Florida, a survey was sent to the ten SUS graduate deans to help determine in part: 1) the ability of Florida's graduate programs to attract and retain quality students, particularly in high technology fields, 2) the adequacy of state funding for graduate education; 3) the extent of collaborations between higher education institutions and industry to foster economic growth and expand opportunities for internships, stipends, and jobs for the state's advanced degree holders; and, 4) strategies needed to identify and strengthen those graduate programs that are directly linked to economic development and future workforce needs.

Graduate Education

Graduate education is inexorably linked to the state's economic well being and workforce needs. According to a 1996 study by the University of Florida, the total incremental contribution to the Florida economy resulting from the increased earning power of advanced degree holders is $161 million annually. Yet historically, Florida lags behind the national average in the per capita production of graduate degree recipients, awarding less than one-half the national average of engineering and science degrees (1995), 82 percent of the national average of master's degrees, and 83 percent of doctoral degrees. However, the State's pipeline to future advanced degree production may be improving. Florida had the ninth highest graduate enrollment (Fall, 1995) in the nation and was seventh in graduate enrollment among public institutions. In addition, the percentage of all SUS graduate students who are enrolled in the

academic fields deemed to be the most relevant to the needs of high technology business and industry is comparable to the enrollment percentage of the top ten economically sound states identified in ***Challenges and Choices*** (1998*)* and with those states with the largest research and development expenditures in 1996. (See Tables 2 and 3). When one compares enrollment figures by institutions, i.e., comparing Florida's top graduate institutions with those of competitive state universities however, the result is not as encouraging. For instance, when measuring graduate enrollment as a percentage of all students, the University of Florida (UF) at 19 percent, ranks far below the average of the top ten Association of American Universities (AAU) public universities (27 %). When compared to fifteen of the largest public AAU institutions, UF ranks last in the number of graduate students enrolled in science fields, seventh in the number enrolled in engineering, and twelfth overall in the number enrolled in engineering and science disciplines (NCES, 1996).

The University of Florida's new Graduate Fellowship Initiative is an eight-year plan to increase its proportion of graduate students to 26 percent by 2006. The initiative includes graduate minority fellowships, which will help recruit more minorities, especially in engineering and physical sciences.

The overall number of SUS students receiving graduate degrees in engineering has decreased.

While the number of SUS engineering Ph.D.s increased from 144 in 1994-95 to 171 in 1996-97, the number of SUS students receiving a master's degree in engineering decreased from 1,006 in 1994-95 to 872 in 1996-97. Thus, the overall number of SUS students receiving graduate degrees in engineering has decreased by 10 percent in two years. (The number of SUS baccalaureate engineering degrees has increased during the same time period). The number of students receiving graduate degrees in engineering from the private sector in Florida (the University of Miami and Florida Institute of Technology only) decreased by 53 percent during that same time period.

There is a dearth of minority students enrolled in the engineering and science fields.

Of particular concern is the dearth of minority students enrolled in the engineering and science fields throughout the SUS. Despite systemwide efforts to increase those numbers, only twelve blacks and six Hispanic students received a Ph.D. in engineering from an SUS institution from 1992-1995. Of the 165 Ph.D.s in the physical sciences, three were awarded to blacks and nine to Hispanics during that same time. The Board of Regents recently reported that in 1996-97, less than three percent of all engineering Ph.D.s were awarded to black students, and no black student received a Ph.D. in mathematics, chemistry or physics in that year. Nationwide, the number of black Ph.D.s in science and engineering has increased in recent years. From 1996 to 1997, the number of black engineering Ph.D.s increased from 74 to 97.

At the Master's level, blacks received three percent of engineering M.A.s at SUS institutions in 1996-97, five percent of mathematics and physical science degrees, four percent of life science degrees, and one percent of the computer and information M.A. degrees. It should be noted that competition for minority graduate students is intense nationwide, particularly at the Ph.D. level and in certain fields.

Graduate Outcomes

As has been repeatedly noted, graduate education has a positive economic effect on the state and enhances the quality of life of its communities. Despite what is known about the benefits of graduate education however, the SUS does not have a systemwide method for tracking the career success of its institutions' advanced degree holders. A recent study by the Association of American Universities noted that although unemployment rates for Ph.D.s are generally very low (only 2 percent of people who had earned their Ph.D.s from one of the 60 member AAU institutions from 1991-1994 were unemployed), research universities need to do a better job in determining exactly how their Ph.D.s are employed—whether, for example, they are underemployed and not using their doctoral training. The report urges universities to do a better job of systematically tracking their Ph.D.s to find out what kinds of jobs they land. That information also would help universities figure out which programs to scale back and where to limit admission. During the past few years, much has been written about the "Ph.D. glut", that is, high rates of underemployment—if not unemployment—for new Ph.D.s in most fields. Despite such warnings, 42,705 students nationwide received a Ph.D. in 1997, the twelfth consecutive record breaking year. This trend has led some academics, policy makers, and industry leaders to recommend a reduction in the number or size of doctoral programs. Such actions might be unnecessary if the enrollment declines continue as noted in a November 1998 report by the Council of Graduate Schools. The report reveals that nationwide, graduate student enrollment has dropped for the second year in a row. A strong job market for new B.A.s and a relatively weak one for Ph.D.s may be responsible for the decline, according to the report.

Graduate education has a positive economic effect on the State.

In September 1998, the National Research Council reported that the number of Ph.D.s in the life sciences exceeded the jobs available to them in academia, government, and industry. Concern about the academic job market in the arts, humanities, and social sciences have been prevalent for over a decade, although students continue to seek advanced degrees in those areas. Some critics, including those in the Modern Language Association (MLA), recently charged that the overproduction of Ph.D.s in English and foreign languages has combined with an increasing reliance on part-time instructors to keep many new Ph.D.s out of the academic job market. At a November 1988 MLA meeting, members voted to

recommend that departments that have failed to place many of their new Ph.D.s in tenure-track jobs reduce the number of graduate students they admit. The delegates also supported a new approach to training graduate students that would focus more on teaching and less on research so that Ph.D.s will seek jobs at community colleges and high schools with the same zeal that they have for pursing positions at research universities. The continuing weakness in the job market for Ph.D.s in the humanities was debated in November 1998 at the meeting of the American Studies Association where some participants accused campus administrators of placing pressure on departments to expand doctoral enrollments, despite weakness in the job market, in order to use teaching assistants as "cheap labor."

The "soft job market" for some Ph.Ds is improving insists the American Economic Association. According to the association's recent survey, 80 percent of students who received a Ph.D in Economics in 1997 were in permanent employment positions one year later. When compared to other identical outcome studies, recent recipients of Ph.Ds in economics were more likely than their counterparts in chemistry, engineering, mathematics, physics, psychology, physical science and sociology to have permanent in-field jobs, the survey contends.

Several major universities have reduced graduate enrollment in order to give all students greater financial support.

Reducing the number of graduate programs and doctoral enrollments creates a natural selection process that leads to better graduate students and more financial aid and support for the very best students in the fields, some educators insist. Indeed, several major universities including Indiana University at Bloomington, Washington University in St. Louis, the University of Michigan and Duke University, have reduced graduate enrollment in order to give all students greater financial support. The departments most affected by these changes are in the colleges of humanities and social sciences because students in the hard sciences are more often supported by external grants. Typically, universities do not reduce the amount of money coming into a department that has limited enrollment, but redistribute funds as stipends and waivers. Instead of cutting enrollment however, some institutions are increasing their support of graduate students through fund raising.

Over enrollment is not a problem in fields as diverse as history, mathematics, chemistry, and English, some critics of the "over-supply" theory observe, pointing to recent increases in advertisements for job openings. While some academic positions may be opening up, more and more Ph.D.s are looking for employment outside of academe. According to the National Research Council, the proportion of all history Ph.D.s working in four-year colleges and universities dropped to 64 percent in 1994 from 73 percent in 1979. By 1995, just over 50 percent of doctoral recipients in science, mathematics, and engineering worked outside four-year colleges and universities. That bodes well for industry and

government some analysts note, but working outside academe is a trend that requires colleges and universities to revamp how they train graduate students and produce research, a process criticized by some as being too narrow to be "useful" in the "real" world. Most students entering Ph.D. programs do so because they are intensely interested in a specific field and hope to find careers in that field, but graduate schools typically have not tried to prevent students from enrolling in programs that might not lead to jobs.

The idea of developing a strict accountability between graduate enrollment and supply and demand in the job market worries many faculty and critics who point to the less utilitarian benefits of advanced learning including personal enlightenment and intellectual growth, that benefits both the individual and community. Universities are being encouraged from many quarters to pay more attention to advising and counseling students, providing more interdisciplinary options in graduate programs including research activities and internships, and assuring financial aid support. In December 1988, the Woodrow Wilson National Fellowship Foundation unveiled plans to expand career opportunities for Ph.Ds within and beyond academia. Projects will include awarding grants to departments that have encouraged doctoral students "to interact with the world outside the academy as part of their training." These and related activities are needed to decrease the time students spend earning their degree while making their education applicable to their future careers and personal interests.

Developing a stricter accountability between graduate enrollment and marketplace demands is being encouraged at some universities.

Much of the discussion surrounding graduate education has focused on the career options and directions of Ph.D. recipients. However, most institutions nationwide provide far more M.A.s than doctorates. In 1996-97, SUS institutions awarded 9,166 M.A. degrees and 1,041 Ph.Ds. A study conducted by the SUS and the Florida Education and Training Placement Information Program (FETPIP) revealed that of the top ten programs producing the largest numbers of doctoral graduates in 1990-91, only 30 percent of Ph.D. recipients remained in Florida five years after graduation (14% of electrical engineers), while 50 percent of M.A. recipients from programs with the largest enrollment (34% of electrical engineers) were still employed in the state five years after graduation. The study found that for most programs there was an earnings advantage to obtaining a degree at the next higher level in the same discipline. This was particularly true in the mathematics, science and engineering fields included in the study.

The BOR conducts program reviews of each academic discipline every seven years. Such reviews assess the quality of academic programs, including student placement, and provide recommendations for improvement. The Board has not conducted a systemwide survey to determine the relevance of graduate programs to the job market or to measure the level of personal success or satisfaction of program graduates.

According to BOR staff, professional associations and accrediting agencies do a better job of tracking that type of assessment data. Some academic disciplines, such as business, are most likely to do in-depth surveys to measure career success as they are directly geared to the job market. According to BOR staff, while they have recommended that certain academic tracts be eliminated or absorbed into larger programs, universities do not have the luxury of supporting programs with low degree productivity. Consequently, institutions have made efforts to reallocate funds to support the most productive faculty and programs. New program proposals submitted by the institutions are evaluated according to several measures including relevance to the institution's mission. Approximately 180 potential graduate programs were submitted by the institutions to the BOR to be included in the SUS Strategic Plan for 1998-2003. Of those programs, BOR staff recommended approval of 40 percent.

For the majority of SUS institutions, there is not a standard measure for assessing the productivity of graduates.

According to the survey of SUS deans, follow-up surveys of advanced degree holders are usually done at the college level or through the alumni association and through various anecdotal methods. For the majority of institutions, there is not a standard measure for assessing the productivity of their graduates or the relativity of their programs. The University of West Florida is developing a survey instrument (May 1999) that focuses on process as well as the typical outcome information. The University of Florida conducts a survey of its undergraduates and graduates every five years. The latest survey, conducted May through August 1998, revealed that 94 percent of the doctoral recipients are employed in positions that require the skills and knowledge from their Ph.D. training. The survey found that most (60%) doctoral degree holders earn an annual salary of $50,000 or more with at least 26 percent earning $70,000 or more.

Graduate Stipends and Fee Waivers

Graduate deans were asked how graduate stipends, fee waivers and other incentives were funded and distributed at their institutions and how that process could be improved. Although their answers varied considerably on the survey, Florida's SUS graduate deans agreed overwhelmingly that the "paucity" of financial aid available for graduate students seriously affects the universities' ability to attract and retain top graduate students, particularly in the sciences, engineering, and other high wage fields where jobs are plentiful. Several deans noted that some other states, including neighboring Georgia, substantially reduce or waive the tuition of graduate students, putting Florida's institutions at a disadvantage, particularly when recruiting out-of-state and international students. Florida's inadequate funding for fee waivers, stipends, fellowships, and other incentives, not only undermines their institution's ability to compete with other universities for graduate students, the deans attest, but adversely affects

the mission of the research universities and limits the growth of and quality of graduate and research programs systemwide.

The University of Florida noted that its stipend level for both teaching and research assistants is at the bottom of its peer group nationally. Adding to the problem is the fact that all of the research institutions competing with UF for students contribute all or a substantial portion of graduate assistants' health insurance premiums. Data collected by the National Science Foundation and the Association of American Universities indicate that UF provides a low number of fellowships to full-time science and engineering graduate students and ranks 26th among AAU institutions for the percentage of engineering science students primarily funded by teaching assistantships.

Graduate stipends are supported from a combination of Education and General (E&G) funds, contracts and grants, and auxiliary funds. In most cases, general revenue is made available to the universities to be distributed as OPS funds to pay graduate assistants, particularly teaching assistants. In addition, faculty lines can be converted to OPS dollars and used to pay graduate teaching and research assistants as well as adjunct faculty. Those decisions are made at the college or department level and greatly determine how much funding is available to support graduate assistants. According to the BOR, funds available for stipends, adjuncts and new positions are often diverted to pay for the institution's infrastructure cost. In 1990-91, the SUS lost $165 million when state budgets were cut, and the system has not received appropriation increases to meet the increasing demands of its operations including technology updates, utilities, classroom materials, etc. The Chancellor has made the restoration of these funds a top priority in the SUS Legislative Budget Request.

Top graduate students are increasingly deciding what institutions to attend based on the financial incentive packages that are available.

Decisions on stipend levels and students to receive assistantships are usually made at the college and departmental level. Fellowships are generally awarded at the university level. The availability of a sufficient level of support for a graduate student to cover basic living expenses as well as the costs of education is, of course, a major factor influencing the choice of an institution. According to the SUS institutions, top graduate students are increasingly deciding what institution to attend based on the financial incentive packages that are available. In 1989, the Commission and the Board of Regents conducted a study on graduate fee waivers and stipends, in part, to compare Florida's ability to attract qualified graduate students with other states. The Commission and the BOR recommended that state support for graduate assistants should continue to be enhanced to provide increases for stipends as a means to ensure opportunities for competitiveness with out-of-state institutions. In addition, the Commission and the BOR determined that each SUS institution should ensure that the level of stipend awarded was "reasonable compensation"

in relationship to the academic discipline in which the assistant was employed and among comparable institutions.

Fee waivers have not been fully funded by the Legislature in seven years.

In their 1989 study, the Commission and the BOR recommended that matriculation and tuition fee waivers be provided to graduate assistants employed at one-quarter time or more and graduate students on fellowships. The study recommended that waivers should be fully funded based on the prior year's number of graduate assistants and fellows who were fully qualified. Despite a steady increase in the number of graduate students attending SUS institutions, fee waivers have not been funded based on growth in seven years. In addition, for 1996-97 and 1997-98, the Legislature did not provide fee waiver resources required for fee increases adopted by the Legislature. According to the Board of Regents funding methodology, the 1996-97 fee waiver allocation ($34,938,334) fell short by some $9.6 million of meeting the total fee waiver need (a $7.2 million deficit for graduate waivers) within the SUS. In 1996-97, 19,772 graduate students (65% Florida residents) received waivers. Seventy-eight percent of the recipients attended UF, FSU, or USF, the state's three Research I institutions. There was concern among some SUS institutions that the current distribution of fee waivers (based on the previous year) benefits the three large research universities and prohibits other SUS institutions from increasing graduate enrollment. Because the base funding for fees has not been reallocated in four years, the proportion of fee waivers allotted to each university has not changed despite enrollment growth and fluctuation among the institutions. The Board of Regent's plan to classify the ten state universities by mission would allow the Research I institutions to increase graduate enrollment and, with legislative approval, receive additional state funding to support graduate education and research. Additional fee waiver monies would need to be appropriated by the Legislature. If fee waivers are fully funded, the BOR could allocate new monies based on the funding formula, which would normalize the distribution to all universities. The BOR has requested an additional $14.5 million ($8.5 million for graduate waivers) to be added to base monies ($40million) to fully fund SUS fee waivers for 1999-2000.

One argument used against "full funding" for fee waivers is the lack of clear data on how many SUS students receiving waivers are supported by stipends or grants from sources other than E&G funds; and, if those outside funds cover matriculation and tuition fees over the course of the students' education. Because of the great variety among granting agencies on how funds can be used, some students are prohibited from using outside monies to pay for tuition or matriculation fees, while other grants cover those costs. In addition, some states waive tuition for all out-of-state graduate students, while others greatly reduce those fees. Until complete information is provided by the SUS on how institutions use outside grant funds to support a graduate student's education and for how long, there

is legislative resistance to fully fund fee waivers based on the formula established by the BOR. The Board is currently compiling such information recently submitted by its universities and will provide that data to legislative staff for analysis.

In short, state support for graduate students, whether in the form of fee waivers, stipends, or other incentives, should be adequately funded by the Legislature and effectively managed by the SUS institutions. The BOR, the institutions, and the Legislature should work cooperatively together to determine the best method of funding and distributing state monies so that Florida is competitive with other states in attracting and retaining the most qualified graduate students.

Opportunities for Graduates in Florida

Florida is losing many of its high-tech graduates to other states.

Evidence that Florida is experiencing a "brain drain" among segments of its highly trained graduates, particularly in the engineering and science fields, was discussed throughout this study's deliberations. According to recent news articles, Florida may be losing its best minds to other states that have done a better job of attracting high-tech companies that offer more high-wage job opportunities. In its 1998 report, the Southern Technology Council grouped each of the fifty states into one of four quartiles based on the state's ability to retain its recent science degree graduates and to attract science degree holders from other states. Florida was grouped in the second quartile, behind eleven other states, for retaining college graduates with science degrees, and in the third quartile, trailing 24 states, for attracting recent science degree recipients from elsewhere. According to some industry spokespersons, Florida is developing a reputation for exporting more talented high-tech graduates than it retains or imports.

According to the survey results, a majority of SUS graduate deans agreed with the "brain drain" theory. FAU and UCF disagreed, the latter noting that its high-tech graduates, most of who were part-time students, generally remain in the Central Florida area. The UCF dean did note that the university had trouble attracting graduate students from other states because of a dearth of financial aid. FSU agreed, noting that it loses a lot of native students to out-of-state graduate schools who often do not return to work in Florida. In 1998, the Southern Technology Council identified Florida is a leader in building technology-based state economies. Nevertheless, Florida loses a number of graduates to regions that provide more career opportunities and advancement in high tech areas. The deans agreed that Florida should continue to increase the quality of the state's science and engineering graduate programs, while enhancing the ability of universities to employ technology transfer, including trained graduates, to business and industry. UWF's dean underscored the need for a stronger state commitment to economic

development including incentives for hiring Florida students. In recent years, increased emphasis on high technology development in Florida has created a critical need for a well-educated and highly skilled workforce. While graduate programs supply many of the workers needed by this industry, they also produce the entrepreneurs who form these new high-tech companies. Thus, UF's dean noted, the state must continue to expand the capacity of its universities for this advanced training. The deans stressed the need for more stipends and waivers to attract graduate students, many of whom will stay in Florida if the state continues to invest in high technology development and expansion.

University/Industry Collaborations

The deans were asked what collaborations existed between and among their institutions and private business and industry for securing internships, stipends, and employment for advanced degree holders. The University of Florida reported that its colleges have collaborated with other SUS institutions to provide additional access to specialized degree programs that lead to high wage job opportunities. The university has over $2 million in active subcontracts with other SUS universities in areas such as marine science, diabetes research, and materials science. The College of Engineering alone has contracted out $3.6 million to other SUS universities for ongoing projects and has received over $1.6 million from other SUS institutions. The university has hundreds of strong ties to industry that often lead to paid internships and full-time positions after graduation.

One of the most lucrative university/ industry partnerships is the I-4 corridor initiative.

One of the most lucrative examples of institutional cooperation is the USF-UCF I-4 Corridor Partnership. That partnership has led to stipends, internships, and employment for UCF and USF graduates while stimulating the economy in 13 counties straddling the Interstate 4 Corridor. Over the last three years, the Legislature has appropriated over $15 million in matching funds to support I-4 activities while permanently increasing the base of the two universities. Other examples of SUS institutions working in joint ventures with industry and government to stimulate economic development include the Magnetic Lab at FSU, the Florida Center for Solid and Hazardous Waste Management, which involves eight universities and provides support for the state and private industry, the North Florida Technology Innovation Corporation Applications Center, and many others. FAU, FIU, and the University of Miami have submitted a joint proposal to the BOR to fund a I-95 Corridor Project to "assist the development of high technology enterprise in the region."

Graduate deans stressed the importance of internships in graduate education, noting that such opportunities not only provide practical experience but often lead to jobs for graduates. FSU has plans to develop

a web-based clearinghouse to provide information on internship opportunities. Such information could be replicated on a statewide basis to link students with internship opportunities in government, business, and industry.

When asked if there was a need to strengthen and expand certain graduate programs in Florida to maximize economic development and diversification, the SUS graduate deans answered yes. The fields most often mentioned for expansion were engineering, physical sciences, health sciences, computer sciences, management information systems, bimolecular sciences, and materials sciences. UCF's dean stressed the importance of enhancing and expanding programs in early childhood education, gerontology, and human and health services, noting that high-tech employers want to move into areas where schools are strong and where there are adequate and appropriate social programs.

There is a need to strengthen and expand certain graduate programs in Florida to maximize economic development.

UWF's dean noted that when creating or expanding graduate programs, institutions need to know what in-state industries are hiring and which in-state industries have to go out of state to hire graduates. In general, the deans agreed that graduate programs need to be constructed to align current trends in the market to prepare students for the 21st century workforce but with the realization that trends change considerably and quickly in the high-tech fields. UF noted that in many fields, the master's degree is becoming the entry–level degree.

Graduate Education and Economic Development

When asked if the state's graduate programs should be designed with an emphasis on the state's future economic development, the SUS deans agreed that economic development should be just one of the factors considered in program design. FSU's dean noted that new discoveries will open up different fields and areas, so there must be a balance in the university. Trying to predict the future is risky, UF's dean warned. When new programs are proposed at UF, one of the key criteria is the market need for graduates of the program. The current emphasis at that institution is the development of programs, particularly at the master's level, that are directly responsive to the perceived needs in the market place. While today's economy may indicate a greater need for MBAs and engineers, technological changes in the 21st century could shift the emphasis to some new, currently undefined fields. Because faculty are at the cutting edge of developments in their field, they should drive the curriculum development and encourage the field's growth outside the university, the deans agreed.

The deans underscored the importance of emphasizing programs in areas that Enterprise Florida and other economic development entities have targeted. At the same time, however, other graduate programs should

not be neglected, as economic development is only one of the bases for graduate program development. While a technically prepared workforce is essential, FAU's dean noted that the quality of life is also a key determinant in a company's location decision. Culture, the environment, and good schools are all key considerations in a company's decision to locate or expand in a state.

Funding for Graduate Education

Finally, when asked how graduate education should be funded, the SUS deans strongly restated their support for increased funding for stipends, fellowships, and fee waivers. Suggestions included waiving tuition for out-of-state and international students, establishing tuition waiver agreements between those Florida institutions where students are dually enrolled, and establishing additional stipends monies for placing graduates in settings that will directly benefit the state. Several deans suggested that the state establish a separate funding source for assistantships while allowing each university to receive incremental funding based on its developmental needs, particularly for tuition waivers. UWF's dean voiced support for training in grant proposal preparation for graduate faculty while matching faculty with possible funding sources. UF's dean stressed the importance of graduate enrollment growth at those institutions whose mission encompasses graduate education and research and that funding for growth should account for the difference in costs between a doctoral and master's education and the differences in research funding required based upon the level of Ph.D. education. The deans unanimously called for more state funds to build and enhance the quality of graduate and research programs.

Research and Development

As part of this study on graduate education, a survey was sent to the ten SUS research vice-presidents to 1) ascertain what key research initiatives at the institutions have led to collaborative partnerships with business and industry that have resulted in increased economic development and job opportunities in Florida, 2) determine the best examples of collaborative, statewide research/economic development activities among SUS institutions, 3) identify strategies that Florida should adopt to strengthen the state's research and development infrastructure and collaborative university/industry research partnerships, and 4) find out what the universities' key research leaders believe are the best ways to stimulate and support partnerships between universities and industry that will enhance the economy of Florida and support research critical to Florida's needs.

As the Commission has noted, graduate education is inseparable from university research and development. Academic research and

development (R&D) makes a vital contribution to the nation's well-being by advancing the frontiers of knowledge, by finding new cures and treatments for diseases, by helping to develop new technologies, and by training future generations of researchers and teachers. The economic impact of university R&D is irrefutable. The Association of American Universities estimates that in 1995, over 951,000 jobs were supported by academic R&D funding in the U.S. According to the Board of Regents, 16,000 jobs were created or supported in Florida by federal R&D dollars alone.

Based on its performance-based budgeting, the SUS expects its major research universities to generate at least three sponsored research dollars from outside the institution for each state dollar spent on research by faculty. The state's public and private universities generated almost $600 million in research and development activities in 1996, placing the state twelfth among the 50 states in total R&D expenditures at doctorate-granting institutions. (See Table 4). To meet the average R&D expenditures of the doctorate-granting institutions in the 11 states that exceed Florida's, however, federal expenditures would have to increase by 147 percent, state expenditures by 145 percent, industry expenditures by 161 percent and institutional expenditures by four percent. (See Tables 5 & 6). While the federal government was the largest source of university research expenditures (53%), Florida TaxWatch recently noted that the state ranks 49th in the amount of per capita aid received from federal grants. The organization noted that Florida's spending decisions, including the amount spent on matching programs, needs to be revised. Clearly, the state's research institutions could benefit by obtaining more support from business and industry and increasing technology transfer to the workplace. At the same time, as several vice presidents for research at the SUS institutions noted, the state could help increase the amount of federal awards by increasing the amount of matching funds available to the universities. There is some agreement that a more systemwide lobbying effort and unified presence in the nation's capital would lead to an increase in federal research dollars for Florida institutions.

The state's public and private universities generated almost $600 million in research and development activities in 1996.

University/Industry Partnerships

In *Challenges and Choices*, the Commission noted the importance of developing strategies between universities, business, and government to foster economic development and strengthen graduate education. In its recently completed Strategic Plan, the Board of Regents responds to this challenge by pledging to work with business and industry to foster partnerships and strategies that benefit the missions of the institutions and facilitate economic development in Florida. In addition, the BOR has directed its institutions to develop collaborative research strategies related to the main geographic corridors within Florida, particularly focused on interstate highways I-4, I-10, and I-95. As was noted in

Challenges and Choices, the Commission has recommended that the SUS identify needs of the state that are critical to improving the quality of life for all Floridians and engage in research activities related to these fields. Enterprise Florida has focused its resources and initiatives on six industries in which the state can compete effectively for new and improved job creation: Silicon technologies; aviation/aerospace; automotive; health technologies, computer simulation and training, and information technology. The SUS institutions are focusing on these and other key areas of research strength including materials science and environmental and agricultural sciences that will enhance economic competitiveness and improve Florida's quality of life. Currently, several institutions are partners in research alliances with private industry that focus on economic development activities.

SUS institutions are focusing on key areas of research strength to enhance Florida's economic competitiveness.

Each of the ten state universities has centers and institutes which work cooperatively with local, regional, and national agencies to provide applied research and development activities that benefit economic development and graduate education. Enterprise Florida works with individual institutions through quick response training grants, small business development centers, and innovation commercialization centers to link university expertise with business and industry needs. The organization's Technology Development Board is promoting increased funding for a technology development fund that would link Florida universities with private companies to conduct applied research. Under the fund, the state would match, by some formula, research grants from the private sector. However, the program has never been funded at more than $1 million per year. In comparison, other states with similar programs (e.g., Georgia, Texas) provide $25 to $30 million a year in funding. It is clear that the BOR needs to take a more active role in bringing the universities' research programs into the deliberations of Enterprise Florida, the organization established to enhance economic development in the state.

In order to better focus and coordinate the application of university resources to issues affecting Florida residents and elected officials, the 1998 Legislature created the Leadership Board of Applied Research and Public Service. The Board's mission is to help ensure that SUS applied research and public service are responsive to decision makers in state and local governments. In other words, the Board, chaired by SUS Chancellor Adam Herbert, will seek to link university resources and faculty expertise with policy makers to help solve problems critical to Florida's future well being. In just a few months of existence, the Board has created a standardized contract to be used between state agencies and universities, avoiding some of the pitfalls of delay, inconsistencies and duplication. The Board has plans to establish an Information Clearinghouse on available university resources and capabilities. The Board will also focus on identifying cost-effective opportunities for

expanding high-quality student internships in conjunction with applied research and public service activities. Clearly, the activities of this new board would benefit from coordination with the efforts of the SUS vice-presidents to create cooperative research alliances and link basic and applied research to economic development.

As part of the survey, the SUS Vice presidents for Research were asked to describe some key research initiatives with business and industry that have resulted in increased economic development in Florida. As might be expected, the larger research institutions provided the most evidence of such collaborations. Below are just a few examples of how graduate education and research are intertwined with economic development and job creation and expansion in Florida.

Graduate education and research are intertwined with economic development in Floirda.

Working with Enterprise Florida, the University of Florida helped develop the North Florida Technology Innovation Center that stimulates support of small businesses in the North Florida region. UF also created a unique Biotechnology Center at Progress Park using federal awards from the U.S. Department of Agriculture and the National Institutes of Health in which several start-up companies share space and facilities during their formative years exchanging equity for deferred rent. In addition, the university has also been active in licensing inventions to spin-off companies to take university technology to the market place for public good. The flexible terms of these licenses have allowed companies with limited capital to advance the technology using their capital which otherwise would have been paid in licensing fees to the university.

Florida State University has created an Office of Technology Transfer to proactively seek out situations aimed at achieving increased economic development and job opportunities in Florida. Technology transfer is, of course, an important performance measure related to university/industry relations and economic development. U.S. universities earned more than $446 million in royalties in 1997, a 33 percent increase over 1996. Faculty inventions placed FSU first among public universities in the U.S. in the amount of royalties earned in 1997. The top ten schools (including public and private) named in the seventh annual licensing survey done by the Association of University Technology Managers (AUTM) includes both FSU in fourth place and the University of Florida in seventh. FSU earned more than $29 million in royalties in 1997 thanks to the cancer-fighting drug Taxol. Royalties arise from the commercialization process, or technology transfer, which involves identifying discoveries made in academic research laboratories, patenting them, and licensing the patents to industry to enable them to be developed into commercial products. The AUTM estimates that $30 billion of economic activities and 250,000 jobs each year are attributable to commercializing academic innovations.

Much of the value-adding economic benefit of university technology transfer is migrating out of the South.

A recent report by the Southern Technology Council (1997) revealed that the pace of university-industry technology transfer is accelerating throughout the South, and that there is strong evidence that it is contributing significantly to national economic growth. Despite those positive trends, the report revealed that much of the value-adding economic benefit of university technology transfer is migrating out of the Southern region. That is, the majority of licensee companies are not based in the same state in which the university is located. The report noted that the nature of the regional economy—such as the concentration of R&D intensive firms—is more likely to influence the outcome of technology transfer rather than the willingness or ability of the university to transfer such technology. The University of Florida, Florida State University, the University of Central Florida, and Florida Atlantic University, were all well represented among the "benchmark" universities in the study that measured outcome measures such as licenses, patents, and royalties. However, the University of Florida was singled out as being "ahead of its peers" in measures pertaining to technology transfer.

The National High Magnetic Field Laboratory (NHMFL) in Tallahassee is a premier example of teamwork between UF and FSU to win the center that had for fifty years been operated by MIT. The economic and research output of NHMFL has fostered many research spin-offs. The connection with the UF Brain Institute in Magnetic Resonance Imaging for medical applications is one such example. The tobacco settlement dollars are being accessed by universities with FSU as lead collaborator/administrator for a series of research contracts aimed at youth education and research. The contracts include FSU and other SUS institutions as well as the University of Miami. The Southern Technology Applications Center provides information to the federal laboratory system of technology developed by SUS institutions and funded by NASA. The Gulf Coast Alliance for Technology Transfer is an alliance of programs from across the state that provides a forum to address issues related to development and transfer of technology to benefit the entire state.

Specific research interactions between FSU and a number of federal labs in northwestern Florida are in the planning stage. The preliminary goal is joint access to increased research finances, but a secondary goal is to strengthen linkages with local companies interacting with those federal labs to increase their competitiveness and employment in Florida. The survey respondents noted that the Strategic Plan accepted by the BOR will lead to greatly enhanced interactions with the private sector ranging from technology transfer licensing, retention of new spin off companies based on university technology, private sector contracts and grants, and activities with local chambers of commerce to attract research based companies. FSU has held its first meeting of its Council of Industrial Research Advisors (CIRS) to stimulate university/industry partnerships to, in part, increase student placements in local technology driven companies.

The University of South Florida has a strong and active commitment to developing industry partnerships that benefit graduate education and strengthen the local and state economy. The university has established major research partnerships with nearly two dozen businesses because of the success of the I-4 initiative. These businesses provide internships and employment opportunities for USF graduates. The University Technology Center is being developed to attract high-technology firms that interact with academic and research programs and with faculty, staff, and students to the south central area of Florida. At the university's research park, reciprocal industry/university projects support joint research and development activities. A Joint-Use Agreement was developed by the USF Office of Research in 1990 that allows Research Park tenants to avail themselves of USF resources while providing contracts, internships, and other associations with faculty and graduate students.

The USF Research Foundation, Inc. provides broad and flexible financial mechanisms in support of research operations, contracts, and grants and facilitates the commercialization of university inventions and works. Fifteen spin-off companies have formed over the past few years as a direct result of USF patents and technologies. Beginning in January 1999, the Division of Patents and Licensing will begin offering limited incubator space and services to start-up companies in the University Technology Center. Growth in external funding at USF has grown from $37 million in 1987-88 to $134.9 million in 1997-98, $53 million of which was received from private partnerships.

Support for more collaborative research efforts among universities has benefited economic development in Florida.

Support for more collaborative research efforts among universities has resulted in several initiatives that benefit economic development and graduate education while minimizing duplicity and maximizing resources. Such alliances are particularly advantageous in areas of intense competition for federal and private funding. The Florida Space Grant Consortium is a seven year old cooperative alliance of all of the SUS universities and several private colleges, universities and community colleges throughout the state that use NASA funds to foster research and education initiatives with Florida corporations engaged in space business. The consortium has led to many joint projects, including winning the NASA award for the Space Communications Technology Center. The center was one of two such centers in the U.S. funded by NASA. It performs research on satellite networks for transmission of high definition of video and digital information for commercial purposes.

The SUS vice presidents for research were asked what strategies Florida should adopt to strengthen the state's research and development infrastructure and what strategies should be undertaken to develop new university/industry collaborative research partnerships. While UF's vice president noted that the BOR's strategy of concentrating on the

enhancement of the research intensive universities is sound and should provide infrastructure that can service the needs of researchers at the less research-intensive universities in the state, FIU's vice president suggested that research and development money should be funneled into geographic areas where industry currently exists, i.e., to the large metropolitan universities. He noted that cheap land was an important consideration when developing new university/industry collaborative partnerships. The FIU Hemispheric Center on Environmental Technology redevelops "brownfields" (abandoned industrial sites) for productive use. Several industry spokespeople agreed that land, as well as transportation, water, utility rates, and a variety of incentives including university resources were all important considerations when relocating or expanding operations.

Institutional research foundations were identified as natural avenues to seek areas of mutual benefit. The UWF vice president suggested formalizing a communication network between SUS institutions and industry representatives to exchange ideas, share expertise, and cooperatively develop responses to state and national opportunities. He noted that it would be advantageous to develop a clearinghouse for information on programs in which SUS institutions and state agencies are working and to find matches of needs and resources for developing cooperative programs. Several survey respondents suggested that roundtable discussions between representatives from SUS institutions, business, industry and government on areas of mutual interest and concern would foster economic development and collaborative research partnerships.

A reactiviated Chancellor's Research Alliance could contribute to the development of research strategies and cooperative proposals in Florida.

The USF vice president noted that it would be quite advantageous to re-activate the research alliance that was initiated by previous SUS Chancellor Charlie Reed in 1997. Currently, the vice presidents are meeting on an ad hoc basis, but with BOR support and cooperation, this group could "contribute immensely to the development of research strategies and should be encouraged to do so by providing an audience at the BOR level." The vice presidents for research could serve as liaisons to their constituents at each university while the chancellor could serve as a conduit for further collaborations by relaying government initiatives that may impact research. During last session, the SUS vice presidents successfully pushed to have legislative language removed that impeded research collaboration between universities. Prior to the change, if two state agencies were collaborators on one proposal for funding; one would be selected as prime contractor, the other as subcontractor to the prime. While the prime would receive the 46 percent overhead rate on a federal government contract for the work it performed, the subcontractor would receive only an overhead rate on five percent on the work it performed. This financial disincentive to collaboration was removed thus paving the way for more collaborative brainstorming to identify other barriers to collaborative research activities.

The SUS vice presidents strongly agreed that Florida must continue to develop incentives for business and industry to encourage relocation and expansion here. As was noted in the background paper, the Legislature has passed a series of tax reduction bills in the last few years that are designed to lure and keep industry in Florida and to encourage reciprocal research activities with universities. Both the business and higher education communities have responded favorably to such incentives. Enterprise Florida, as well as other industry and higher education leaders, supports expanding existing sales tax exemptions on machinery and equipment in silicon technology research and development to all, or other research areas. Support exists for a legislatively appropriated incentive fund, a pool of new money that would be accessible by SUS institutions collaboratively engaged in research partnerships with industry. Such a fund exists in several other states. According to some vice presidents, if the state funded more applied research to augment basic research programs, the economic return would be substantial. What is really needed in Florida some analysts agree, is an infusion of private investment funds into emerging high-technology business and industry. Florida's poor track record in attracting venture capital hinders business expansion and negatively impacts economic growth. By raising the profile of university research and augmenting its transfer into the workplace, Florida's high tech industries may be able to attract badly needed private investment dollars to help expand their operations.

An infusion of private investment funds is needed to help emerging high-technology industries in Florida.

According to a recent study conducted by the University of South Florida's Office of Economic Development and College of Business Administration, tax breaks and other business incentives are not as important to high-technology companies considering locating or expanding in Central Florida as the availability of adequately trained workers and quality re-training programs. Currently, the dearth of information technology (IT) employees in some counties along the I-4 corridor is stifling business expansion in the area. The biggest perceived drawback to attracting business in the regions "is the lack of quality of education at the K-12 level." This sentiment was underscored by a representative of the Cirent Corporation at the Commission's Program Committee meeting in October, who noted that quality employees are needed at all levels of production in high-technology industry, not just at the Ph.D. scientist level. Currently, representatives of Cirent are working with the public schools and community colleges in Central Florida to improve access to high technology courses and careers. Clearly, the education and industry sectors have a joint interest in improving access to a quality, seamless system of education in Florida.

The lack of quality education at the K-12 level is hampering business expansion in some areas in Florida.

University research parks and affiliates are used by many states to assist their faculty in developing new companies as a means of marketing their new technologies. More than one SUS vice president for research noted that the State University System and the Faculty Union view faculty

A more comprehensive commericalization program in the SUS is needed.

entrepreneurism as negative instead of positive for the institution and consequently impede the process. While some SUS institutions have been successful in commercializing available technologies evolving from research, there is need for a more comprehensive commercialization program. The vice presidents overwhelmingly agreed that a major impediment to strengthening the state's R&D infrastructure is the requirement that the Legislature approve land and building purchases. For instance, the USF Research Foundation is attempting to purchase three buildings and several vacant lots in their affiliated research park. The university must wait until the Legislature convenes to obtain approval to buy the property although the BOR and the city of Tampa have approved the purchase.

Cooperative Research Initiatives

The SUS vice-presidents were asked if the creation of a mutual interest research alliance comprised of Florida's research universities, business community, and state government would lead to increased investment in sponsored research activity, enhance the transfer and applicability of scientific discovery and knowledge, and attract new high technology industry to the state. There was general agreement that such an alliance would be beneficial, but impediments to its success were noted. UF's vice president observed that the wide-ranging topics of commercial interest among the Florida corporations works against consensus. He suggested, however, that industry associations in certain business sectors may be a source of guidance about the type of state support to universities that would provide the best leverage to the sector as a whole. The biotechnology sector has been the most active in other states he noted, and the space sector is one in which Florida has strength due to the Kennedy Space Center and its movement from a launch center to a research center. Other vice presidents noted the size of Florida and its state universities would make a single alliance unwieldy but that regional alliances (such as the I-4 Corridor) might be more effective in managing university resources and expertise. Fears that an alliance might be micro-managed by the legislature or that a layer of bureaucracy would slow dealings with the federal government or private sector were noted. There was some optimism that with the right direction, momentum, will, and leadership, a research alliance would enhance economic development and sponsored research activity. The UWF vice president noted that the SUS institutions that are not classified as research universities often have meaningful direct and tangible links with business, government, and industry partners. The comprehensive universities are "uniquely situated to be in touch with trends, plans, and the developments in the business and industry communities." If these institutions were excluded from a research alliance, he added, the state would create confusion and missed partnership opportunities.

Survey participants made several suggestions as to how the state can best stimulate and support partnerships between universities and industry that would enhance the economy of Florida and support research critical to Florida's needs. The UF vice president observed that the state should provide funds earmarked for matching support of proposals to win federal research centers. Leveraging these federal funds provides a stimulus for the industry and the universities to get together. The selection process provides a filter that only the highest quality proposals can pass through, thereby assuring the relevance of the proposal. Besides tax incentives for industries that work with SUS institutions and state funding for enhanced initiatives to seek new research opportunities and partnerships, UWF's vice president noted that a statewide informational database or format to highlight individuals with knowledge and expertise in particular areas would be useful to other programs and researchers throughout the state. Replicate the I-4 corridor in other areas, FIU's vice president argued, but do not give up after four or five years. It takes two decades to gear up a hugely successful effort. The Legislature's patience he noted, lasts four to five years and then it tries to redirect more faculty effort back into the classroom. The best method for the state to stimulate and support industry/university partnerships FSU's vice president observed, is to use all of the tools at its disposal—taxes, zoning, water management, education, and legislative dollars— to "provide a clarion call, assemble the political will, and create the momentum to make it happen." The universities took a first step in 1998 toward identifying research strengths and activities that benefited economic development in response to legislation directing the Board of Regents to develop a performance based strategy for the SUS's contribution to the economic development of the state. While the BOR compiled an overview of each institution's contribution to the economy of the state that included recommendations for improving SUS research capabilities, there is still a need to identify what areas of university research excellence the state should focus on to enhance Florida's reputation and its position as a competitor for federal and private research dollars. Despite efforts to develop cooperative statewide research strategies, Florida universities largely still operate as autonomous research entities without the benefit of a mechanism or system for communicating information and sharing resources on research activities, interests, and resources.

A statewide information database on researchers and research activities in the SUS is needed.

The State must marshal all of its resources to stimulate and support industry/university partnerships.

The survey respondents were asked if the SUS would benefit from a more collaborative approach to obtaining sponsored research funds. Except for FAU's and FAMU's vice presidents for research, who were opposed to such an alliance, there was cautious support for an entity that would coordinate grants and proposals if the process did not force membership on the team for institutions that could not enhance the proposal. Forcing team memberships for institutions that had aspirations to be filed, but did not have current credentials, would be stifling to the type of writing that is needed to win in intense competitions, said UF's

vice president. It is important to remember, one respondent noted, that the successful teaming, as in the case of the Florida Space Grant Consortium, was done at the scientist level and nurtured through the research administration level with the incentive that SUS matching funds would raise the proposal above the threshold of visibility versus other proposals from other states. It was agreed that matching funds from the state is an essential key in winning federal grants through a consortium or institutional effort. It would be important, respondents warned, that persons very knowledgeable of the research processes staff any type of research alliance. It is clear that a research alliance would not supersede individual or institutional research activities but would be most effective in managing research proposal and grants in certain key high visibility areas in which the state is an acknowledged leader.

SUMMARY AND RECOMMENDATIONS

Graduate Education

- Graduate education is inexorably linked to the state's economic well-being.
- Florida lags behind the national average in the per capita production of graduate degree recipients.
- Florida had the ninth highest graduate enrollment in the nation in 1995.
- The percentage of SUS graduate students enrolled in academic fields deemed most relevant to the needs of high technology business and industry is comparable to the enrollment percentage of the top ten "economically sound states."
- Graduate enrollment at the state's only AAU institution ranks far below the average of the top ten AAU public universities.
- The number of minority graduates in sciences and engineering needs to be increased.
- The SUS does not have a systemwide method for tracking the career success of its institution's advanced degree holders.
- Nationwide, graduate student enrollment has dropped for two years in a row.
- According to some industry spokespersons, Florida is developing a reputation for exporting more talented high-tech graduates than it retains.
- The number of Ph.D.s in the life sciences exceeded the jobs available to them in academic, government, and industry in 1998.
- The job market for Ph.D.s in the humanities continues to be weak.
- There is no national consensus for developing a strict accountability between graduate enrollment and supply and demand.
- The BOR conducts program reviews of each academic discipline every seven years. BOR staff recommended approval of approximately 40 percent of graduate programs submitted for inclusion in the SUS Strategic Plan for 1998-2003.
- Florida's inadequate funding for fee waivers, stipends, fellowships and other incentives undermines competition for graduate students with other states' universities and adversely affects the mission of the research universities.
- Fee waivers have not been funded based on growth in seven years. The 1996-97 fee waiver allocation ($34,938,334) fell short by some $9 million.
- The BOR's plan to classify the ten state universities by mission would allow the Research I institutions to increase graduate enrollment and, with legislative approval, receive additional state funding to support graduate education and research.
- A majority of SUS graduate deans agreed that Florida is experiencing a "brain drain" among segments of its highly trained graduates, particularly in the engineering and science fields.
- Technology transfer between university and industry in Florida should be enhanced.
- More opportunities for internships in graduate education are needed.

Florida's inadequate funding for fee waivers and other incentives undermines competition for top graduate students.

- There is a need to strengthen and expand certain graduate programs in Florida to maximize economic development and diversification and prepare students for the 21st century workforce.
- Economic development is just one of the factors to be considered in program and curriculum design.
- Collaborations between and among SUS institutions and private business and industry for securing internships, stipends, and employment for advanced degree holders should be expanded.

Recommendations:

1. ***The Legislature should provide adequate funding to SUS institutions for graduate stipends and fee waivers to ensure Florida's competitiveness with out-of-state institutions. The universities should ensure that those funds are effectively managed with outside grants to maximize available resources for supporting graduate incentive packages. Complete information on the sources of all graduate waivers and stipends should be routinely provided by the universities to the BOR to be used in budget planning and development.***

2. ***The BOR, in conjunction with the Council of Graduate Deans, should develop a systemwide method for tracking the career success of its institutions' advanced degree holders.***

3. ***The Council of Graduate Deans should work closely with Enterprise Florida and industry leaders in Florida to determine if additional graduate programs need to be created or if existing programs should be expanded and/or restructured to prepare students for the 21st century workforce and to meet existing unmet needs in industry throughout the state. Graduate enrollment increases should be limited to those institutions whose mission encompasses graduate education and research.***

4. ***The State University System should establish a web-based site to link graduate students with internship opportunities in government, business, and industry.***

5. ***The Board of Regents, in consultation with the Council of Graduate Deans, should identify strategies, including financial incentives, for increasing the number of minorities enrolling in and receiving M.A.s and Ph.D.s in the sciences and engineering. The Board should set a policy goal that includes the recruitment of minority students into graduate level science and engineering programs that meets or exceeds the national average of minority enrollments in these programs.***

Research and Development

- Academic R&D makes a vital contribution to the nation's well-being by advancing the frontiers of knowledge, by finding new cures and treatments for diseases, by helping to develop new technologies, and by training future generations of researchers and teachers.
- Florida's public and private universities generated almost $600 million in research and development activities in 1996, placing the state 12th nationwide in total R&D expenditures at doctorate-granting institutions. To meet the average expenditures of the states that exceeded Florida's (eight of which have smaller populations) federal, state, and industry expenditures would have to increase by approximately 150 percent.
- In its Strategic Plan, the BOR pledged to work with business and industry to foster partnerships and strategies that facilitate economic development in Florida.
- The BOR has called on state universities to develop collaborative research strategies related to the main geographic corridors within Florida.
- Enterprise Florida and the SUS have identified industries and corresponding areas of research strength in which the state can most compete effectively for new and improved job creation.
- Cooperation and coordination between Enterprise Florida and the SUS institutions need to be enhanced in order to maximize research and development projects, economic development activities, and job opportunities for advanced degree holders.
- The 1998 Legislature created the Leadership Board of Applied Research and Public Service to help ensure that SUS applied research and public service activities are responsive to decision makers in state and local government.
- SUS institutions have instigated technology transfer efforts to increase economic development and job opportunities in Florida. Some are collaborative alliances that are particularly advantageous in areas of intense competition for federal and private funding.
- SUS vice presidents for research recommend different strategies for strengthening the state's research and development infrastructure but agree that it would be advantageous to develop a formalized communication network with BOR support to facilitate the development of research strategies and cooperative R&D efforts.
- Support exists for a legislatively appropriated incentive fund, a pool of new money that would be accessible by SUS institutions collaboratively engaged in research partnerships with industry.
- Private out of state investment in high technology businesses and industries in Florida must be increased in order to facilitate economic expansion and competition.
- According to a recent USF study, the biggest perceived drawbacks to attracting business along the I-4 Corridor is the lack of quality education at the K-12 level and the dearth of adequately trained information-technology employees. Clearly, the education and industry

The BOR has called on state universities to develop collaborative research strategies.

Private investment in high technology businesses and industries in Florida must be increased.

sectors have a joint interest in improving access to a quality, seamless system of education in Florida.

- According to the SUS Vice Presidents for Research, there is a need for a more comprehensive commercialization program within the SUS to enhance available technologies evolving from university research.
- Interest exists for the establishment of a mutual interest research alliance composed of Florida's research universities, business community, and state government to increase investment in sponsored research activity, enhance the transfer and applicability of scientific discovery and knowledge, and attract new high technology industry to the state.
- A statewide database providing information on research expertise, resources and interests is needed to highlight R&D capabilities and augment cooperative opportunities throughout the SUS.
- There is still a need to identify what areas of university research excellence the state should focus on to enhance Florida's reputation and its position as a competitor for federal and private research dollars.
- Florida universities largely still operate as autonomous research entities without the benefit of a mechanism or system for communicating information and sharing resources on research activities, interests, and resources.

There is still a need to identify focus areas of university research excellence.

Recommendations:

6. The Board of Regents should identify specific new strategies by which the universities can participate in enhancing the economic growth of the state. Such strategies should include: identifying and strengthening interactions that are being taken or can be taken by university-industry partnerships; identifying areas of research excellence that will allow the universities to more successfully compete for federal and private research funds; providing a web-based site for information on research activities within the SUS; matching needs and resources for developing cooperative research programs; developing actions designed to strengthen the transfer of university ideas and products to the marketplace; stimulating the establishment of businesses by professors; and, developing other actions necessary to bring the universities' research programs into the deliberations of Enterprise Florida.

7. The Board of Regents should reactivate the Chancellor's Research Alliance composed of the SUS Vice Presidents for Research and provide staffing for that body. The Alliance should be charged with, but not limited to, developing research strategies for the SUS such as: increasing the amount of government and private industry support for university research

and development; maintaining communication between the Board and the universities on government and industry issues affecting university research and development; initiating collaborations for increasing the state's research infrastructure and resources; establishing roundtable discussions and fostering interaction with Enterprise Florida, the Leadership Board for Applied Research and Public Service, and other business, industry and government leaders; and making recommendations to the Legislature for enhancing the state's economic well-being.

8. ***The Chancellor's Research Alliance, in conjunction with Enterprise Florida, should review existing laws, rules, and policies affecting economic development and university/industry partnerships and recommend the deletion or substitution of any regulations or requirements that are impediments to enhancing or strengthening the state's research and development infrastructure including securing venture capital from private and public sources.***

9. ***The Legislature should provide additional incentives to attract new high technology industry to Florida. Potential strategies include: extending the silicon technology research and development sales tax exemptions to other or all areas of university/industry research; providing incentive funds to the universities to develop collaborative research strategies related to the main geographic corridors within Florida; providing an incentive fund composed of new money that would be accessible by SUS institutions collaboratively engaged in research partnerships with industry; and, providing funds earmarked for matching support of proposals to win federal research funds and /or centers.***

TABLE 1
SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS
1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
ENGINEERING, GENERAL	**0**	**x**	**x**	**10**	**x**	**x**	**141**	**x**	**x**	**x**	**x**	**x**	**151**	**151**
MASTERS	0	x	x	5	x	x	141	x	x	x	x	x	146	**146**
DOCTORATE	x	x	x	5	x	x	x	x	x	x	x	x	5	**5**
AEROSPACE ENGINEERING	**8**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**x**	**8**	**9**
MASTERS	4	x	x	x	x	x	x	x	x	x	1	x	4	**5**
DOCTORATE	4	x	x	x	x	x	x	x	x	x	0	x	4	**4**
AGRICULTURAL ENGINEERING	**10**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**10**	**10**
MASTERS	6	x	x	x	x	x	x	x	x	x	x	x	6	**6**
DOCTORATE	4	x	x	x	x	x	x	x	x	x	x	x	4	**4**
CHEMICAL ENGINEERING	**13**	**3**	**0**	**9**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**x**	**25**	**26**
MASTERS	10	3	0	6	x	x	x	x	x	x	1	x	19	**20**
DOCTORATE	3	0	x	3	x	x	x	x	x	x	0	x	6	**6**
CIVIL ENGINEERING	**65**	**10**	**9**	**27**	**8**	**x**	**4**	**13**	**x**	**x**	**5**	**5**	**136**	**146**
MASTERS	55	10	9	25	8	x	2	13	x	x	4	5	122	**131**
DOCTORATE	10	0	x	2	x	x	2	x	x	x	1	0	14	**15**
COMPUTER ENGINEERING	**22**	**x**	**x**	**37**	**25**	**x**	**18**	**10**	**x**	**x**	**9**	**0**	**112**	**121**
MASTERS	20	x	x	34	23	x	17	10	x	x	8	x	104	**112**
DOCTORATE	2	x	x	3	2	x	1	x	x	x	1	0	8	**9**
ELECTRICAL ENGINEERING	**78**	**13**	**0**	**38**	**18**	**x**	**49**	**13**	**x**	**x**	**29**	**12**	**209**	**250**
MASTERS	49	12	0	30	14	x	35	13	x	x	22	8	153	**183**
DOCTORATE	29	1	x	8	4	x	14	0	x	x	7	4	56	**67**

x indicates that degree program is not offered at the particular institution

TABLE 1
SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS
1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
OPTICAL ENGINEERING	**x**	**x**	**x**	**x**	**x**	**x**	**2**	**x**	**x**	**x**	**x**	**x**	**2**	**2**
MASTERS	x	x	x	x	x	x	2	x	x	x	x	x	2	**2**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
ENGINEERING MECHANICS	**12**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**12**	**12**
MASTERS	10	x	x	x	x	x	x	x	x	x	x	x	10	**10**
DOCTORATE	2	x	x	x	x	x	x	x	x	x	x	x	2	**2**
ENVIRONMENTAL ENGINEERING	**38**	**x**	**x**	**13**	**x**	**x**	**10**	**3**	**x**	**x**	**7**	**1**	**64**	**72**
MASTERS	33	x	x	13	x	x	10	3	x	x	7	1	59	**67**
DOCTORATE	5	x	x	x	x	x	0	x	x	x	x	x	5	**5**
INDUSTRIAL MNFCTRING ENG.	**x**	**7**	**7**	**5**	**x**	**x**	**9**	**5**	**x**	**x**	**x**	**6**	**33**	**39**
MASTERS	x	7	7	5	x	x	5	5	x	x	x	5	29	**34**
DOCTORATE	x	x	x	x	x	x	4	x	x	x	x	1	4	**5**
MATERIALS ENGINEERING	**56**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**56**	**56**
MASTERS	30	x	x	x	x	x	x	x	x	x	x	x	30	**30**
DOCTORATE	26	x	x	x	x	x	x	x	x	x	x	x	26	**26**
MECHANICAL ENGINEERING	**33**	**10**	**4**	**9**	**9**	**x**	**24**	**8**	**x**	**x**	**2**	**4**	**97**	**103**
MASTERS	27	6	4	9	3	x	17	7	x	x	1	2	73	**76**
DOCTORATE	6	4	x	0	6	x	7	1	x	x	1	2	24	**27**
NUCLEAR ENGINEERING	**26**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**26**	**26**
MASTERS	21	x	x	x	x	x	x	x	x	x	x	x	21	**21**
DOCTORATE	5	x	x	x	x	x	x	x	x	x	x	x	5	**5**

x = degree not offered

TABLE 1

SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS

1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
OCEAN ENGINEERING	**11**	**x**	**x**	**x**	**17**	**x**	**x**	**x**	**x**	**x**	**11**	**x**	**28**	**39**
MASTERS	9	x	x	x	12	x	x	x	x	x	11	x	21	**32**
DOCTORATE	2	x	x	x	5	x	x	x	x	x	0	x	7	**7**
SYSTEMS ENGINEERING	**41**	**x**	**x**	**x**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**42**	**42**
MASTERS	40	x	x	x	1	x	x	x	x	x	x	x	41	**41**
DOCTORATE	1	x	x	x	x	x	x	x	x	x	x	x	1	**1**
ENGINEERING MANAGEMENT	**x**	**x**	**x**	**32**	**x**	**x**	**x**	**x**	**x**	**x**	**10**	**x**	**32**	**42**
MASTERS	x	x	x	32	x	x	x	x	x	x	10	x	32	**42**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
BIOENG. & BIOMEDICAL ENG.	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**3**	**x**	**3**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	2	x	**2**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	1	x	**1**
TOTAL ENGINEERING	**413**	**43**	**20**	**180**	**78**	**x**	**257**	**52**	**x**	**x**	**75**	**31**	**1043**	**1149**
MASTERS	314	38	20	159	61	x	229	51	x	x	65	23	872	**960**
DOCTORATE	99	5	0	21	17	x	28	1	x	x	10	8	171	**189**
BIOLOGY	**x**	**13**	**1**	**5**	**x**	**13**	**7**	**13**	**x**	**x**	**3**	**7**	**60**	**70**
MASTERS	x	8	1	x	x	13	7	10	x	x	x	4	47	**51**
DOCTORATE	x	5	x	5	x	x	x	3	x	x	3	3	13	**19**
BIOCHEMISTRY	**8**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**8**	**8**
MASTERS	1	x	x	x	x	x	x	x	x	x	x	x	1	**1**
DOCTORATE	7	x	x	x	x	x	x	x	x	x	x	x	7	**7**

TABLE 1

SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS

1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
BOTANY	**8**	**x**	**x**	**7**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**15**	**15**
MASTERS	7	x	x	7	x	x	x	x	x	x	x	x	14	**14**
DOCTORATE	1	x	x	x	x	x	x	x	x	x	x	x	1	**1**
PLANT PATHOLOGY	**9**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**9**	**9**
MASTERS	1	x	x	x	x	x	x	x	x	x	x	x	1	**1**
DOCTORATE	8	x	x	x	x	x	x	x	x	x	x	x	8	**8**
MOLECULAR BIOLOGY	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**x**	**x**	**1**
MASTERS	x	x	x	x	x	x	x	x	x	x	1	x	x	**1**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
PLANT MOLECULAR CELL BIOLOGY	**6**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**6**	**6**
MASTERS	1	x	x	x	x	x	x	x	x	x	x	x	1	**1**
DOCTORATE	5	x	x	x	x	x	x	x	x	x	x	x	5	**5**
ECOLOGY	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**3**	**x**	**x**	**3**
MASTERS	x	x	x	x	x	x	x	x	x	x	3	x	x	**3**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
MICROBIOLOGY	**9**	**x**	**x**	**7**	**x**	**x**	**6**	**x**	**x**	**x**	**x**	**x**	**22**	**22**
MASTERS	4	x	x	7	x	x	6	x	x	x	x	x	17	**17**
DOCTORATE	5	x	x	x	x	x	x	x	x	x	x	x	5	**5**
ANATOMY	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**0**	**x**	**0**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	0	x	**0**

TABLE 1
SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS
1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
NEUROSCIENCE	**x**	**2**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**2**	**3**
MASTERS	x	0	x	x	x	x	x	x	x	x	x	x	0	**0**
DOCTORATE	x	2	x	x	x	x	x	x	x	x	x	1	2	**3**
ZOOLOGY	**9**	**x**	**x**	**9**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**18**	**18**
MASTERS	6	x	x	9	x	x	x	x	x	x	x	x	15	**15**
DOCTORATE	3	x	x	x	x	x	x	x	x	x	x	x	3	**3**
MARINE/AQUATIC BIOLOGY	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**6**	**12**	**x**	**18**
MASTERS	x	x	x	x	x	x	x	x	x	x	6	5	x	**11**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	7	x	**7**
ENTOMOLOGY	**19**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**19**	**19**
MASTERS	11	x	x	x	x	x	x	x	x	x	x	x	11	**11**
DOCTORATE	8	x	x	x	x	x	x	x	x	x	x	x	8	**8**
PHYSIOLOGY	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**0**	**x**	**0**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	0	x	**0**
BIOTECH RESEARCH	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**0**	**x**	**x**	**0**
MASTERS	x	x	x	x	x	x	x	x	x	x	0	x	x	**0**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
BIOLOGICAL/LIFE SCI., OTHER	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**10**	**x**	**10**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	10	x	**10**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**

TABLE 1
SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS
1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
TOTAL LIFE SCIENCES	**68**	**15**	**1**	**28**	**x**	**13**	**13**	**13**	**x**	**x**	**13**	**30**	**159**	**202**
MASTERS	31	8	1	23	x	13	13	10	x	x	10	19	107	**136**
DOCTORATE	37	7	x	5	x	x	x	3	x	x	3	11	52	**66**
MATHEMATICS	**13**	**7**	**x**	**13**	**6**	**3**	**x**	**x**	**x**	**x**	**x**	**4**	**42**	**46**
MASTERS	9	3	x	7	5	3	x	x	x	x	x	0	27	**27**
DOCTORATE	4	4	x	6	1	x	x	x	x	x	x	4	15	**19**
APPLIED MATH	**x**	**x**	**x**	**x**	**x**	**x**	**16**	**3**	**3**	**x**	**6**	**x**	**22**	**28**
MASTERS	x	x	x	x	x	x	16	3	3	x	3	x	22	**25**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	3	x	x	**3**
STATISTICS	**20**	**15**	**x**	**x**	**x**	**x**	**5**	**x**	**x**	**x**	**x**	**x**	**40**	**40**
MASTERS	14	14	x	x	x	x	5	x	x	x	x	x	33	**33**
DOCTORATE	6	1	x	x	x	x	x	x	x	x	x	x	7	**7**
TOTAL MATH	**33**	**22**	**x**	**13**	**6**	**3**	**21**	**3**	**3**	**x**	**6**	**4**	**109**	**119**
MASTERS	23	17	x	7	5	3	21	3	3	x	3	0	82	**85**
DOCTORATE	10	5	x	6	1	x	x	x	x	x	3	4	27	**34**
ASTRONOMY	**7**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**7**	**7**
MASTERS	4	x	x	x	x	x	x	x	x	x	x	x	4	**4**
DOCTORATE	3	x	x	x	x	x	x	x	x	x	x	x	3	**3**
ATMOSPHERE/METEROLOGY	**x**	**23**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**23**	**23**
MASTERS	x	15	x	x	x	x	x	x	x	x	x	x	15	**15**
DOCTORATE	x	8	x	x	x	x	x	x	x	x	x	x	8	**8**

TABLE 1

SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS

1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
CHEMISTRY	**37**	**19**	**8**	**7**	**5**	**x**	**x**	**3**	**x**	**x**	**3**	**12**	**79**	**94**
MASTERS	9	14	8	3	5	x	x	3	x	x	1	6	42	**49**
DOCTORATE	28	5	x	4	x	x	x	x	x	x	2	6	37	**45**
CHEMICAL PHYSICS	**x**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**1**
MASTERS	x	0	x	x	x	x	x	x	x	x	x	x	0	**0**
DOCTORATE	x	1	x	x	x	x	x	x	x	x	x	x	1	**1**
INDUSTRIAL CHEMISTRY	**x**	**x**	**x**	**x**	**x**	**x**	**4**	**x**	**x**	**x**	**x**	**x**	**4**	**4**
MASTERS	x	x	x	x	x	x	4	x	x	x	x	x	4	**4**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
GEOLOGY	**5**	**9**	**x**	**4**	**2**	**x**	**x**	**6**	**x**	**x**	**x**	**5**	**26**	**31**
MASTERS	5	3	x	3	2	x	x	6	x	x	x	1	19	**20**
DOCTORATE	0	6	x	1	x	x	x	x	x	x	x	4	7	**11**
OCEANOGRAPHY/MARINE SCI.	**x**	**8**	**x**	**19**	**x**	**x**	**x**	**x**	**x**	**x**	**16**	**x**	**27**	**43**
MASTERS	x	3	x	11	x	x	x	x	x	x	15	x	14	**29**
DOCTORATE	x	5	x	8	x	x	x	x	x	x	1	x	13	**14**
PHYSICS	**14**	**22**	**8**	**4**	**5**	**0**	**5**	**3**	**x**	**x**	**1**	**9**	**61**	**71**
MASTERS	5	16	8	4	4	0	2	3	x	x	1	6	42	**49**
DOCTORATE	9	6	x	x	1	x	3	x	x	x	0	3	19	**22**
GEOPHYSICAL FLUID DYNAMICS	**x**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**1**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
DOCTORATE	x	1	x	x	x	x	x	x	x	x	x	x	1	**1**

TABLE 1
SELECT GRADUATE DEGREES AWARDED BY FLORIDA INSTITUTIONS
1996-1997

DISCIPLINE AND DEGREE	UF	FSU	FAMU	USF	FAU	UWF	UCF	FIU	UNF	FGCU	FIT	UM	SUS	TOTAL
MOLECULAR BIOPHYSICS	**x**	**3**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**3**	**3**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
DOCTORATE	x	3	x	x	x	x	x	x	x	x	x	x	3	**3**
EARTH & PLANETARY SCIENCE	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**0**	**x**	**x**	**0**
MASTERS	x	x	x	x	x	x	x	x	x	x	0	x	x	**0**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	x	x	**x**
ASTROPHYSICS	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**1**	**x**	**x**	**1**
MASTERS	x	x	x	x	x	x	x	x	x	x	1	x	x	**1**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	0	x	x	**0**
MISCELLANEOUS PHYSICAL SCI.	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**4**	**x**	**4**
MASTERS	x	x	x	x	x	x	x	x	x	x	x	1	x	**1**
DOCTORATE	x	x	x	x	x	x	x	x	x	x	x	3	x	**3**
TOTAL PHYSICAL SCI.	**63**	**86**	**16**	**34**	**12**	**0**	**9**	**12**	**x**	**x**	**21**	**30**	**232**	**283**
MASTERS	23	51	16	21	11	0	6	12	x	x	18	14	140	**172**
DOCTORATE	40	35	x	13	1	x	3	x	x	x	3	16	92	**111**
TOTAL DEGREES AWARDED	**577**	**166**	**37**	**255**	**96**	**16**	**300**	**80**	**3**	**x**	**115**	**95**	**1530**	**1740**
MASTERS	391	114	37	210	77	16	269	76	3	x	96	56	1193	**1345**
DOCTORATE	186	52	0	45	19	x	31	4	x	x	19	39	337	**395**

TABLE 2
GRADUATE ENROLLMENT AT SELECT STATE UNIVERSITY SYSTEMS

1996-1997

TABLE 2

GRADUATE ENROLLMENT AT SELECT STATE UNIVERSITY SYSTEMS
1996-1997

STATE UNIVERSITY SYSTEM AND DISCIPLINE	GRADUATE ENROLLMENT (PUBLIC INSTITUTIONS AND DISCIPLINE)	DISCIPLINE ENROLLMENT AS A PERCENTAGE OF TOTAL GRADUATE ENROLLMENT
CALIFORNIA SUS	***94,836***	
EDUCATION	11,756	12%
ENGINERING	6,387	7%
LIFE SCIENCES	4,243	4%
MATHEMATICS	1,264	1%
PHYSICAL SCIENCES	3,358	4%
COMPUTER AND INFORMATION SCIENCES	1,896	2%
FLORIDA SUS	***36,560***	
EDUCATION	8,047	22%
ENGINERING	3,484	10%
LIFE SCIENCES	772	2%
MATHEMATICS	395	1%
PHYSICAL SCIENCES	1,254	3%
COMPUTER AND INFORMATION SCIENCES	754	2%
GEORGIA SUS	***28,106***	
EDUCATION	9,379	33%
ENGINERING	2,275	8%
LIFE SCIENCES	766	3%
MATHEMATICS	274	1%
PHYSICAL SCIENCES	577	2%
COMPUTER AND INFORMATION SCIENCES	924	3%
ILLINOIS SUS	***42,108***	
EDUCATION	8,283	20%
ENGINERING	1,560	4%
LIFE SCIENCES	740	2%
MATHEMATICS	486	1%
PHYSICAL SCIENCES	567	1%
COMPUTER AND INFORMATION SCIENCES	506	1%
MARYLAND SUS	***25,609***	
EDUCATION	3,834	15%
ENGINERING	1,462	6%
LIFE SCIENCES	896	3%
MATHEMATICS	296	1%
PHYSICAL SCIENCES	510	2%
COMPUTER AND INFORMATION SCIENCES	1,008	4%
MASSACHUSETTS SUS	***18,775***	
EDUCATION	4,333	23%
ENGINERING	2,264	12%
LIFE SCIENCES	618	3%
MATHEMATICS	227	1%
PHYSICAL SCIENCES	902	5%
COMPUTER AND INFORMATION SCIENCES	1,063	6%

TABLE 2
GRADUATE ENROLLMENT AT SELECT STATE UNIVERSITY SYSTEMS

1996-1997

continued....

TABLE 2
GRADUATE ENROLLMENT AT SELECT STATE UNIVERSITY SYSTMS

1996-1997

STATE UNIVERSITY SYSTEM AND DISCIPLINE	GRADUATE ENROLLMENT (PUBLIC INSTITUTIONS AND DISCIPLINE)	DISCIPLINE ENROLLMENT AS A PERCENTAGE OF TOTAL GRADUATE ENROLLMENT
MICHIGAN SUS	***46,737***	
EDUCATION	8,071	17%
ENGINERING	2,937	6%
LIFE SCIENCES	665	1%
MATHEMATICS	678	1%
PHYSICAL SCIENCES	818	2%
COMPUTER AND INFORMATION SCIENCES	881	2%
NEW YORK SUS	***58,759***	
EDUCATION	15,163	26%
ENGINERING	1,468	3%
LIFE SCIENCES	2,144	4%
MATHEMATICS	583	1%
PHYSICAL SCIENCES	1,429	3%
COMPUTER AND INFORMATION SCIENCES	1,470	3%
NORTH CAROLINA SUS	***27,271***	
EDUCATION	4,775	18%
ENGINEERING	1,558	6%
LIFE SCIENCES	1,452	5%
MATHEMATICS	531	2%
PHYSICAL SCIENCES	743	3%
COMPUTER AND INFORMATION SCIENCES	465	2%
OHIO SUS	***41,893***	
EDUCATION	9,685	23%
ENGINEERING	3,885	9%
LIFE SCIENCES	1,315	3%
MATHEMATICS	792	2%
PHYSICAL SCIENCES	1,776	4%
COMPUTER AND INFORMATION SCIENCES	634	2%
TEXAS SUS	***66,913***	
EDUCATION	16,852	25%
ENGINERING	5,990	9%
LIFE SCIENCES	2,188	3%
MATHEMATICS	925	1%
PHYSICAL SCIENCES	2,463	4%
COMPUTER AND INFORMATION SCIENCES	2,454	4%

TABLE 3
PERCENT OF TOTAL GRADUATE ENROLLMENT (AVERAGE AMONG SELECT STATE UNIVERSITY SYSTEMS)
1996-1997

TABLE 3
PERCENT OF TOTAL GRADUATE ENROLLMENT (AVERAGE AMONG SELECT STATE UNIVERSITY SYSTEMS)
1996-1997

DISCIPLINE	PERCENT OF TOTAL GRADUATE ENROLLMENT (AVERAGE OF SELECT STATES)	PERCENT OF TOTAL GRADUATE ENROLLMENT IN FLORIDA SUS
EDUCATION	21%	22%
ENGINEERING	7%	10%
LIFE SCIENCES	3%	2%
MATHEMATICS	1%	1%
PHYSICAL SCIENCES	3%	3%
COMPUTER AND INFORMATION SCIENCES	3%	2%

TABLE 4

RESEARCH AND DEVELOPMENT EXPENDITURES AT SELECT DOCTORATE GRANTING INSTITUTIONS BY SOURCE OF FUNDS* FISCAL YEAR 1996

[Dollars in Thousands]

State	Total	Federal Gov't	State/Local Gov't	Industry	Institutional Funds*	All other sources**
California-Pub	2,031,073	1,306,690	105,473	89,969	346,656	182,285
California-Priv	760,135	627,424	7,309	49,346	52,475	23,581
Total	2,791,208	1,934,114	112,782	139,315	399,131	205,866
New York-Pub	421,572	254,089	12,933	30,391	75,658	48,501
New York-Priv	1,298,611	855,497	66,110	64,280	152,715	160,009
Total	1,720,183	1,109,586	79,043	94,671	228,373	208,510
Texas-Pub	1,274,320	658,101	166,228	93,280	222,409	134,302
Texas-Priv	238,823	134,987	6,316	16,607	25,964	54,949
Total	1,513,143	793,088	172,544	109,887	248,373	189,251
Maryland-Pub	413,747	205,633	81,636	45,467	68,673	12,338
Maryland-Priv	798,468	710,119	2,322	12,388	30,668	42,971
Total	1,212,215	915,752	83,958	57,855	99,341	55,309
Pennsylvania-Pub	584,859	369,888	13,741	65,825	119,444	15,961
Pennsylvania-Priv	604,887	424,697	23,352	57,394	48,604	50,840
Total	1,189,746	794,585	37,093	123,219	168,048	66,801
Massachusetts-Pub	165,751	165,751	91,130	12,663	40,530	12,452
Massachusetts-Priv	1,008,569	736,333	4,084	82,427	101,521	84,204
Total	1,174,320	902,084	95,214	95,090	142,051	96,656
Illinois-Pub	433,408	218,949	41,183	23,366	123,687	26,223
Illinois-Priv	442,112	283,191	6,086	25,216	87,228	40,391
Total	875,520	502,140	47,269	48,582	210,915	66,614
Michigan-Pub	805,196	425,180	48,252	57,063	198,317	76,384
Michigan-Priv	2,921	1,202	0	1,593	97	29
Total	808,117	426,382	48,252	58,656	198,414	76,413

continued…

State	Total	Federal Gov't	State/Local Gov't	Industry	Institutional Funds*	All Other Sources**
N. Carolina-Pub	408,122	237,328	96,791	30,200	43,104	699
N. Carolina-Priv	317,566	205,476	5,845	55,494	20,991	29,760
Total	725,688	442,804	102,636	85,694	64,095	30,459
Georgia-Pub	489,075	189,565	53,995	52,661	189,587	3,267
Georgia-Priv	220,520	145,558	7,788	10,800	32,942	23,432
Total	709,595	335,123	61,783	63,461	222,529	26,699
Ohio-Pub	467,737	226,523	49,203	52,263	105,487	34,261
Ohio-Priv	187,796	144,314	4,623	11,944	14,926	11,989
Total	655,533	370,837	53,826	64,207	120,413	46,250
Florida-Pub	456,775	212,998	29,801	17,889	176,655	19,432
Florida-Priv	139,327	100,557	3,433	14,828	7,767	12,742
Total	596,102	313,555	33,234	32,717	184,422	32,174
Washington-Pub	505,113	361,502	11,356	39,329	76,573	16,353
Washington-Priv	N/A	N/A	N/A	N/A	N/A	N/A
Total	505,113	361,502	11,356	39,329	76,573	16,353
New Jersey-Pub	322,748	135,654	40,651	17,133	110,989	18,321
New Jersey-Priv	130,169	79,905	2,164	6,570	30,835	10,695
Total	452,917	215,559	42,815	23,703	141,824	29,016
Virginia-Pub	423,676	245,078	43,599	39,580	67,930	27,489
Virginia-Priv	24,365	14,057	0	7,781	99	2,428
Total	448,041	259,135	43,599	47,361	68,029	29,917
Connecticut-Pub	147,522	53,009	16,653	8,026	61,755	8,079
Connecticut-Priv	240,612	180,924	3,285	15,352	17,199	23,852
Total	388,134	233,933	19,938	23,378	78,954	31,931
New Hampshire-Pub	45,693	23,305	1,752	1,315	12,250	7,071
New Hampshire-Priv	52,945	39,682	2,081	2,571	2,774	5,837
Total	98,638	62,987	3,833	3,886	15,024	12,908
Delaware-Pub	54,154	29,509	2,410	2,964	13,074	6,197
Delaware-Priv	N/A	N/A	N/A	N/A	N/A	N/A
Total	54,154	29,509	2,410	2,964	13,074	6,197

SOURCE: ***Survey of Research and Development Expenditures at Colleges and Universities,*** National Science Foundation, 1996

***Institutional Funds** include related indirect costs that institutions spent for R&D activities.

****All Other Sources** include awards for R&D from nonprofit foundations and voluntary health agencies.

TABLE 5

FEDERAL OBLIGATIONS* FOR RESEARCH AND DEVELOPMENT IN FLORIDA
FISCAL YEAR 1995

[Dollars in Thousands]

Agency	Total**	Universities and Colleges	% of Total
Dept. of Agriculture	33,691	12,461	37%
Dept. of Commerce	29,084	3,682	13%
Dept. of Defense, research	115,173	28,234	25%
Dept. of Defense, total development	1,629,193	16,884	1%
Dept. of Energy	21,046	10,827	51%
Dept. of Health and Human Services	127,429	116,198	91%
Dept. of the Interior	14,195	3,124	22%
Dept. of Transportation	5,280	955	18%
Environmental Protection Agency	18,670	2,122	11%
National Aeronautics and Space Administration	356,445	17,734	5%
National Science Foundation	53,693	50,751	95%
	2,403,899	262,972	11%

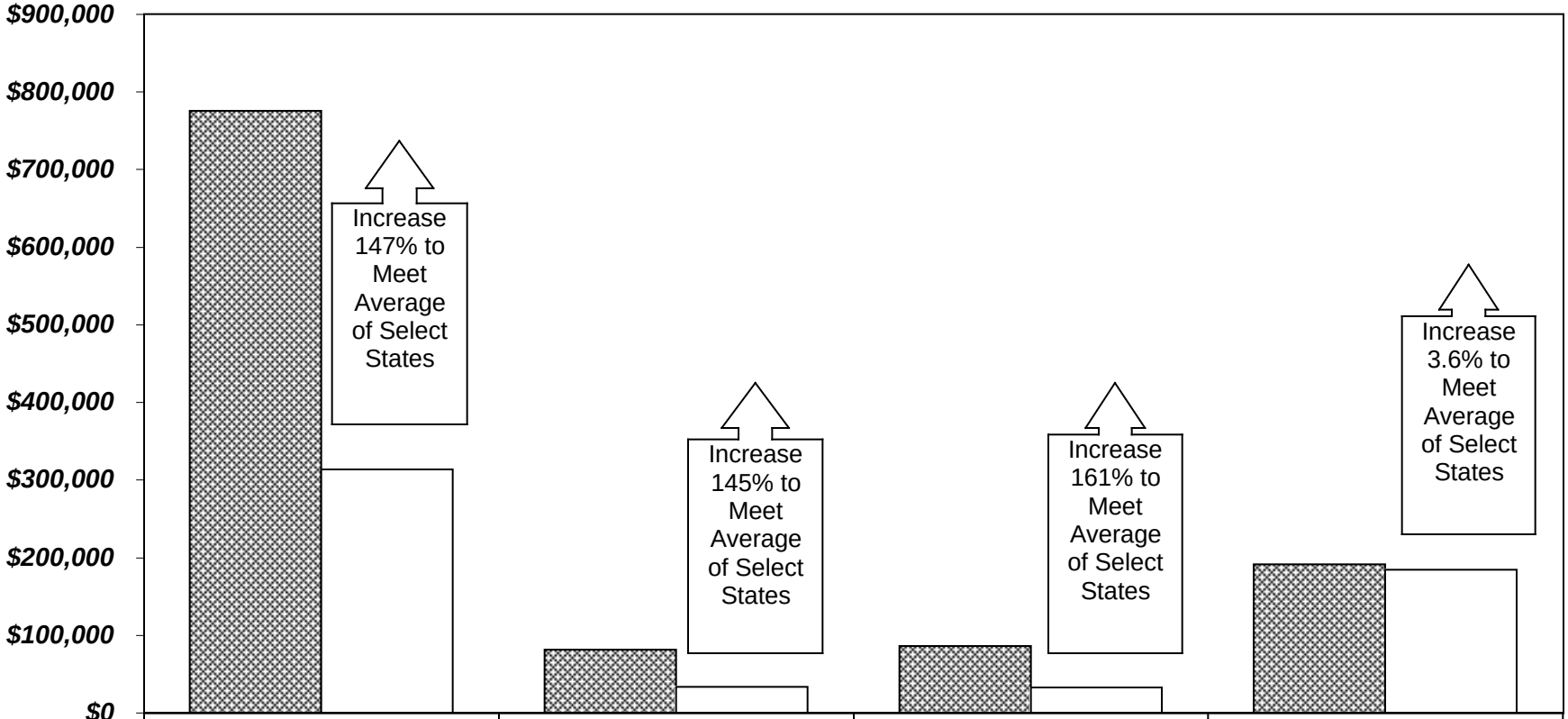
SOURCE: ***Federal Funds for Research and Development, Fiscal Years 1995, 1996, and 1997*** , National Science Foundation, 1997

*__Federal Obligations__ represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period.

**__Total__ includes federal obligations to Federal Agencies, Industrial Firms, Federally Funded Research and Development Centers, Non-profit Institutions, and State and Local Governments.

TABLE 6

AVERAGE RESEARCH AND DEVELOPMENT EXPENDITURES AT SELECT DOCTORAL GRANTING INSTITUTIONS* BY SOURCE OF FUNDS
FISCAL YEAR 1996



	Federal Expenditures	State Expenditures	Industry Expenditures	Institutional Expenditures
Average	$775,136	$81,309	$85,512	$191,062
Florida	$313,555	$33,234	$32,717	$184,422

*NOTE: Averages are computed using the expenditures of the 11 states that have total R&D expenditures greater than Florida's.

SOURCE: ***Survey of Research and Development Expenditures at Colleges and Universities,*** National Science Foundation, 1996