RAND

Achieving the Texas Higher Education Vision

Roger Benjamin, Stephen Carroll, James Dewar, Robert Lempert, Sue Stockly; Assisted by Anders Hove and Tatsuro Yoda

DRU-2305-CAE

June 2000

Prepared for Texas Higher Education Coordination Board

Council for Aid to Education

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PREFACE

The Texas higher education system faces severe challenges in responding to the twin demands placed on it by economic growth and by the increasing problems of access to higher education that many Texans experience. This report presents the results of analyses of how well the higher education system in Texas will likely meet these challenges if current trends and patterns continue. It identifies the kinds of changes needed to realign higher education in Texas with these demands. Specifically, we recommend that the Texas Higher Education Coordinating Board rethink its underlying goals, missions, and priorities, as well as differentiate more clearly among the missions of different parts of the higher education system. Such a fundamental effort will require a new effort for achieving the Texas higher education vision.

Because of the special concern for the Texas higher education system to meet the future needs for health care professionals, we conducted a separate analysis focusing on health care education programs, including those for physicians, nurses, and allied health professionals. We present the results of that analysis in a separate report, *Looking to the Future: Health Professions Education in Texas* (Richard Rettig, 2000, RAND: Santa Monica, California, DRU-2307).

This research was funded by the Texas Higher Education Coordinating Board. It is part of a larger body of research on the challenges that face higher education across the United States conducted by the Council for Aid to Education, an independent subsidiary of RAND. Further information on the Council for Aid to Education can be obtained at:

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1. INTRODUCTION

BACKGROUND

The Texas higher education system has experienced a sustained period of growth in the past fifty years. This growth during one of the most rapid periods of population growth in recent American history has accomplished much. There are many excellent programs throughout the system, Nobel Prize winners at the University of Texas at Austin and at the University of Texas Southwestern Medical School, and notable academic programs at community colleges, four-year institutions, and research universities.

The system has helped Texas achieve substantial and sustained intergenerational social and economic mobility. With only some exceptions, each new Texas generation has done better than the previous generation.

Now, however, the system is faltering, not responding well to the twin demands placed on it by economic growth in the state and by the increasing problems of access to higher education that many Texans experience. Realigning higher education in Texas with these demands will require rethinking its underlying goals, missions, and priorities, as well as differentiating more clearly among the missions of different parts of the higher education system. Such a fundamental effort will require a new effort for achieving the Texas higher education vision.

THIS STUDY

We explore the new effort needed through several separate analyses. These include analyses on:

Views of Texas leaders on the future questions regarding higher education. There are widely varying perspectives among educational, community, political, and business leaders about the future needs of Texas higher education. Nevertheless, the consensus that does exist suggests some goals to supplement those set by the Texas Higher Education Coordinating Board.

Student-related goals. Among the few areas of consensus among leading Texans and education officials of the state is for greater participation and success among all groups of students. Achieving these goals will require very large gains in entry and advancement rates.

Institution-related goals. The Coordinating Board seeks to improve the quality and scope of research conducted by Texas

institutions of higher education, as well as to improve the overall excellence of Texas colleges and universities. This will require the board to make several decisions regarding the goals and priorities, and differentiate among the missions, of each part of the system.

Health professions education. A growing population needs more health professionals. No new medical schools are needed at present but Texas does face a severe nursing shortage. More than 40,000 additional registered nurses are needed in Texas to match the national ratio of population to nurses. Further, half of the current number of Texas nurses will retire within 15 years. Because of the special concern for the Texas higher education system to meet the future needs for health care professionals, we conducted a separate analysis focusing on health care education programs, including those for physicians, nurses, and allied health professionals. We present the results of that analysis in a separate report, *Looking to the Future: Health Professions Education in Texas.*[1]

The appendices to this report describe our analysis of labor market needs in Texas, the modeling methodology we used to assess higher education's future prospects, state benchmarks in higher education, the processes we used to gauge the views of leading Texans on educational issues, and our data sources.

THE GOALS FOR TEXAS HIGHER EDUCATION

The Texas Higher Education Coordinating Board has set four goals for the state's higher education system. These include two student-related goals:

- Increasing *participation* in higher education from current enrollment levels reflecting 4.9 percent of all Texans[2] to 5.2 percent, the level prevalent in other big states, by 2010 and to 5.5 percent by 2015
- Increasing *success*, or the percentage of students enrolled in higher education who to complete the program in which they are enrolled.

The Board has also set two institution-related goals:

---

[1] Richard Rettig, 2000, *Looking to the Future: Health Professions Education in Texas*, RAND: Santa Monica, California, DRU-2037.

[2] The Board focused on participation rates for the total population to allow comparisons between Texas participation rates and those of other states. Statewide participation rates generally are available

- Improving the quality and scope of *research* conducted by Texas institutions of higher education, with a particular goal of establishing Texas as the third biggest recipient of federal research and development expenditures at institutions of higher education
- Improving the overall *excellence* of programs at Texas institutions of higher education, with particular goals of increasing the number of high-ranking public research universities, public liberal arts institutions, and academic programs.

Our discussions with leading Texans found widely varying opinions on the most pressing issues facing higher education in the state over the next decade. These discussions led us to identify two additional student-related goals for the system. These are:

- Reducing *disparities* among Texans in higher education participation and success, particularly by increasing the participation and success in higher education of Hispanics and African Americans
- Reducing *job deficits*, or the number of jobs for which there are not enough adequately trained workers.

2. DETERMINING FUTURE ISSUES FOR TEXAS HIGHER EDUCATION: THE DELPHI APPROACH

To help identify the major problems and issues of Texas higher education in the next fifteen years, we assembled groups of educational, community, political, and business leaders. We wanted to stimulate a group discussion so as to get a wider sampling of perspectives and concerns than usually develop from individual discussions. At the same time, we were aware of the limitations to group discussions, in which some participants may dominate the discussion while others may posture on behalf of their perceived constituency. Costs and timing problems also can limit the effectiveness of group discussions in a state as large as Texas.

To generate the benefits of group discussion while avoiding its limitations, we turned to the Delphi Approach. This methodology is explained in Appendix D. In the Delphi Approach, discussion leaders pose a written question to all group participants and ask for written responses. These responses are then circulated anonymously among group members so as to stimulate other perspectives from group members while avoiding domination of the group by any particular member. Group discussion under this approach continues by using the responses from one round of discussion as the basis for a subsequent set of written questions and responses.

Because this exercise can be done in writing, it can be done at the convenience of participants. Because our goal was not to seek a scientific sample of opinion, we encouraged participants to discuss this process with their colleagues and friends and to get their input as well, thus broadening the sources of discussion input.

An extensive list of possible participants in the Delphi Exercise was compiled through a series of interviews in Austin. Key staff at the Texas Higher Education Coordinating Board, the Offices of the Governor, the Lt. Governor, the Chairman of the Texas Senate State Education Committee, the Comptroller, the Legislative Budget Board, the Texas Workforce Commission, and the State Office of State Occupational Information Coordinating Committee all helped develop the list. A total of 347 contacts were generated for the master list. Of these, we selected 48 participants in Texas for this exercise, including leaders in education (17 candidates, of whom 12 participated in at least one round of the Delphi), local communities (11, of whom 10 participated), politics (10, of whom five participated), and business (10, of whom six participated). The question we posed to them was:

> You have it on unimpeachable authority that a time traveler will appear to you early in the new millennium. That traveler comes from 10 years in the future and knows everything you could possibly want to know about the situation surrounding higher education in Texas in the year 2010. You will get to ask that time traveler 10 questions about that future. The single drawback to this extraordinary situation is that the time traveler is mute. S/he can only nod yes or no to your questions. What are your 10 questions?

We compiled all the responses we received, circulated them anonymously among all participants, and then asked them, now that they had seen the questions everyone else had asked, if they wanted to change their questions. That is, their response to the second round was, again, a set of 10 questions for the time traveler. We conducted a third round, and asked them to cut their list of questions down to six (as a means of gauging their priorities).

A total of 33 people participated in one or more of the rounds with 24 (73%) participating in the final round. The final round yielded 66 questions that were identified by at least one participant as among the six most pressing questions facing higher education. There was scant consensus on these. Of the 66 questions posed by participants, less than half (30) were considered important by at least one member in each of two or more groups. It is these overlapping questions that are of most interest for our purposes and they are summarized for the final round of the Delphi in Figure 1. The ovals in the chart represent the four stakeholder groups. Areas included in two or more ovals represent questions that were asked by at least one member of each stakeholder group. The number in each area of the figure identifies the number of questions that were identified by at least one participant in each of the groups included in the overlapping area. For example, the number "4" appears in the overlap of the political and community ovals. That means there were 4 different questions that appeared on at least one political member's list and at least one community member's list, but did not appear on any education or business leader's list.

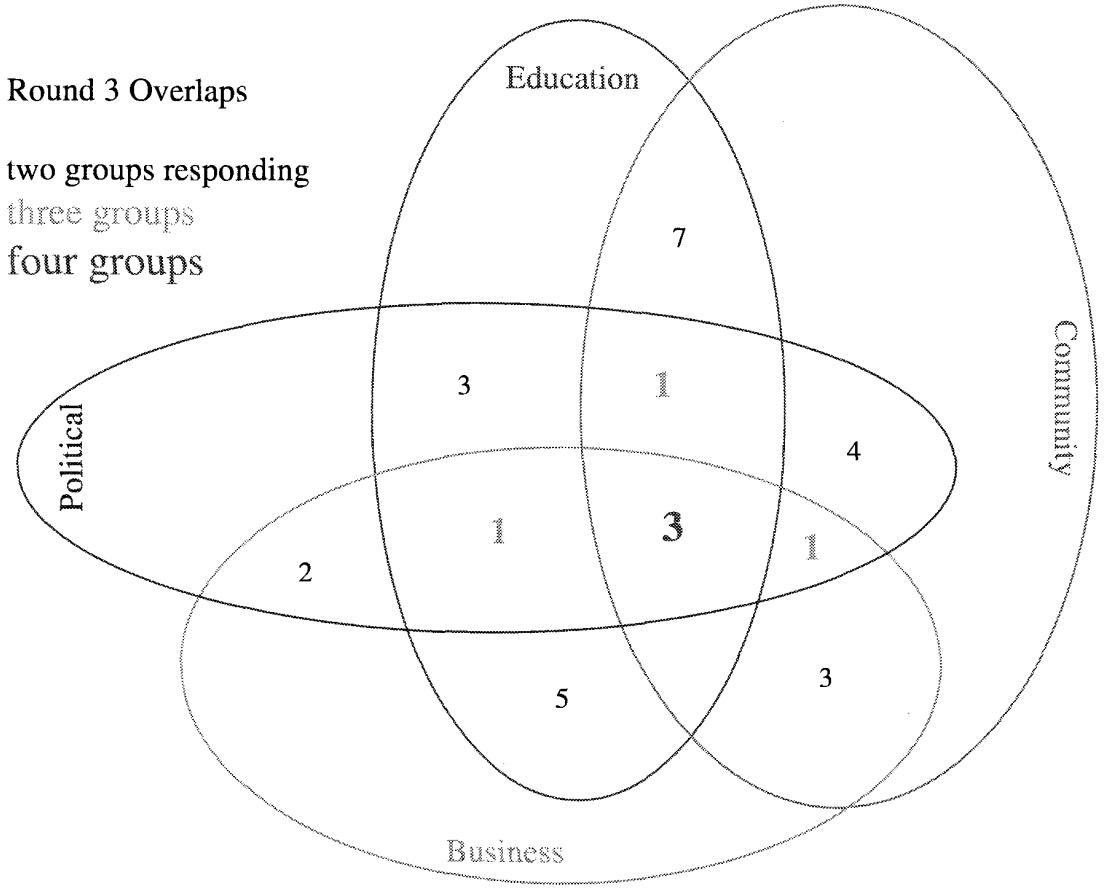

Figure 1—Little Consensus over Most Pressing Questions for Future of Texas Higher Education

From Figure 1, there were only three questions that appeared on the final list of at least one member in each stakeholder group. These questions thus represent the only ones that were among the top priorities in all four groups. The questions are:

> Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?
>
> Are all Texans who want to pursue a higher education degree able to secure the financial means and academic preparation to attend college?

> Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years, such that student bodies of undergraduate, graduate and professional schools reflect the state's population?

Surprisingly, only three other questions appeared in at least three of the stakeholder groups. One would have expected as many or more in *each* of the groups taken three at a time than in the overlap of all four groups. This suggests that the questions above represent a very important set of concerns.

The three questions that appeared in the lists of at least three of the stakeholder groups are:

> Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?
>
> Is the Texas higher education system receiving national/international recognition for its contribution to the state's innovative capacity and economic growth?
>
> Do the graduates being produced by Texas higher education reflect the actual workforce needs of both public- and private-sector employers in Texas?

In summary, the analysis of leading Texans' views of the future of higher education in the state found widely varying opinions on the most pressing issues facing higher education in the state over the next decade. Where there was consensus, however, it was striking and went beyond the Planning Committee's goals. This discussion led us to identify two goals for the system beyond those identified by the Planning Committee. These are:

- Reducing *disparities* among Texans in higher education participation and success, particularly by increasing the participation and success in higher education of Hispanics and African Americans
- Reducing *job deficits*, or the number of jobs for which there are not enough adequately trained workers.

3. MEETING STUDENT-RELATED GOALS

The Delphi analysis led us to add two student-related goals to those that the Texas Higher Education Coordinating Board had suggested. To analyze these goals and the prospects Texas has for meeting them, we developed a model for predicting educational success, costs, and job deficits. The details and flows of this model are shown in Figure 2.

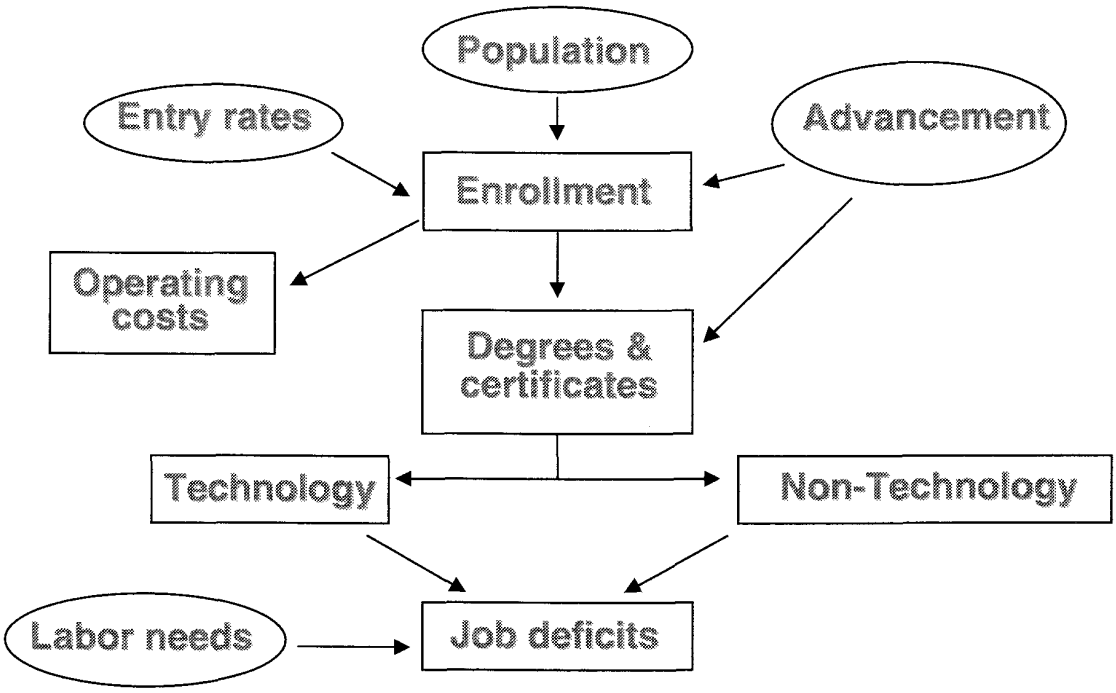

Figure 2—Modeling Texas Higher Education Needs

The model uses population projections and assumptions about entry and advancement rates to predict future enrollment. Future enrollment generates costs for the system that affect other goals for the system that we will discuss. Enrollment and advancement rates in turn affect the number of degrees and certificates that students will earn. We classify the degrees and certificates that students earn into two types, technology and non-technology. The number and types of degrees and

certificates that students earn combine with future labor needs to determine what will be future job deficits.

We used this model to identify educational needs and performance for different parts of the state and its population, running the model for population groups defined by race and ethnicity, sex, academic sector, and territory. We produced model results for 54 different populations defined by these categories, aggregating statewide results from results for each of these populations. We produced, for example, a model for Hispanic males at research universities in one of our three areas that would differ from the model done for African American females at a community college in a different area. Our three race and ethnicity categories included African Americans, Hispanics, and all others. Our three academic sector categories included Carnegie-defined research universities, other four-year institutions, and community and technical colleges.

AREAS OF TEXAS EMPLOYMENT AND HIGHER EDUCATION

We chose areas defined by demographics and labor market patterns, as shown in Figure 3. Territory 1 comprises those Workforce Development Areas where the Texas Workforce Commission projects there will be more than one hundred new technology-related[3] jobs every year through 2008 and where 1998 unemployment was below the statewide average of 4.7 percent. This area comprises the large urban areas of the state, including Dallas, Fort Worth, San Antonio, Austin, and Houston.

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[3] Appendix A lists "technology-related" occupations.

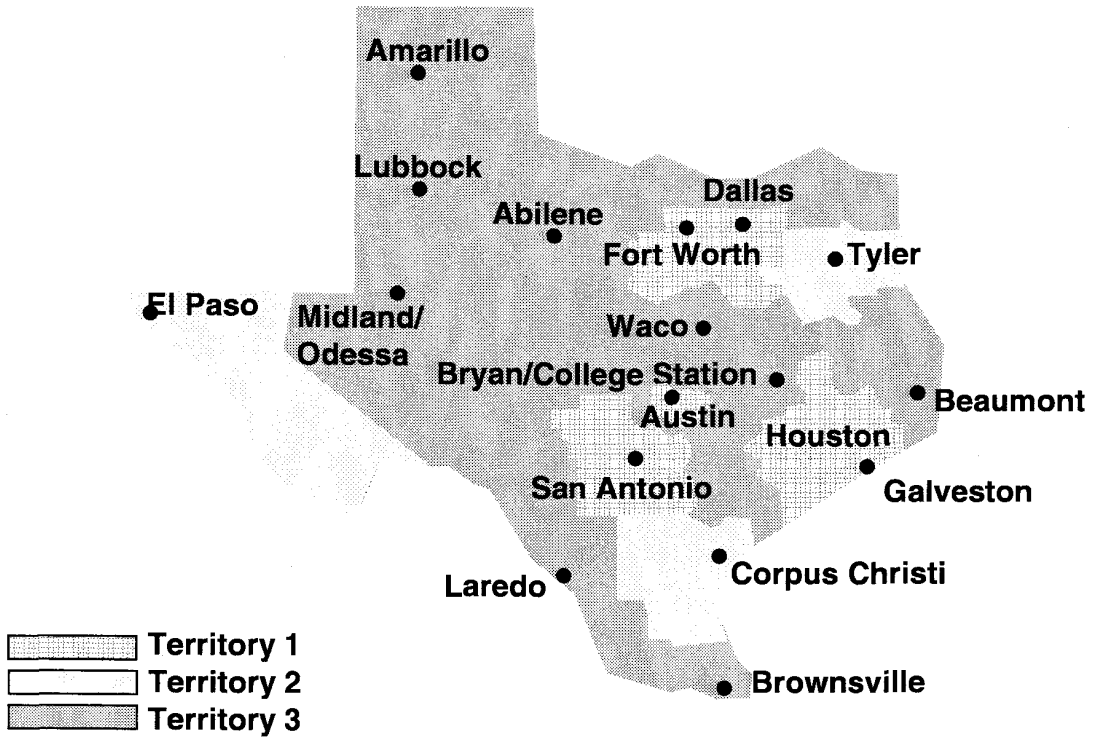

Figure 3—RAND Territories

Territory 2 comprises those workforce development areas where rapid technology-related job growth (i.e., more than one hundred jobs annually) is also expected to occur but where unemployment currently exceeds the statewide average. This area comprises areas near El Paso, Corpus Christi, and Tyler.

Territory 3 comprises the rest of the state, or those areas in which there is little or no projected growth of technology-related employment. This territory comprises much of the vast open rural area of the state, with relatively low population and little expected job growth of any sort. This territory also encompasses many border areas experiencing rapid population growth with little projected increase in technology employment.

Each of these territories is roughly similar to each other and to the whole state in its racial and ethnic composition, as shown in Figure 4. In dividing the state into areas defined by labor market criteria, we did not divide it into areas with substantial racial and ethnic differences.

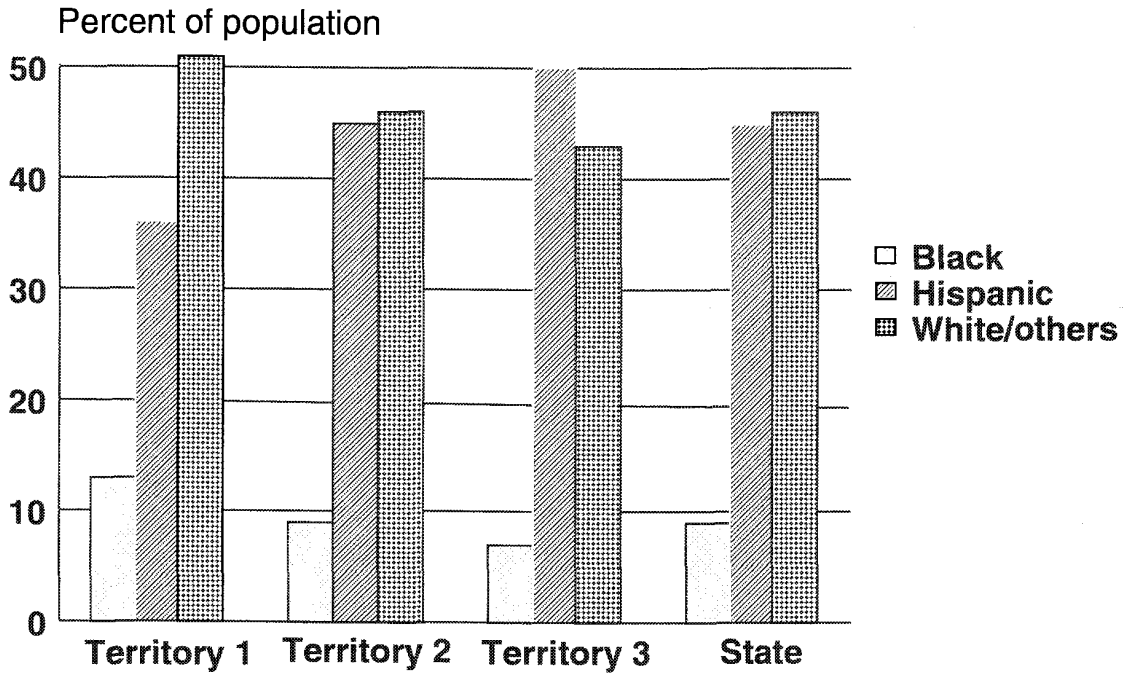

Figure 4–Estimated 1998 Population by Territory and Race/Ethnicity

Several caveats are in order regarding job deficits and job growth in these areas. There is not an exact match between a given job and its putative qualifications. Jobholders in a given field may have few common degrees, and a given degree can lead to several different jobs.[4] Occupational forecasts can be wrong. State-level occupational forecasts, for example, frequently fail to get the direction (e.g., positive or negative) of job growth right, much less the magnitude. Finally, however, the Texas economy is growing at a great rate, and the Texas higher education system can expect a stiff challenge both in producing the graduates the economy will need and in inducing higher

[4] The Bureau of Labor Statistics, for example, identifies six different degrees that lead to the occupation of computer programmer. Conversely, the Bureau notes that a degree in "computer programming" can lead to twenty different occupations. Furthermore, workers may enter or hold a job in a field without a formal degree qualifying them for it; two in five computer programmers, for example, lack a bachelor's degree, and many with such a degree hold it in fields such as history or music.

participation and success rates among Hispanic and African American young adults.

MEETING PARTICIPATION AND SUCCESS GOALS

How can the Texas higher education system meet its overall goals in producing the graduates the economy will need? How will these affect other overall system goals? We address these questions by examining the implications of entry rates and advancement rates for the participation, degree, and cost goals of the system.

Figure 5 shows that sharp increases in entry rates are needed to achieve overall participation goals.

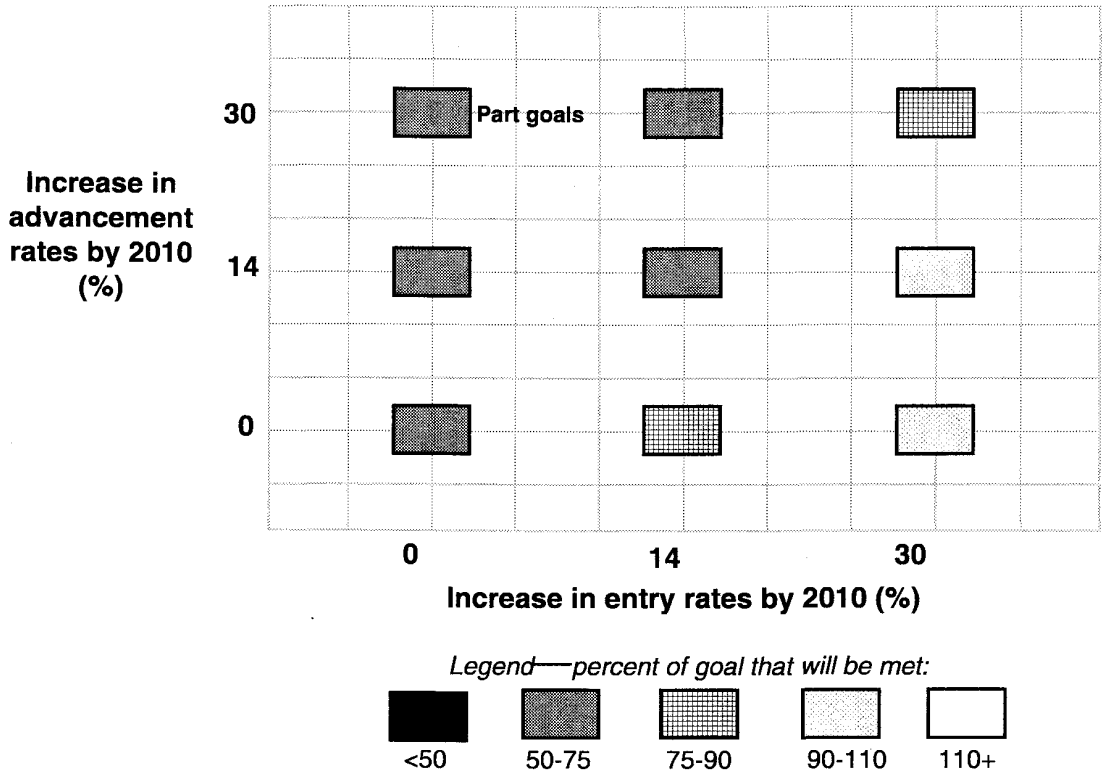

Figure 5—Sharp Increases in Entry Rates Are Needed to Achieve Participation Goals for All Students

Should the current rates of entry (the fraction of the population that enters a higher education institution in a given year) and

advancement (the rate at which enrolled students accumulate credits toward a certificate or degree) through higher education persist, Texas would achieve less than 75 percent of the ambitious goal set by the Texas Higher Education Coordinating Board for participation in higher education. Increasing entry rates is more important to meeting participation goals than increases in advancement rates. A large increase in the entry rate will see Texas meet its participation goal regardless of changes in the advancement rate. Increasing advancement rates alone will not help Texas meet its goal for participation.

Increases in the advancement rate can adversely impact the participation rate as defined by the Coordinating Board. If students move through the system more quickly, they are counted among those attending a higher education institution in fewer years.

Figure 6 shows advances in either advancement or entry rates will help Texas meet its success or degree goals. We define degree goals in terms of the proportion of students who complete their studies and achieve their intended goal of certification or a degree. If entry or advancement rates remain unchanged, we estimate that Texas will reach less than 75 percent of its degree goal in 2010. If advancement rates increase by 30 percent, we estimate that Texas will exceed its degree goals even if entry rates remain unchanged.

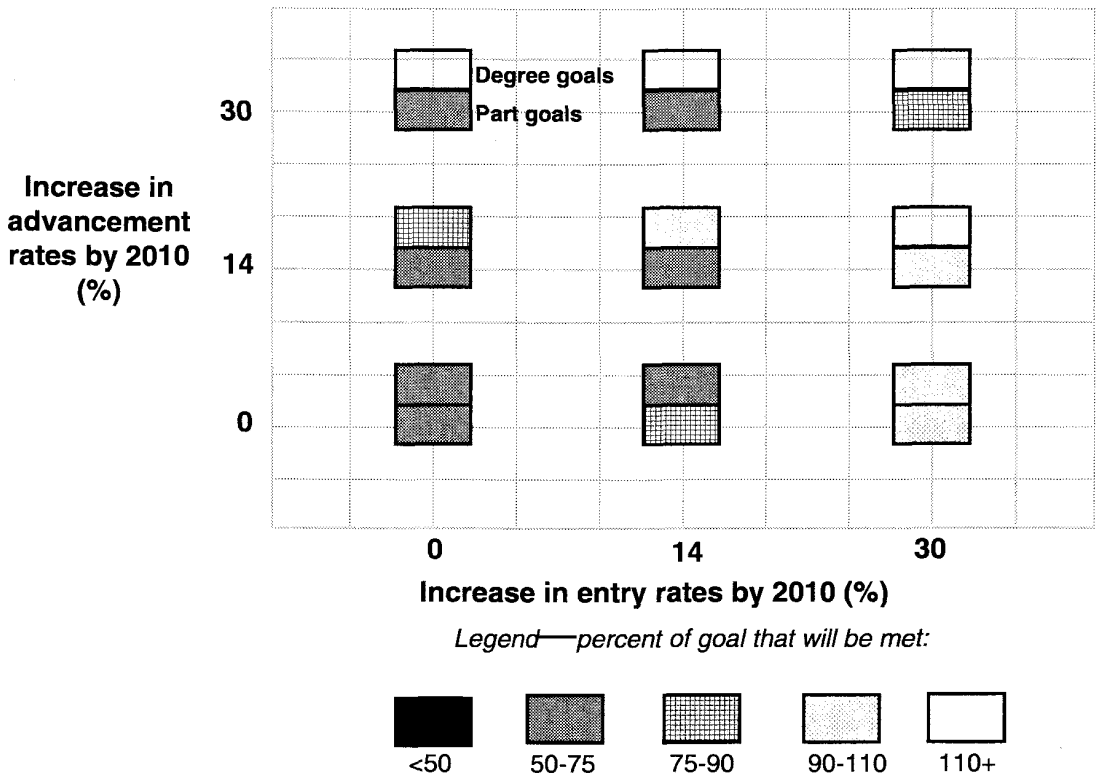

Figure 6—Increases in Either Advancement or Entry Rates Will Achieve Degree Goals for All Students

Increasing entry rates can help Texas meet its participation and degree goals, but they will affect adversely system costs. Bringing more students into the system will cost more money. Over the last two decades, state support for higher education in Texas, adjusted for inflation,[5] grew at an average annual rate of two percent per year. Because this period included a wide range of economic conditions ranging from depression to rapid growth, with the consequent effects on the state's budget, it seems unlikely that much greater increases can be expected in future years. Accordingly, we assume that Texas will not be

[5] We used the Higher Education Price Index (HEPI) to adjust for inflation. The HEPI is defined in much the same way as the Consumer Price Index, but as a price index for the particular goods and services purchased by institutions of higher education.

able to increase state support for higher education by more than two percent annually, on average, in real terms over the next decade.

Such increases will not be enough to cover the costs incurred by higher entry rates. Figure 7 shows that a 14 percent increase in entry rates, with no increase in advancement rates, will see the system achieve less than 90 percent of its implicit cost goal, or maintaining current per student spending with an annual two percent increase in real total spending on higher education. A large increase in entry rates will see the system achieve less than 75 percent of its implicit cost goal. Higher advancement rates mean that students move through the system more rapidly and consume fewer resources.

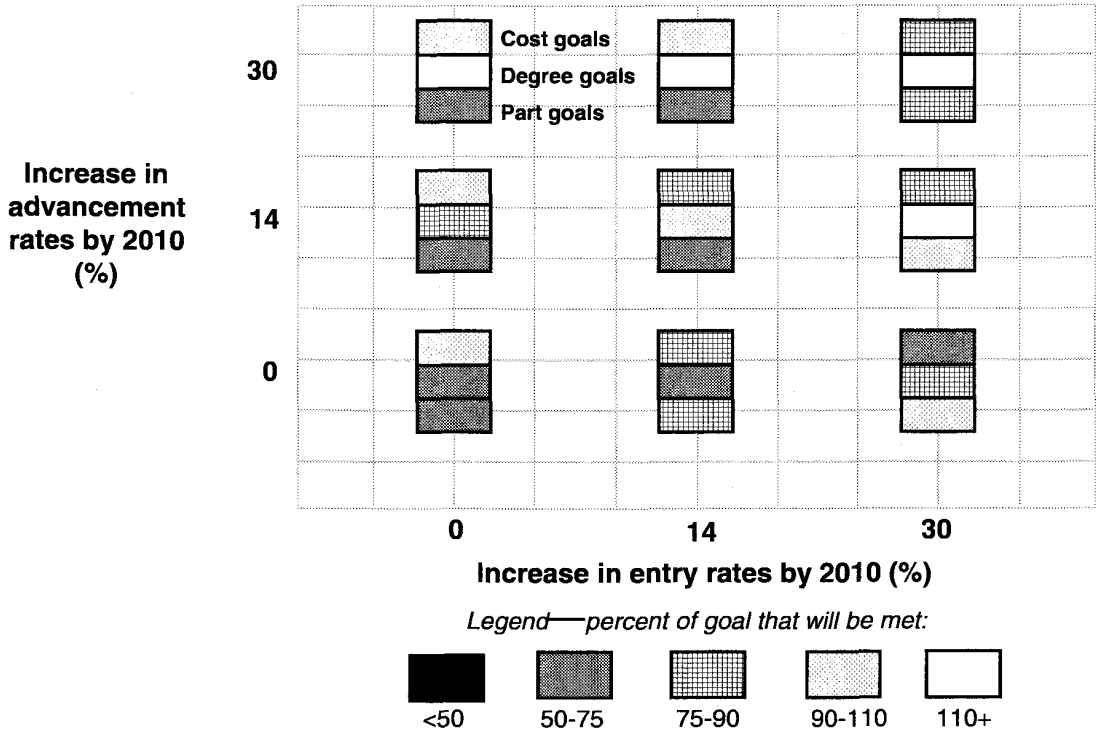

Figure 7—Sharp Increases in Entry Rates for All Students Will Drive Costs Above Implicit Targets

In sum, in order to meet participation goals, entry rates must increase substantially, by 30 percent above their current levels. Degree or success goals are more manageable; these can be achieved with more modest increases in entry or advancement rates. Increases in entry

rates, however, which are crucial to meeting participation goals and can help make advancement goals more manageable, will likely see system costs increase at rates faster than those at which the state makes funds available to higher education.

REDUCING DISPARITY AND IMPROVING PARTICIPATION AND SUCCESS FOR HISPANICS AND AFRICAN AMERICANS

The increases needed to meet participation and success goals for Hispanic and African American students are much greater than those needed to meet the goals for all students. If, for example, advancement rates for Hispanics remain unchanged, their entry rates will have to increase by 60 percent, as Figure 8 shows, in order to exceed the participation goal for Hispanic students in 2010. Our models for African American students show similar results.

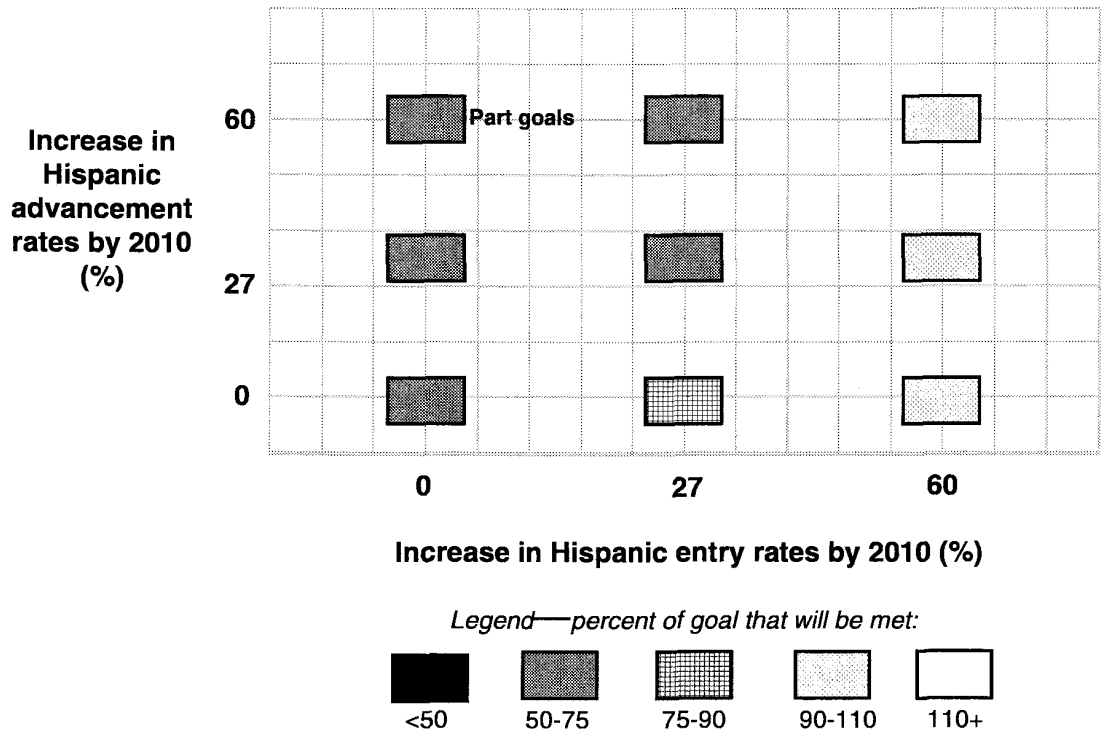

Figure 8—Sharp Increases in Hispanic Entry Rates Are Needed to Achieve Participation Goals

For both Hispanic and African American students, very large increases in both entry and advancement rates are needed to reach degree goals. Figure 9 shows the effects of increases in entry and advancement rates on Hispanic students in meeting statewide degree goals. If entry and advancement rates for Hispanic students remain unchanged, in 2010 they will reach less than 75 percent of the statewide success goal. Entry rate increases alone will not be enough for Hispanic students to reach statewide degree goals. Even a 60 percent increase in entry rates, for example, if unaccompanied by an increase in advancement rates, will leave them at less than 75 percent of the statewide degree goals. Increases in advancement rates will help them more in reaching degree goals. A 60 percent increase in advancement rates will help them match statewide goals, even if entry rates remain unchanged. The results for African American students are similar.

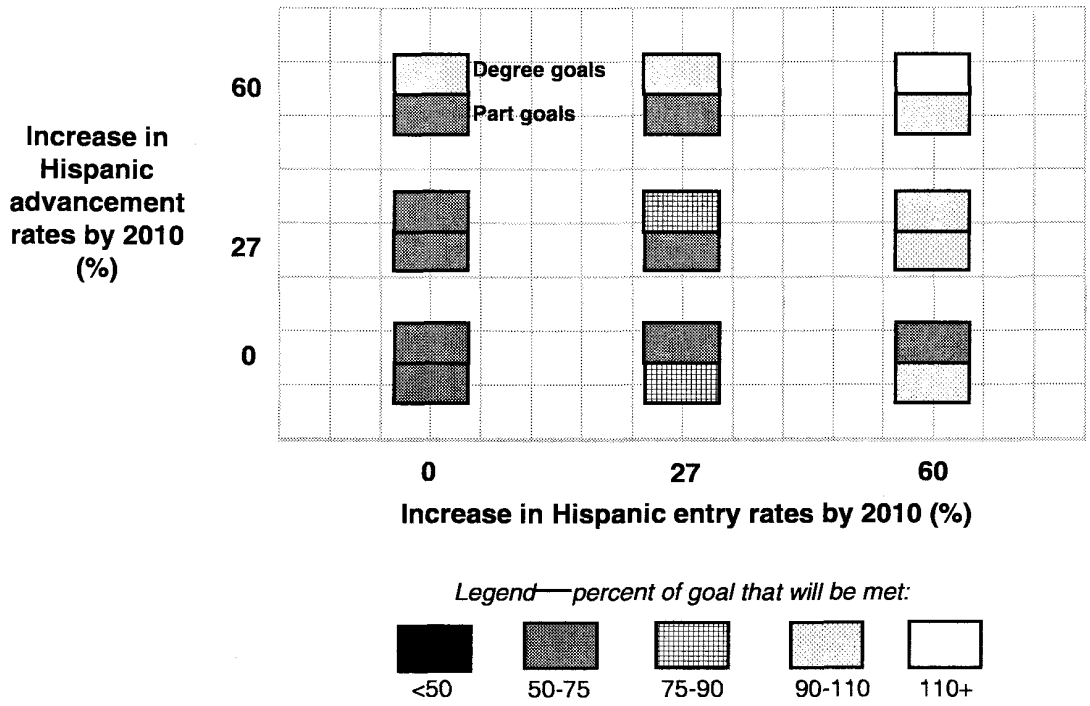

Figure 9—Sharp Increases in Hispanic Advancement or Entry Rates Are Needed to Achieve Degree Goals

While very large increases are needed in entry and advancement rates for African American and Hispanic students to reach participation

and degree goals, these increases, if attained, will not affect the implicit cost goals of the system. This is because Whites comprise a very large majority of Texas higher education students. Increasing entry and advancement rates for the small number of Hispanic or African American students will have little effect on costs if White entry and advancement rates remain unchanged. In fact, as Figure 10 shows, only a 27 percent increase in entry rates for Hispanic students will keep the system from matching its implicit cost goals, and then only if Hispanic advancement rates remain unchanged. Even in the face of such monumental increases, the system still reaches between 75 and 90 percent of its implicit cost goals. Similar increases in entry and advancement for African American students also produce manageable costs.

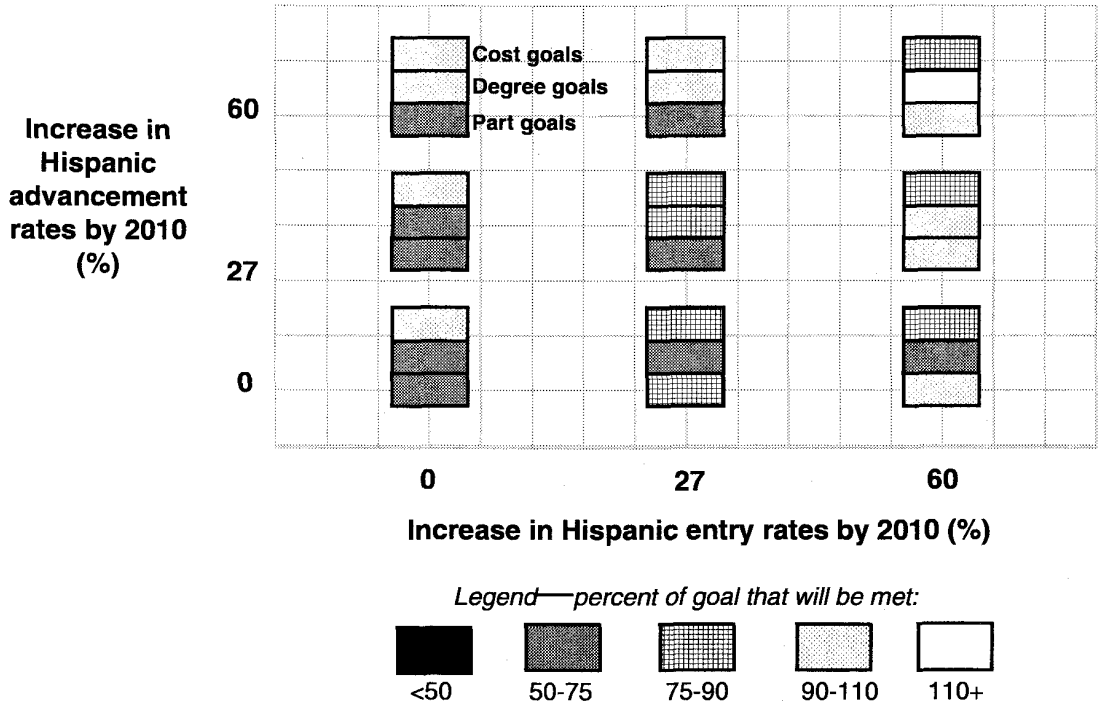

Figure 10—Costs Are Manageable for Increasing Hispanic Entry and Advancement Rates

FUTURE JOB DEFICITS

Improving participation and degree goals has other effects besides those on students. They also affect whether the Texas economy will have the future workers that it needs. Figure 11 shows that large increases are needed in both entry and advancement rates for all students in order for Texas even to come near overcoming its projected job deficit. Even with a 45 percent increase by 2010 in both entry and advancement rates, Texas will still face a job deficit of at least 25 percent, with the higher education system producing fewer than 75 qualified persons for every 100 new jobs.

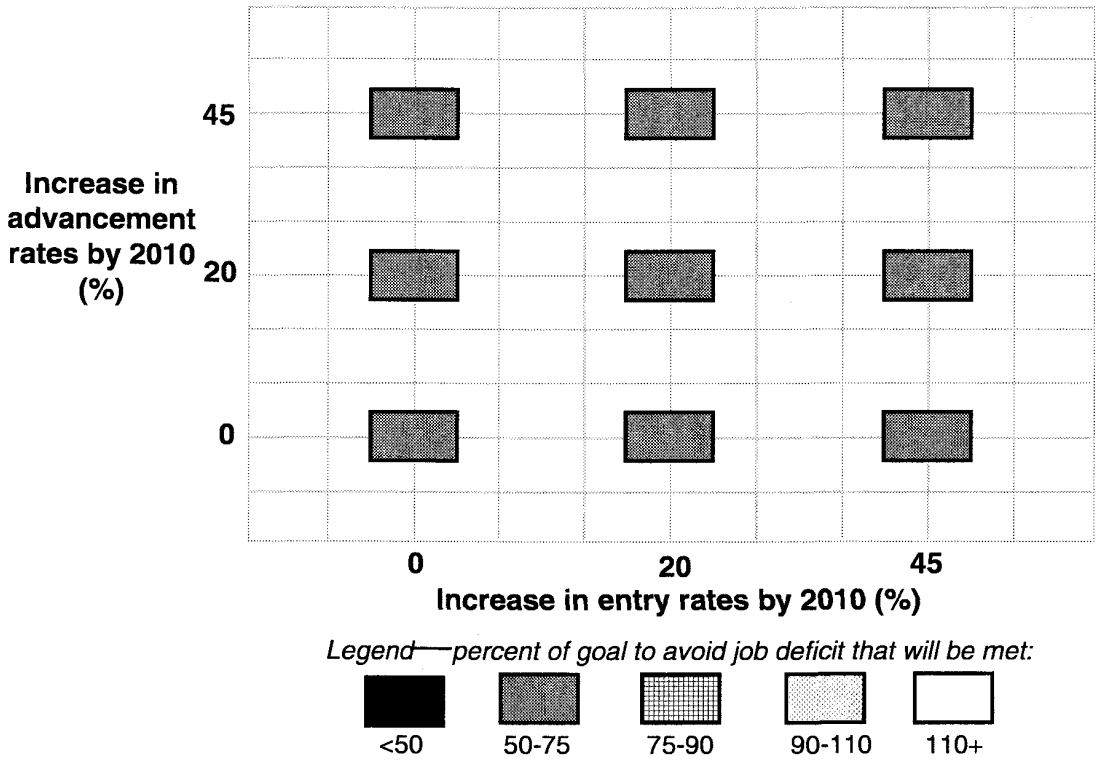

Figure 11—Statewide Job Deficits Are Likely

The projected job deficits are large at many levels and for many jobs. Figure 12 shows the projected deficits for technology and non-technology jobs for positions requiring a four-year degree and for those requiring a two-year degree or certification. In all four of the resulting categories, the projected job deficit is at least 30 percent.

That is, we expect each of the four sectors of the Texas economy, as we have defined them, to need at least 30 percent more qualified workers than will be in the state. In some cases, the need will be more than double that.

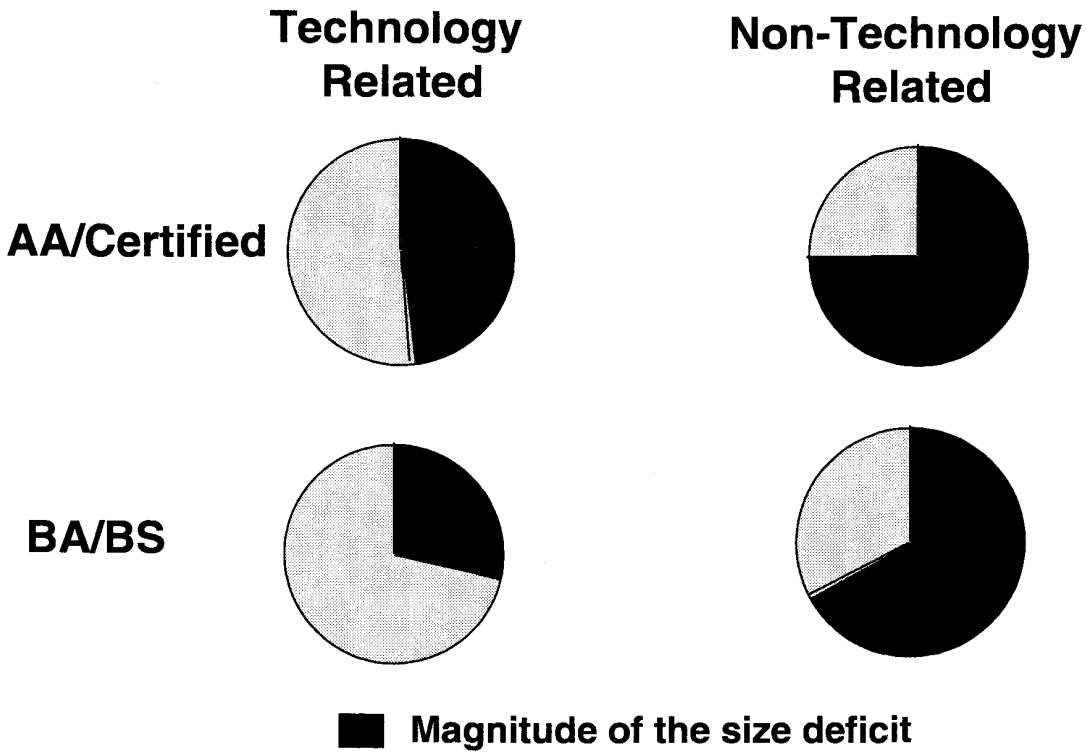

Figure 12—Estimated Statewide Job Deficit in 2010 by Type of Job and Qualification

Despite the concern over the growing need for qualified persons in technology jobs in coming years, this chart shows that the greatest need will be in non-technology jobs. One particular sector of non-technology jobs that will be of great concern to educators is the need for future teachers. Texas is going to have to develop more than ten thousand new elementary and high school teachers annually over the next ten years to meet the projected need. Furthermore, unlike projections for many other types of jobs, the future demand for teachers is not merely speculative. Most students who will be in school in 2010 have already been born. While teachers will be needed in technology-related subjects, many teachers will also be needed in non-technology subjects such as art,

history, civics, and, particularly in a state with many immigrants, English.

By area, job deficits are projected to be greatest where the labor market is already tightest. Figure 13 shows that, regardless of the statewide changes in entry and advancement rates in higher education, Territory 1 will have less than 50 percent of the qualified workers with a four-year degree that it needs to avoid a job deficit. Territories 2 and 3 will have the qualified workers they need. Projected uneven patterns of job growth will lead to uneven patterns of job deficits.

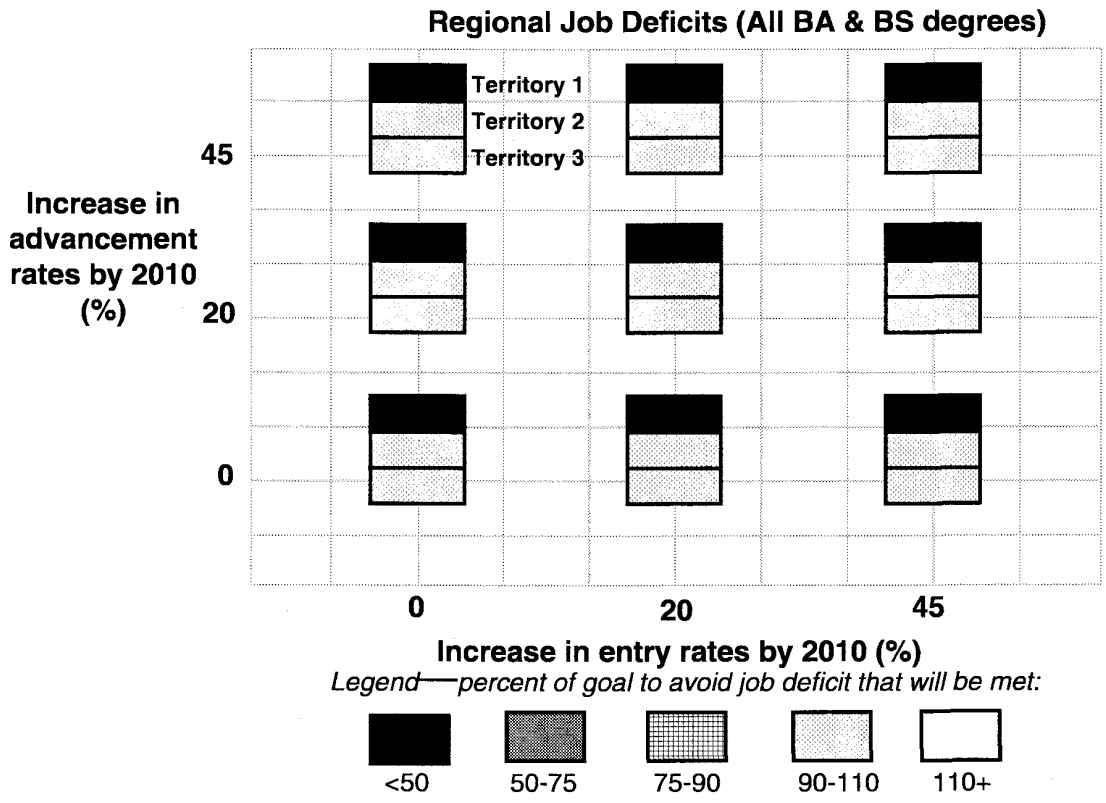

Figure 13—Large Differences Are Likely Among Territories in Job Growth and Deficits

The very broad perspectives held by leading Texans and Texas education officials yield little consensus on the most pressing problems for Texas higher education. The consensus that exists points to problems in participation and success that can be addressed through

increases in entry to and advancement through higher education. Enormous increases are needed to overcome some of the disparities between Hispanic and African American students on the one hand and other students, primarily White, on the other. Large increases in entry to higher education may challenge the implicit cost goals of the system, although the increases needed for Hispanic and African American populations likely can be met within the expected levels of future funding.

Participation goals will be more challenging to meet than degree or success goals. Participation goals can be met only by large increases in entry rates. Entry rates for all students must increase by nearly 30 percent in order for the system to meet its participation goals, and those needed for Hispanic and African American students are much higher still. Degree or success goals, however, can be met by increasing advancement rates alone. Increased entry rates can help the system meet its degree goals, but are not necessarily needed.

Even if both entry and advancement rates increase greatly and participation and degree goals follow suit, however, the resulting increase in the number of qualified workers is not likely to eliminate the job deficits that will face the Texas economy. This is true for workers at all levels of qualification in all sectors of the economy. It is most true for the large urban areas of the state where the labor market is already tight.

RECOMMENDATIONS

What steps can Texas institutions of higher education take to help meet system goals of participation and success? We suggest the Texas Higher Education Coordinating Board consider the following decisions and the steps that would follow them:

- First, create greater mission differentiation among the parts of the system. This will allow the new, more specialized parts to achieve greater quality and offer more access.
- Second, set priorities for greater effectiveness and efficiency of each part.

These are not the only recommendations that the board might consider, nor are these decisions meant to contradict others the board has made or will consider. Rather, they are meant to show some of the context by which the board might achieve its goals for greater participation and success and better meet the concerns of Texas leaders

who see disparities and job deficits as the important issues likely to face higher education in the future. The fundamental lessons of these recommendations are that the board needs to establish greater mission differentiation between parts of the system and to set priorities for each of these parts.

4. MEETING INSTITUTION-RELATED GOALS

IMPROVING RESEARCH

The board has set the goal for Texas to rank third in federal obligations for research and development. How realistic is that goal? What does it say more generally about research goals at Texas institutions of higher education?

Currently, there are only two Texas universities that rank among the top 30 nationally in federally funded research and development. The University of Texas at Austin ranks 27th and Texas A&M ranks 29th. By comparison, California has six institutions that are among the top ten universities as ranked by federally funded research and development. Having top-ranked universities is critical to a higher rank in research and development funding, but from this perspective, it is difficult to see how Texas will soon meet its goal.

A more intermediate, and more fruitful, approach may be for the state to focus on the numerous individual high-ranking academic programs that the system already has. The University of Texas at Austin has 23 programs ranking among the top 20 programs in their fields, six of which are in the top 10 of their fields. Texas A&M has five programs ranking in the top 20 of their fields. The University of Texas Southwestern Medical Center has two top 10 programs, and the Baylor College of Medicine has one.

Clearly there are many excellent individual programs for Texas to build upon in its effort to get more federal funding for research and development. This suggests both short- and long-term strategies that Texas might follow in its effort to increase federal funding.

In the short term, the board should increase support as quickly as possible for academic programs that are either now in the top ten or are judged capable of reaching the top ten within the next five years. The difference between top-ranked programs and others in basic and applied sciences for attracting research funding is fundamental. The top-ranked departments generate far more research dollars than lower-ranked departments do.

This suggests that any effort by the Coordinating Board to generate more federally funded research and development projects should focus on the top programs. This is needed particularly to attract researchers who will stimulate applied research and development projects and foster partnerships between academe and industry. There is a strong

correlation between highly ranked centers of research and economic growth.

The likely outcome of such a strategy would be more focused support for programs at the University of Texas at Austin. More generally, the state legislature, in order to generate more research and development funding, may wish to reallocate support from programs of lower quality to those of higher quality. Such programs are also more likely to be able to provide the matching support needed for many funded projects.

In the long term, Texas should plan to build or improve four research institutions in high urban growth areas such as Dallas, Houston, San Antonio, and a metropolitan border area. These institutions would join UT Austin, Texas A&M, and Texas Tech to form a clearly defined system of research universities.

Why such an ambitious proposal? The Texas population will continue to grow substantially over the next several decades. Its high-tech companies have aspirations to compete at home and abroad. Texas needs an ambitious plan if state leaders wish to fulfil their aspirations of increasing federally funded research and development in the state. Without an ambitious plan, and the funding for it, Texas is more likely to decline, rather than increase, in rank by research dollars.

The process of creating and expanding a network of research facilities will require careful staging over the next two decades. Such a process should take advantage of existing strengths of health research centers in Dallas, San Antonio, and Houston. More generally, educational leaders should consider the creation of research consortia to take advantage of current research centers in metropolitan areas.

IMPROVING EDUCATION

Texas can also benefit from setting priorities in its effort to have more nationally ranked public research universities and liberal arts institutions as well as in its efforts to improve participation and success in higher education. Past trends in education expenditures, which have increased by two percent annually in real terms over the past two decades, indicate that state funding alone likely will not be enough to help the system reach its goals and improve its access. Some reallocation from lower to higher priorities will be needed. How can the state both set priorities and reallocate its higher education resources?

Several evaluation criteria are available for this task. These criteria allow the board to compare its programs on bases of:

Quality. "Quality" refers to the quality of the faculty in teaching, research, and service, quality of the students, quality of libraries, and quality of other institution services. The Coordinating Board may wish to use both locally designed and nationally standardized measures of quality. Indicators of quality include faculty publications, patents, scientific citations, and rankings; student attrition or graduation rates; and results of other standardized assessments. Texas should seek to build further upon quality where it exists.

Centrality. Each program, college, and university should be evaluated in terms of its contribution to the mission of its particular institution or the system as a whole. Evaluators, for example, may wish to determine how well a campus does in improving participation in post-secondary education, particularly among Hispanics and African Americans, or how much a campus contributes to the overall quality of research in the system.

Student demand and faculty workload. Both short- and long-term demands for each program must be considered in setting priorities. Indicators of demand include trends in student applications, acceptances, admissions, and courses of study; in instruction and research by faculty; and in prospective markets for system graduates. Most institutions maintain statistics on many of these indicators.

Cost-effectiveness. The amount of available resources limits system aspirations, meaning system administrators must continually examine programs to determine if more efficient ways are possible to accomplish the same ends. Yet cost alone cannot dictate the priority of support for a given program. Other goals, such as that of improving access, must also be considered.

Comparative advantage. In setting priorities for programs, institution, and the system, administrators should consider the comparative advantages of each. These may include the rationale for a program or institution or other unique characteristics making it essential to the community, region, state, or other programs or institutions in the system.

Once these criteria are agreed and defined, the Coordinating Board will be positioned to apply them and make decisions for the future of the system. Ideally, administrators will use multiple measures for each set of criteria to increase the validity of their overall rankings.

RECOMMENDATIONS

We offer three examples of how broader criteria can help Texas best place new programs to improve access to higher education. The first of these is in building up community college and four-year institutions to meet new demands. The most obvious criterion for such decisions is current patterns of population growth. Our analysis shows Texas is likely to have the greatest job deficits in metropolitan areas of high population growth, while areas of slower growth are more likely to have enough adequately trained workers for the jobs expected to be available there. Accordingly, planners should cut budgets or make no new net investments in areas with no or slow growth, while increasing budgets in areas with high population growth, particularly, for the sake of improving overall access, where Hispanic population growth is projected to be high.

A second example requiring application of even broader criteria is in the maintenance or establishment of law schools. The current statewide ratio of attorneys to population is 1 to 340. Texas law schools now produce 2,000 graduates each year; 1,000 of these are absorbed into the legal profession. Seven of the nine public law schools in Texas are in five counties, Dallas, Tarrant, Harris, Travis, and Bexar. There are no law schools south of San Antonio or in Texas border areas, where the ratio of attorneys to population is 1 to 750.

Criteria of centrality, student demand, and comparative advantage, as well as the fact that law school is a principal mechanism of leadership mobility, provide a compelling case for establishing a new law school in a border metropolitan area with a large Hispanic population. The statewide surplus of law school graduates means that total system law school enrollment should not increase over the next five to ten years. Rather, the Coordinating Board should recommend that enrollment among existing law schools be cut further than currently planned. Perhaps the law schools with the lowest bar exam pass rates should take the largest budget cuts. Funds gained from these cuts could be reallocated for the new border area law school.

Third, several criteria for improving both institutional and student goals indicate that Texas should review and change its tuition and fee policies. In the 1960s and 1970s, Texas was at the forefront in moving to an enrollment-based, input-driven funding formula. Today, however, Texas is behind other innovators who have adopted new allocation strategies for higher education. Its system of having the state set tuition and institutions set fees has resulted in fees surpassing tuition at some schools. Texas might resolve this incongruity by splitting funding of research from that of teaching.

Research funding should be based on performance and seek to support high-quality work at relatively few institutions.

The Coordinating Board should also recommend an allocation system based on "normative" costs per student that it sets. The current system, being based on actual costs incurred by institutions, does not provide incentives for institutions to contain costs. A system based on normative costs would require institutions to keep per student costs within those limits. For the purpose of increasing access the Coordinating Board also might want to include access goals, particularly for underrepresented ethnic groups, into allocation procedures, with rewards going to those most improving access. Similarly, given the shortage of teachers that Texas faces, the Coordinating Board might recommend an allocation system favoring schools that produce more teachers. Institutions that follow goals of mission differentiation, such as those choosing to focus on four-year and not graduate programs, might also be rewarded.

5. CONCLUSIONS

No matter how Texas responds to the challenges identified in this report, it is clear that it needs a new master plan to do so, particularly to identify the priorities and mission differentiation needed among its institutions of higher education. In order to develop this plan, Texas leaders must agree on the contours of the current system. There must be agreement on a vision for the goals that higher education needs to emphasize. Unfortunately, as our Delphi exercise shows, there is not much current consensus on these issues among community, education, political, and business leaders. Furthermore, there is no group now authorized to lead the development of a statewide vision these constituencies can share and work together to realize. There is no recognition that a strategic exercise is needed to develop a vision, much less adherence to such a vision. Until such recognition develops, it is unlikely that the Texas Higher Education Coordinating Board will be able to meet its goals. Instead, demographic momentum may work to erode existing quality in community college and four-year institutions while aggravating resentment over different rates of access, participation, and success in higher education. The ability of the state to continue building its high technology sector may founder on this problem as well.

Historically, the Texas Higher Education Coordinating Board has played two key roles. In times of economic expansion it has assured quality in the growth of higher education. In times of economic recession it has emphasized cost containment. Now the Coordinating Board must take on a new role in setting priorities and establishing mission differentiation in the system, the two goals needed for Texas to improve higher education access and research quality. It must provide the leadership necessary to construct the new vision of the Texas higher education system and to get support for this vision from key leadership groups in the state. In short, the Coordinating Board should change its mandate from coordination to governing the higher education system, at least long enough to establish the new master plan needed for the system to meet the challenges it faces in access and quality.

Appendix

A. LINKING HIGHER EDUCATION TO LABOR MARKETS

INTRODUCTION—THE CHANGING STRUCTURE OF THE TEXAS ECONOMY

The Texas Higher Education Coordinating Board presently has few mechanisms in place to monitor the state's employment needs and to respond to changing labor market demands. New program approval does require input from employers and Texas Workforce Development Boards, but only on an institution-by-institution basis and only at a local level. The Coordinating Board has usually reacted to economic fluctuations by promoting programmatic growth during expansions and focusing on cost containment during recessions.

Particular concern about higher education's role in labor market coverage, however, was not warranted until now. Figure A.1 shows unemployment rates over the last two decades in Texas and in the rest of the United States. Prior to 1990, the Texas economy was largely dependent on production of primary goods, especially oil. There was a roughly counter-cyclical relationship between Texas and the rest of the country, with significant gaps in unemployment rates. This gave Texas labor markets built-in safety valves. The state could export excess labor supply during recessions and, more significantly, import labor from other states during periods of growth.

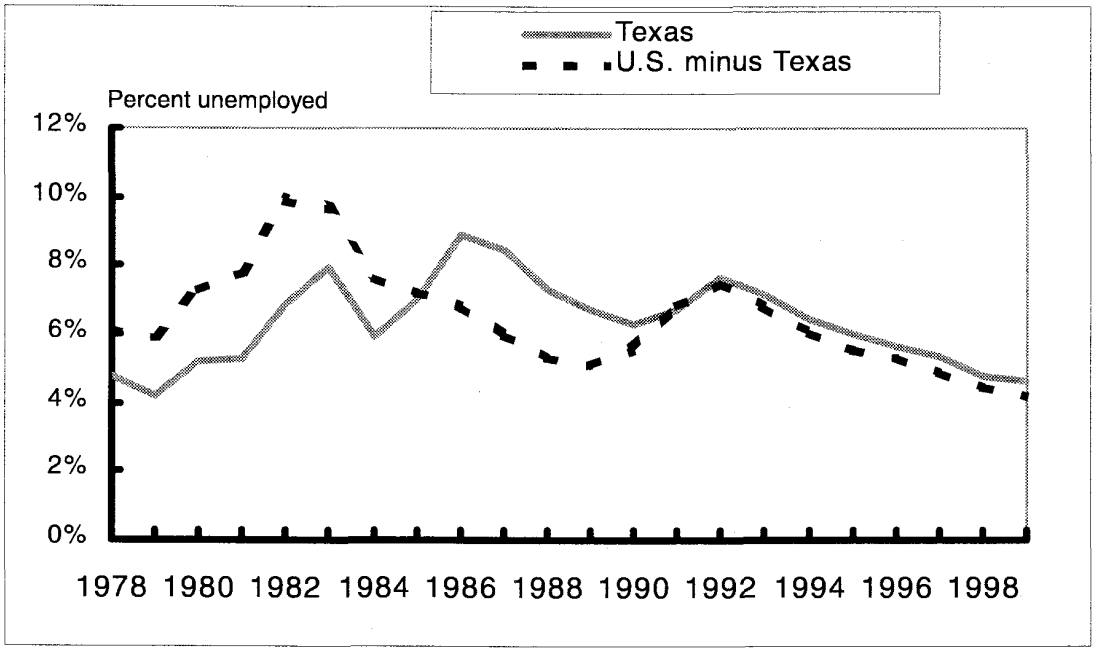

Figure A.1—Civilian Unemployment Rates, Texas and Remainder of Nation, 1978-1999

During the last decade, however, the structure of the Texas economy has become more and more technology driven and now closely follows the rest of the U.S. economy. Labor markets are now tight everywhere and Texas is faced with the possibility of serious limits to economic growth due labor shortages. Further, average wages in Texas tend to be lower than in other parts of the country, which also inhibits the state's ability to attract skilled workers in domestic markets. At the same time, Texas faces rapidly growing minority populations who, on average, are poorer, less skilled, and in even in these times of critical labor shortages, in some parts of the state face double-digit unemployment rates.

Texas is at a crossroads. The state has become more dependent than ever on higher education's ability to provide an adequately trained workforce. The Coordinating Board needs to formulate a vision of how to efficiently respond to the rapidly changing socio-economic climate.

TERRITORIAL ANALYSIS FOR HIGHER EDUCATION

The Coordinating Board has long recognized the need to disaggregate state higher education data. Most of their publications present data for the Ten Comptroller Regions, illustrated in Figure A.2. This division of this state is somewhat arbitrary, however, and does not capture important patterns of urban/high technological development, versus more rural, less-developed areas. For example, the South Texas region includes San Antonio and most of the Rio Grande Valley, two areas with little in common in terms of economic growth.

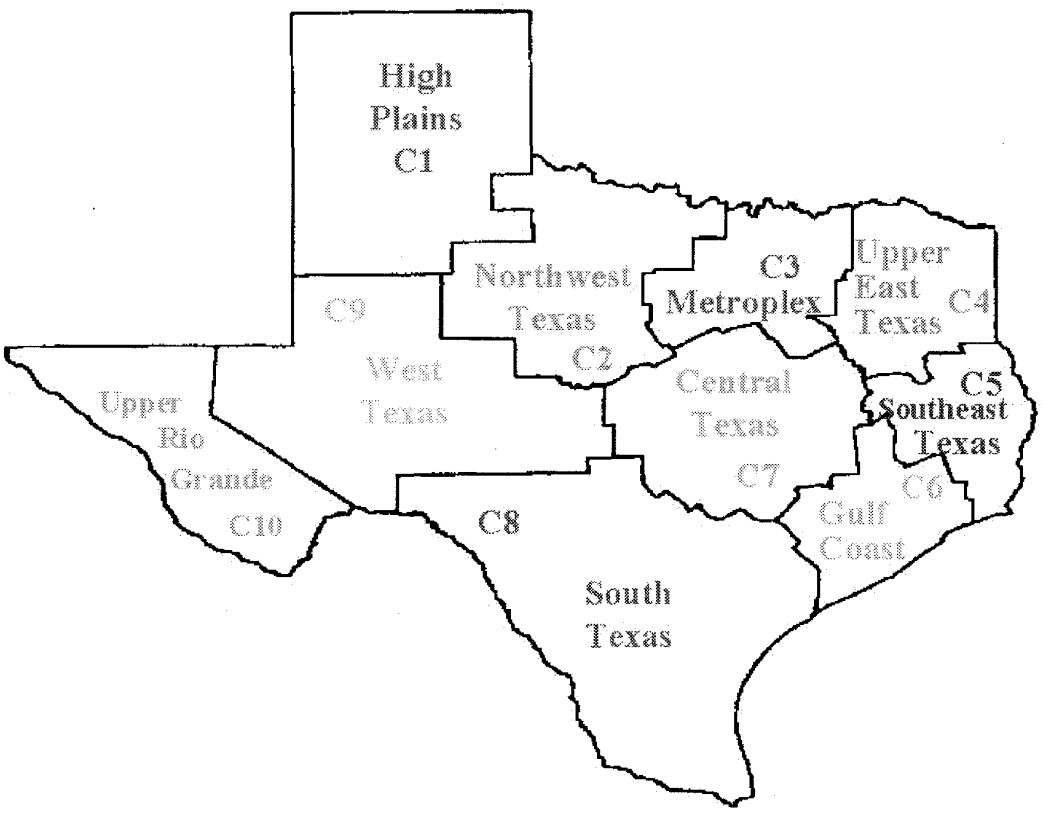

Figure A.2—Texas Comptroller Regions

Regional analyses reported by the Coordinating Board would be enhanced by the use of units that are more logically linked to labor markets. Smaller regions, such as the 28 Texas Workforce Development

Board areas (Figure A.3), could be used; region divisions could specifically group areas based on local trends for labor market demand.

1. Panhandle
2. South Plains
3. North Texas
4. North Central
5. Tarrant County
6. Dallas
7. North East
8. East Texas
9. West Central
10. Upper Rio Grande
11. Permian Basin
12. Concho Valley
13. Heart of Texas
14. Capital Area
15. Rural Capital
16. Brazos Valley
17. Deep East Texas
18. South East Texas
19. Golden Crescent
20. Alamo
21. South Texas
22. Coastal Bend
23. Lower Rio Grande Valley
24. Cameron County
25. Texoma
26. Central Texas
27. Middle Rio Grande
28. Gulf Coast

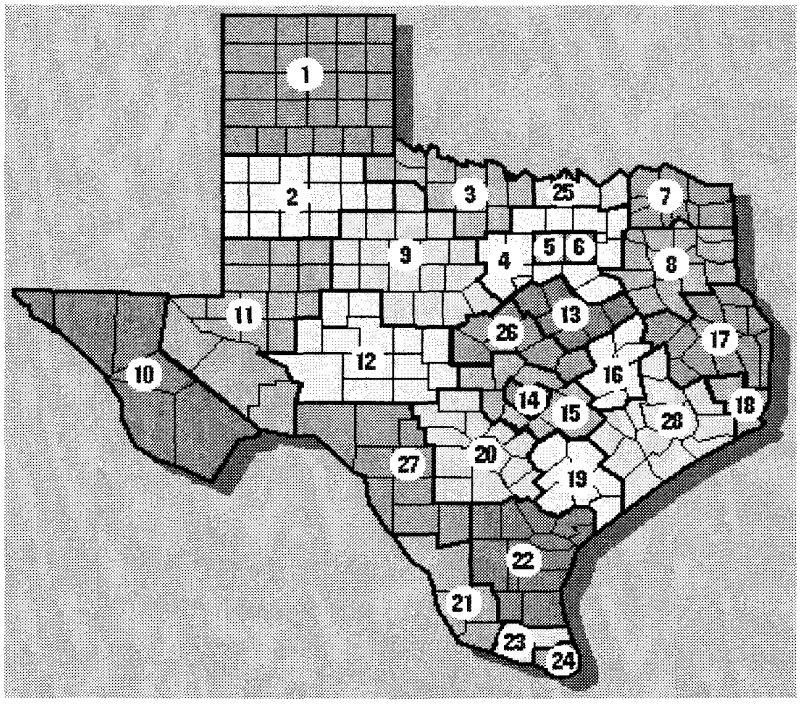

Figure A.3—Texas Workforce Development Areas

The present analysis offers one such possibility by dividing the state into three territories, based on high-tech industrial development and levels of unemployment. Table A.1 details the criteria that were used to build the RAND territories discussed in the main body of the report.

The basic unit of analysis is the Workforce Development Area (WDA). Population data in these areas are readily available from the Texas Workforce Commission (TWC). Higher education data compiled by the Coordinating Board is available by institution and easily matched to a WDA or a RAND territory.

Table A.1

Unemployment and Technology Job Openings by Workforce Development Area

	Workforce Development Area	Projected Annual New Job Openings for Engineers	Unemployment Rate
Territory 1	Alamo	470	3.2
	Capital Area	875	2.3
	Dallas	1,365	3.5
	Gulf Coast	2,485	4.7
	North Central	490	2.6
	Tarrant County	465	3.1
Territory 2	Coastal Bend	105	6.9
	East Texas	140	5.5
	Upper Rio Grande	110	9.5
Territory 3	**Brazos Valley**	**45**	**2.9**
	Cameron County	**20**	**9.8**
	Central Texas	**25**	**3.5**
	Concho Valley	**30**	**4.5**
	Deep East Texas	**40**	**6.6**
	Golden Crescent	**40**	**4**
	Heart of Texas	**65**	**3.5**
	Hidalgo – Willacy	**40**	**14.5**
	Middle Rio Grande	**0**	**13.1**
	North East	**15**	**5.9**
	North Texas	**15**	**4.4**
	Panhandle	**35**	**3.9**
	Permian Basin	**50**	**8.5**
	Rural Capital	**85**	**2.2**
	South East Texas	**80**	**8.6**
	South Plains	**95**	**3.9**
	South Texas	**45**	**12.2**
	Texoma	**20**	**4.3**
	West Central	**35**	**4.3**

In constructing the RAND territories, the first cut was to distinguish between those WDAs that could be considered high tech and low tech. The average number of annual job openings for engineers with BA or BS degrees, but no work experience, projected for each WDA by the TWC, was used as a proxy for industrial development. Nine WDAs have average annual projected job openings (1996-2006) for engineers ranging from 105 to 2,455 and are considered "high tech." The other 19 WDAs had job openings of less than 100, ranging from none to 95. This second "low tech" group then became RAND Territory 3.

A second cut within the high tech WDAs was deemed necessary due to contrasting levels of employment, measured by 1999 average unemployment rates. Among the high tech WDAs, six are high tech areas, coupled with

low overall unemployment rates. Unemployment rates range from 2.3 percent to the state average of 4.7 percent. These six WDAs comprise RAND Territory 1. The last three are WDAs are in areas where unemployment rates are substantially above the state average, ranging from 5.5 percent to 9.9 percent and comprise RAND Territory 2, which is characterized by high tech growth, but low overall employment opportunities.

A TERRITORIAL VIEW OF KEY FACTORS IN TEXAS HIGHER EDUCATION

In the RAND model of higher education in Texas, public institutions were divided into three categories:

- research--comprised of the four Research I (Carnegie classification) universities in the state, University of Texas at Austin, Texas A&M, University of Houston, and Texas Tech
- regional--all other four-year public institutions
- community and technical state colleges--all two year public institutions

Ethnic and racial compositions within each are fairly uniform. Projections of population growth rate (see Figure A.4) are also similar within each territory, where each is characterized by significantly larger growth rates for Hispanic populations.

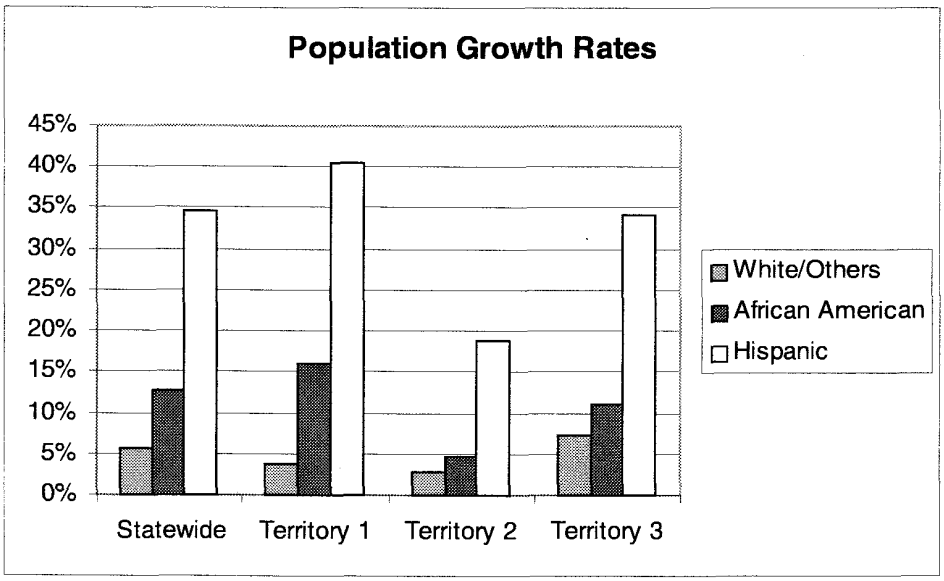

Figure A.4—Projected Population Growth, 1999-2010, by Territory and Ethnicity

The distribution and utilization of higher education within these territories varies substantially. Figure A.5 illustrates the varying participation rates by territory and by race or ethnicity for the 1998 academic year. (There are currently no research universities in Territory 2) Participation rates in previous years vary only slightly.

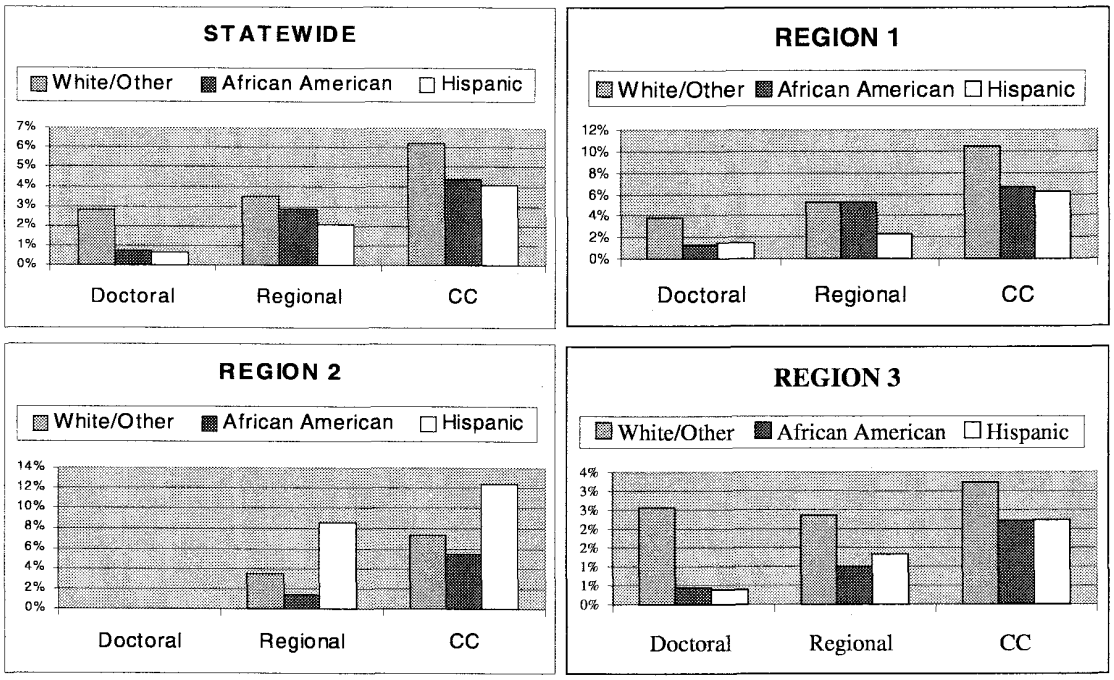

Figure A.5—Participation Rates by Territory and Ethnicity for Persons 15-34 Years Old at Research Universities, Regional 4-Year Institutions, and Community Colleges

With the exception of White students in Territory 3, participation rates are generally greater in the community and technical colleges than in the regional universities that, in turn, generally have greater participation than do the research universities. White and other participation rates exceed the corresponding rates for African-Americans everywhere except in the regional universities in RAND territory 1. White and other participation rates exceed the corresponding rates for Hispanics in RAND Territories 1 and 3 and statewide. There is no clear pattern in the relative participation rates of African-Americans compared to those of Hispanics.

Of those students who do enroll in post-secondary institutions, how many leave before receiving a degree? Attrition rates by territory and race or ethnicity were calculated from Texas Higher Education Coordinating Board data which identified all first-time freshmen who

enrolled in any of the public research or regional universities in 1992 who by 1998 had either graduated or were still enrolled in any public state universities at these levels. Attrition rates for public community and state technical colleges included students who after six years had not received an AA degree or program certification, or were not still enrolled in any two-year public institution, or had not transferred to a public four-year institution.

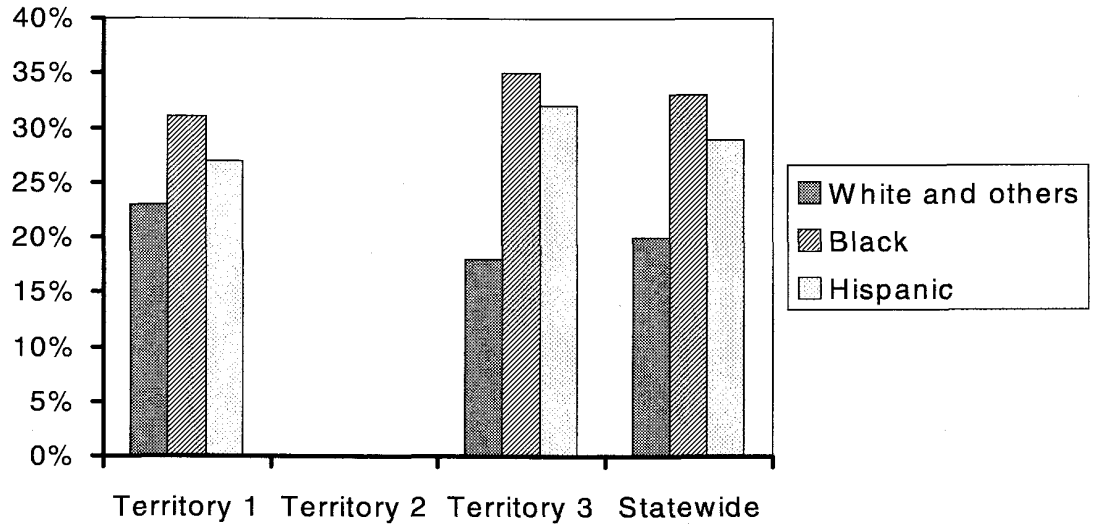

Figure A.6—Attrition Rates by Territory and Ethnicity at Research Institutions (attrition rates expressed as percent of first-time, full-time freshmen in 1992 who, by 1998, had not graduated and were no longer enrolled in school)

The attrition rates at the research university level in Texas (Figure A.6) indicate substantially more minority students leave school without finishing than do their non-minority counterparts.

At regional universities, minorities have higher attrition rates in every instance than do the non-minority students (see Figure A.7), but the gaps between the racial or ethnic groups are smaller.

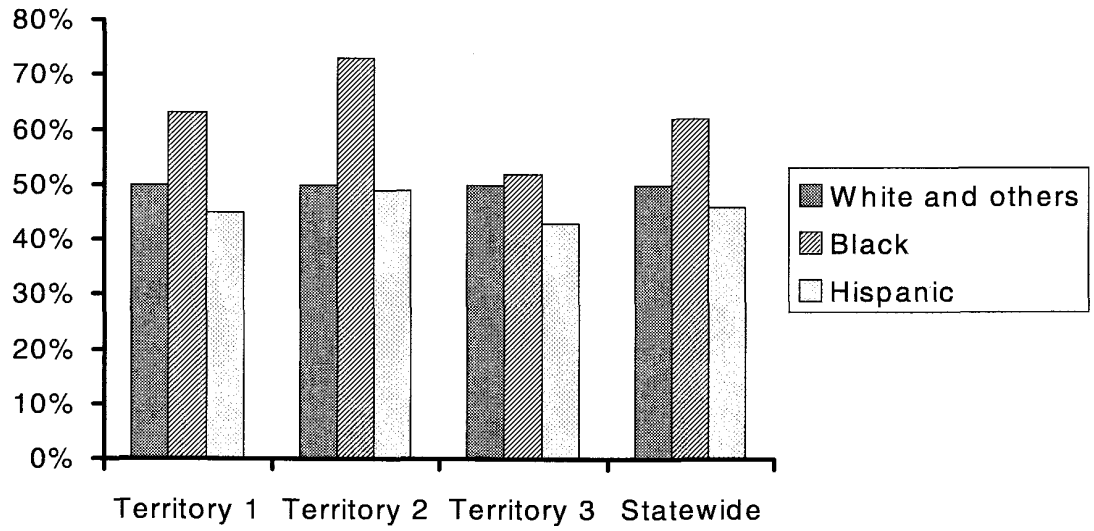

Figure A.7—Attrition Rates by Territory and Ethnicity at Territorial Institutions of Higher Education (attrition rates expressed as percent of first-time, full-time freshmen in 1992 who, by 1998, had not graduated and were no longer enrolled in school)

Attrition rates at the community and state technical colleges also show fewer differences between territories and race or ethnicity (Figure A.8).

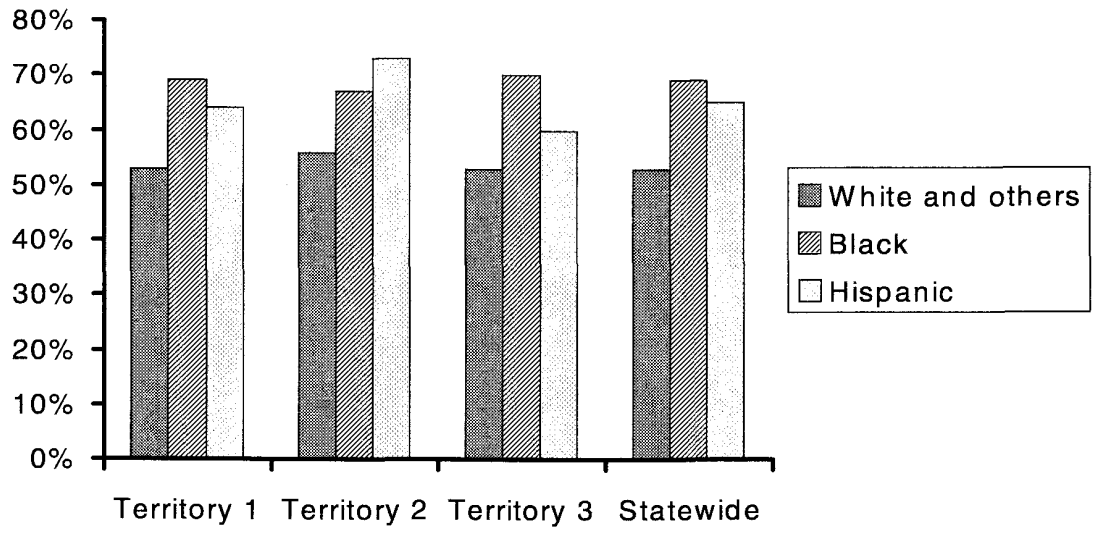

Figure A.8—Attrition Rates by Region and Ethnicity at Community and State Technical Colleges (attrition rates expressed as percent of first-time, full-time freshmen in 1992 who, by 1998, did not graduate or transfer to a four-year school and were no longer enrolled)

A territorial breakdown of data should prove useful in programmatic review and approval by the Texas Higher Education Coordinating Board. If, for example a goal is set to increase minority participation rates, it might be better to focus on Territories 1 and 3, since participation rates are already quite high for Hispanics in Territory 2.

On the other hand, in determining which of the regional universities could receive the funding necessary to increase classification status and move into the Research I category, it might be more effective to concentrate efforts of this type in Territory 2, where there is more potential for higher enrollment and participation at this level among Hispanics than in the other territories.

Also, programmatic efforts to improve retention rates for minority students might be more feasible at the research universities, where the gaps in success rates are so much larger.

The actual regional divisions used will, of course, depend on the most efficient means of assessing the Coordinating Board's objectives, and may vary from task to task. Since a wide range of state data exists

county by county, as well as by Workforce Development Areas, and higher education data is collected by institution, matching varying data sets is a fairly uncomplicated process. The next section describes how the present study used the RAND territories to match labor force demands to higher education production in Texas.

USING LABOR MARKET PROJECTIONS

In its April 1999 publication, *Texas Employment Projections: Industry and Occupation Employment Projections 1996 to 2000*, and on its website, the Texas Workforce Commission, Labor Market Information Department (TWC-LMI), details employment projections for over 700 Occupational Employment Statistics occupations defined by the Bureau of Labor Statistics (BLS), U.S. Department of Labor, at the state level and by Workforce Development Area. This document also lists BLS recommendations for preferred educational requirements.

The present study uses those employment projections for only those occupations that require either a Bachelor's Degree or an Associate Degree, with no work experience. The projections were then aggregated into four job types:

- Technology BA, which consists of all engineering jobs requiring a BA or BS degree
- Technology AA, which consists of all engineering-related jobs requiring an AA degree
- Non-Technology BA, which consists of all other jobs requiring a BA or BS degree
- Non-Technology AA, which consists of all other jobs requiring an AA degree.

The TWC-LMI's projections for total average annual job openings, 1996 to 2000, in each job type were used as a constant for each year of the present analysis, 1998 through 2010, to construct a simple labor market demands by job type, by territory.

The Texas Higher Education Coordinating Board collects data each year on degrees or certificates awarded by Texas institutions, identified by Subject Matter Content (CIP) Codes. The NOICC Crosswalk and Data Center, funded by the National Occupational Information

Coordinating Committee, under the U.S. Department of Labor, Employment and Training Administration, has constructed a "crosswalk," linking OES codes to CIP codes. This crosswalk was used to match the actual Coordinating Board 1998 degree data and the degrees projected by the RAND model up through 2010 to the labor market demands described above to generate the broad labor market coverage projections presented in this study.

DATA LIMITATIONS

Given the data available, it would be possible to generate much more detailed projections as to the numbers of degrees needed to fit more specific occupations than those offered here, but this type of analysis would not be particularly useful. Too many variables are at stake to be able to predict the number of mechanical engineers or respiratory therapists needed with any degree of accuracy.

For example, the underlying population and job growth projections are based on assumptions that hold the level of economic growth in Texas constant. Of course, there is no reason to believe that the Texas economy will not again experience the severe downswings seen in past decades. The price of oil has become increasing volatile, and that will always have an effect on the Texas economy, but given the changing structure and the shift into high tech industries, a rise in oil prices may even generate recessions instead of booms.

Even if the short term brings continued economic expansion, and Coordinating Board efforts result in more students earning more degrees at faster rates, there is little data to indicate where students are employed after graduation. It would be difficult to predict what percentage of these students would stay in Texas and alleviate labor market shortages.

Also, the OES/CIP crosswalks do not and could never give a precise mapping of education to occupations. For example, the BLS estimates that in 1998 over 40 percent of people working in the "Computer Programmer" occupation did not have bachelor degrees. The crosswalk itself links 14 CIP codes to two OES computer programmer codes.

The bigger picture offered by this study is helpful for planning purposes in general terms. Texas is already faced with both shortages of skilled labor, and large and growing unskilled populations. Stronger links between higher education planning and labor market needs can only serve to improve this dilemma.

B. MODELING ENROLLMENT AND DEGREES

Our model uses the same approach as in Park and Lempert (1998) that builds on the "participation rate" methodology used by Shires (1996). The major change is that the model in this study includes the flow of students among three territories and the distinction of students with different majors, engineering and non-engineering. On the other hand, our model does not include the effect of tuition change on participation rate on the demand side and binding constraints on the supply side of the higher education system.

CALCULATION OF FRESHMEN ENROLLMENT

We model the number of first-time freshmen (FTF) of a given ethnicity[6] and gender[7] in a system[8] in a given territory and year as

$$FTF(\text{region } i, system, year, ethnicity, gender) = \sum_{\text{region } j=1}^{3} [\, Demog(\text{region } j, year, ethnicity, gender) * cPRT(\text{region } j, \text{region } i, system, ethnicity, gender) \quad (1)$$

where $Demog(\text{region } j, year, ...)$ is the projected population for the population cohort of the given ethnicity and gender in territory j (one of the three territories in Texas) in a given year; and the participation rate $cPRT(\text{region } j, \text{region } i, system, ...)$ represents the fraction of each population cohort in territory j that becomes freshmen in a given system in territory i. See Figure B.1.

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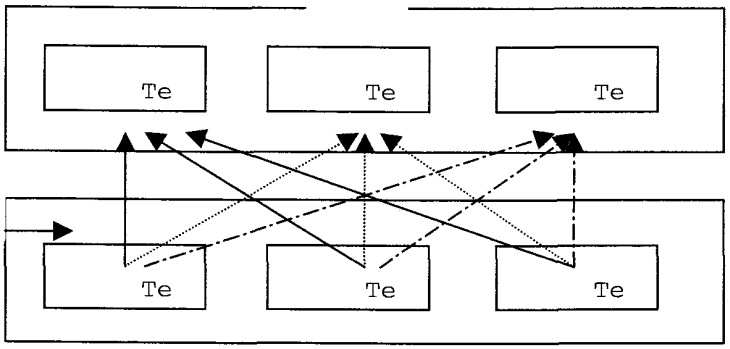
[6] This category has three levels: white plus other, black and Hispanic.

[7] This category has two levels: female and male.

[8] This category has three levels: research university, regional university and community college.



D

Figure B.1–Student Admissions

We use the state demographic data in 1998 to calculate the participation rate as

$$cPRT(\text{region } i, \text{region } j, system, ethnicity, gender) = \frac{FTF(\text{region } j, system, year = 1998, ethnicity, gender)}{Demog(\text{region } i, year = 1998, ethnicity, gender)} \quad (2)$$

The change of the number of first-time freshmen comes from the change in the population in each demographic cohort and the change in participation rate. Participation rate calculated from the enrollment record in 1998 is used as a baseline case for further exploration, for example, on the effect of the change in participation rate on enrollment as is explained later.

The body of enrolled freshmen FRS include, other than first-time freshmen, students who are absent for one year and return as freshmen (returning students)[9] and students who repeat freshmen class (repeaters). We model first-time students and returning students as

[9] We do not include the returning students who are absent for more than one year.

fractions of the population and repeaters as a fraction of the freshmen class in prior year. See Figure B.2.

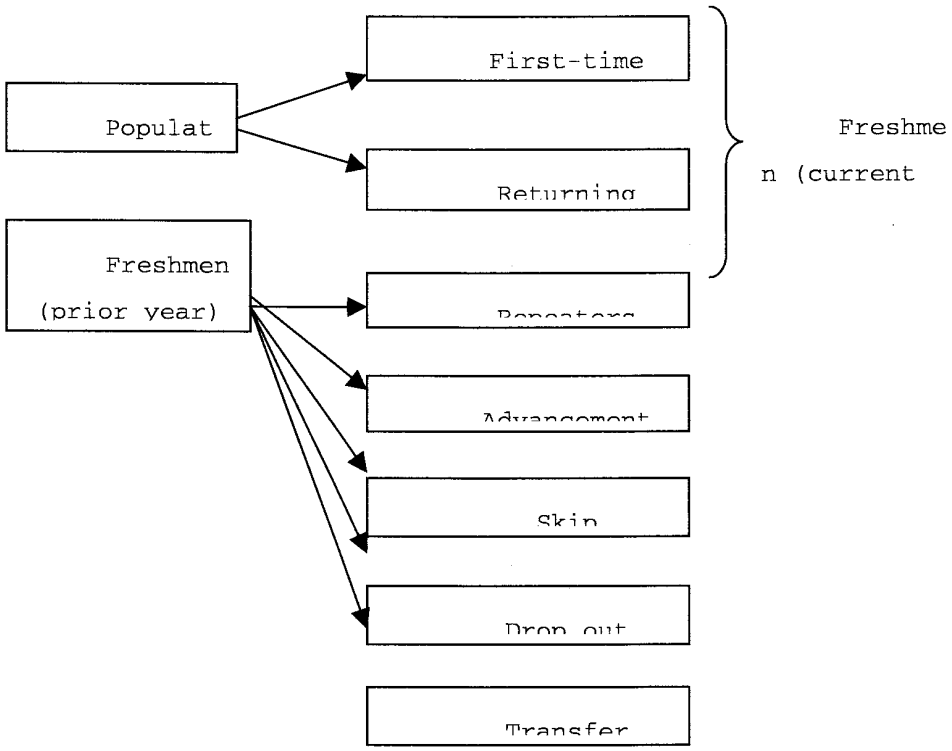


Figure B.2—Freshmen flow

We use the value for the FTF (from Eq. (1)) to calculate the total number of enrolled freshmen FRS as

$$\begin{aligned} &FRS(\,region\,,system,year,ethnicity,gender\,) \\ &\quad = FTF(\,region,system,year,ethnicity,gender\,) \\ &\quad + cHLD_1(\,region,system,ethnicity,gender\,) \\ &\quad * FRS(\,region\,,system,year-1,ethnicity,gender\,) \\ &\quad + Return_1(\,region,system,year,ethnicity,gender\,) \end{aligned} \tag{3}$$

where $cHLD_1$ is the percentage of freshmen in each territory and system who repeat their freshman year, and $Return_1$ is the number of students who return to school after one year of absence.

Because the data on the number of students who return are not reliable enough to calculate the return rate $cReturn_1$, we adjust the return rate so as to make the predicted number of enrolled students in 1999 equal to the number of students in 1998 (base year) in each cohort on a condition that there is no increase of population between 1998 and 1999, in other words, FTF is the same for both years. The assumption is that the enrollment is stable in 1998. $cReturn_1(region\ i, region\ j, system)$ is calculated for each cohort from the Eq. (3) and (4).

$$\begin{aligned} &Return_1(region, system, year, ethnicity, gender) \\ &= \sum_{region\ i=1}^{3} [\, cReturn_1(region\ i, region, system, ethnicity, gender) \\ &\qquad * Demog(region\ i, year, ethnicity, gender)] \end{aligned} \tag{4}$$

$$FRS(region, system, 1999, ethnicity, gender)[\text{no population growth}] = FRS(region, system, 1998, ethnicity, gender)$$

CALCULATION OF SOPHOMORE, JUNIOR, AND SENIOR ENROLLMENT

Students either 1) drop out of the system, 2) advance to the next class, 3) skip for one or two years, 4) transfer to other system or 5) repeat the same class. So the student body next year can be calculated by adding students who advance or skip and students who repeat the same class, and students who return to the system after one year of absence.

We write the number of students enrolled as sophomores, juniors and seniors in each territory and system if we omit the ethnicity and gender from the equation as

$$
\begin{aligned}
SPH(region, system, year) &= cADV_2(region, system) * FRS(region, system, year-1) \\
&+ cHLD_2(region, system) * SPH(region, system, year-1) \\
&+ TRF_2(region, system) + Return_2(region, system) \\
JNR(region, system, year) &= cADV_3(region, system) * SPH(region, system, year-1) \\
&+ cHLD_3(region, system) * JNR(region, system, year-1) \\
&+ TRF_3(region, system) + cSkip1_1(region, system) * FRS(region, system, year-1) \\
&+ Return_3(region, system) \\
SNR(region, system, year) &= cADV_4(region, system) * JNR(region, system, year-1) \\
&+ cHLD_4(region, system) * SNR(region, system, year-1) \\
&+ cSkip1_2(region, system) * FRS(region, system, year-1) + \\
&+ cSkip1_2(region, system) * SPH(region, system, year-1) \\
&+ Return_4(region, system)
\end{aligned}
$$

(5)

where the first term on the right side of each equation is the number of students that advanced into that class from a lower class and the second term is the number that remained in the same class from the previous year. TRF_n is the number that transferred into that class from another system. $Skip1_n$ and $Skip2_n$ are the number of students who skip for one year and for two years respectively, and $Return_n$ is the number of students who return to school after one year of absence. We assume that the number of students from research or regional universities to the community college system do not have a large impact for the purpose of the model, and use only the transfer of students from the community college system to either research or regional universities. We assume that freshmen and sophomore at community college transfer to sophomore and junior classes at research or regional universities respectively.

Transfer rate $cTRF_n(region_i, system_i, region_j, system_j)$ that represents the fraction of students in $system_j$ in $region_i$ who transfer to $system_j$ in $region_j$ is calculated from 1998 enrollment record. By using this rate, the number of transfer students are calculated as

$$TRF_2(region, system)$$
$$= \sum_{region_i} \sum_{system_j} cTRF(region_i, system_j, region, system) * FRS(region_i, system_j, year)$$
$$TRF_3(region, system)$$
$$= \sum_{region_i} \sum_{system_j} cTRF(region_i, system_j, region, system) * SPH(region_i, system_j, year)$$
$$cTRF(region_i, system_j, region, system) = 0$$
$$(\text{if } system_j \neq Community\ College\ (CC) \text{ or } system = CC)$$

(6)

Return rate $cReturn_n$ is calculated by using the same procedures as in freshmen.

$$Return_n(region, system, ethnicity, gender, year)$$
$$= \sum_{region\,i=1}^{3} cReturn_n(region_i, region, system, ethnicity, gender) \quad (7)$$
$$* Demog(region_i, year, ethnicity, gender, year)$$

In any given cohort of any given class, the students must either (1) remain in the same class, (2) advance to the next class (including skip), (3) drop out or transfer to another system. Thus $cHLD_n$ is calculated from other rates as

$$cADV_n(region, sys) + cHLD_n(region, sys) + cSkip1_n(region, sys)$$
$$+ cSkip2_n(region, sys) + cDRP_n(region, sys) + cTRF_n(region, sys) = 1$$
$$cHLD_n(region, sys) = 1 - \{cADV_n(region, sys) + cSkip1_n(region, sys)$$
$$+ cSkip2_n(region, sys) + cDRP_n(region, sys) + cTRF_n(region, sys)\}$$

where $cDRP_n(region, sys)$ refers to students leaving by dropping out.

The model used for the community college system is basically the same as the model described above for the 4-year university system. Although classes at community college are either freshmen or sophomore, the data for community college students are classified by 1 year, 2 years, 3 years and over 4 years of attendance. We match those years of

attendance with freshmen, sophomores, juniors and seniors in the model for research or regional universities respectively. We do not consider the transfer of students from 4 year university system to community college.

DEGREES AWARDED

We calculate the number of bachelor's degrees awarded each year as

$$\begin{aligned} &BachelorsDegrees(region, sys, year) \\ &= cGRAD_4(region, sys) * SNR(region, sys, year-1) \\ &+ (cGRAD_1(region, sys) * FRS(region, sys, year-1) \\ &+ cGRAD_4(region, sys) * SPH(region, sys, year-1) \\ &+ cGRAD_4(region, sys) * JNR(region, sys, year-1)) \end{aligned}$$

where $cGRAD(sys)$ is the graduation rate for each system, broken down into the various student cohorts enumerated above. We use the ratio of the number of degrees awarded to the number of students in a class for $cGRAD_n$. The number of associate degrees $AssociatesDegrees(region, sys, year)$, whose main producer is the community college system, is calculated in the same manner.

MODELING COSTS

We use the operating cost per student for calculating the costs necessary for accepting all the projected enrollment in each system and in each territory.

$$\begin{aligned} &Cost(region, sys) \\ &= pCost(sys) * \{FRS(region, sys) + SHP(region, sys) + JNR(region, sys) + SNR(region, sys)\} \end{aligned}$$

where $pCost(sys)$ is the average cost per student in each system. We assume that there is no territorial difference in the average cost per student in each system. We use $pCost(Doctoral)$=$3928.78,

$pCost(Regional)$=\$2201.5, $pCost(CC)$=\$2365.5 [10]provided by the Texas Higher Education Coordinating Board.

MODELING JOB DEFICITS

We define job deficit as the number of jobs that are not filled by the graduates of the universities in the same territory. We calculate the deficits in the job categories that require bachelors degrees ($JobDeficitBachelors$) and that require associate degrees ($JobDeficitAssociates$), and in the job categories that require engineering major degree and that do not require engineering major degrees, in each territory in a given year. These measures compare the number of graduates with the number of jobs in the same territory, and we do not take into account the transfer of students after graduation across territories.

We write the job deficit as

$$JobDeficitBachelors(region, major, year) = JobDemandBachelors(region, major, year) - \sum_{sys} BachelorsDegrees(region, sys, major, year)$$

$$JobDeficitAssociates(region, major, year) = JobDemandAssociates(region, major, year) - \sum_{sys} AssociatesDegrees(region, sys, major, year)$$

MODELING ALTERNATIVE SCENARIOS

For the exploratory analysis, we consider scenarios different in terms of entry rates, throughput-related rates, and retention-related rates.

We change the annual growth rate p_1 of participation rate $cPRT$ in ethnicity (Hispanic or non-Hispanic) or system (4 year university or community college). If other flow rates inside the system such as advancement rates are held constant, higher growth rate increases both

[10] The reason why cost per student at community college is higher than that for regional universities is that cost per student at regional and research universities do not include the cost for infrastructure.

the enrollment and the number of graduates, since the constraints in terms of operation and capacity are not considered in our model.

$$cPRT(region, sys, year) = cPRT(region, sys) * [1 + p_1]^{year-1998}$$

We change the throughput of the system by changing the advancement rate for freshmen, sophomores, and juniors, and the graduation rate for seniors. The decrease or increase of these rates are compensated by the change of the holding rate $cHLD_n$ in the opposite direction. The increase of throughput rates shortens the average length necessary for graduation. As a result, if the entry rate is held constant, the enrollment decreases, and the number of graduates increases since the chance of dropping out of the system decreases.

1) n=1,2,3 (n=1 at CC)

$$cAVD_n(region, sys, year) = cAVD_n(region, sys) * [1 + p_2]^{year-1998}$$
$$cHLD_n(region, sys, year) = cHLD_n(region, sys) - cAVD_n(region, sys) * \left[1 - (1 + p_2)^{year-1998}\right]$$

2) n=4 (n=2,3,4 at CC)

$$cGRD_n(region, sys, year) = cGRD_n(region, sys) * [1 + p_2]^{year-1998}$$
$$cHLD_n(region, sys, year) = cHLD_n(region, sys) - cGRD_n(region, sys) * \left[1 - (1 + p_2)^{year-1998}\right]$$

We change the retention of each system by changing the dropout rate for freshmen, sophomores, juniors, and seniors. Half of the decrease or increase of these rates is compensated by the change of the advancement rate for freshmen, sophomores, juniors, and the graduation rate for seniors in the opposite direction, and the other half is by the change in holding rate. If participation rate is held constant, the increase in retention rate, or decrease in dropout rate, decreases the number of students who drop out of the system. As a result, both the enrollment and the number of graduates increase.

1) n=1,2,3 (n=1 at CC)

$$cDRP_n(region, sys, year) = cDRP_n(region, sys) * (1 - p_3)^{year-1998}$$

$$cADV_n(region, sys, year) = cADV_n(region, sys) + 0.5 * cDRP_n(region, sys) * \left[1 - (1 - p_3)^{year-1998}\right]$$

$$cHLD_n(region, sys, year) = cHLD_n(region, sys) + 0.5 * cDRP_n(region, sys) * \left[1 - (1 - p_3)^{year-1998}\right]$$

2) n=4 (n=2,3,4 at CC)

$$cDRP_n(region, sys, year) = cDRP_n(region, sys) * (1 - p_3)^{year-1998}$$

$$cGRD_4(region, sys, year) = cGRD_n(region, sys) + 0.5 * cDRP_n(region, sys) * \left[1 - (1 - p_3)^{year-1998}\right]$$

$$cHLD_4(region, sys, year) = cHLD_n(region, sys) + 0.5 * cDRP_n(region, sys) * \left[1 - (1 - p_3)^{year-1998}\right]$$

C. BENCHMARKS

This section presents the following:

1) The steps in academic quality and productivity assessment
2) The role of "benchmarking" in this process
3) Arenas in which benchmarking are used
4) Commonly used benchmark measures
5) Conclusions and recommendations.

First, it is important to identify the steps in the assessment of academic institutions. There is confusion about these steps and whether they are even necessary to carry out. However, in a recent RAND research project it became clear that unless these steps are adhered to, the results are likely not to be regarded as acceptable or even credible by the institutions for which the measures are being developed. Here are the steps as formulated by RAND researchers:

1) Identification of the goals of the institution. Most systems of accountability mandated from legislatures or Higher Education Coordinating Boards do not work sufficiently with the stakeholders, the institutions, and systems to understand the goals the institutions are pursuing. Much time and effort should be devoted to gaining understanding and consensus about the goals because any measures developed must track these goals if they are to be useful.
2) Measurement of outcomes. While indirect measures of performance are useful, it is important to measure actual outcomes in doing assessment. Thus, if one is focused on examining whether access goals are being achieved it is useful to measure retention and graduation rates instead of admission rates only.
3) Evaluation of the extent to which outcomes meet goals. The focus should be on tying the outcomes produced by the

institution back to the stated goals of the institution. Are outcomes and goals aligned?

(Source: "Ensuring Academic Quality and Productivity in the Education and Professional Development of DoD Civilian Personnel," Susan Gates, Roger Benjamin et al., Prepared for the Office of the Secretary of Defense, National Defense Research Institute, October 1999)

THE ROLE OF BENCHMARKING IN THE ASSESSMENT PROCESS

Benchmarks set standard of success of failure in the assessment process. Benchmarks, therefore, should permeate the assessment process:

- Goals must be set with measurable benchmarks in mind
- Measures must be comparable to benchmarks
- Evaluation of goals should be cast in terms of benchmarks.

The question is, do agreed-upon academic benchmarks exist? Currently, there are no definitive standards for such goals as participation rates for all ethnic groups in postsecondary education or the level of college preparation required for admission to college as signaled by SAT scores. There is considerable variation on these and related goals between higher education systems and territories across the country. It is an excellent area for policy research in support of the missions of Higher Education Coordinating Boards and similar state-based groups.

If there is no agreement on actual benchmarks, there is greater agreement on the areas in which benchmarks should be constructed. These are 1) access to higher education--e.g., what should the participation rate in postsecondary education be for each and all ethnic groups; 2) productivity--how efficient are individuals, institutions, and systems of institutions; and 3) Quality of educational product---productivity and quality are merged in this discussion.

Benchmarks in access generally focus on participation rates in higher education. Participation rates can be broken down in several ways, e.g., by ethnicity, by age (15-34 cohort, over 34 age group), territory (rural versus urban, south, north, west, northeast), and income. Benchmarks should be set with specific combination of these

variables in mind. Specific benchmarks for access come in many forms. For example, an institution might strive for

- Yearly percentage increases in participation rates
- Moving higher in state participation rankings
- Absolute participation percentage goals.

Let us consider an example of access benchmarks, the case of Missouri. Recent discussion in Missouri led to the policy goal called the "Funding for Results" program which translates into make the postsecondary participation rates of underrepresented groups equal to the percentage they represent in the Missouri population at large. The population groups to be considered under this program are African-American, Asian-American, American Indian, and Hispanic. Missouri's benchmarks focused on enrollment information and degree completion rates.

Missouri set goals for underrepresented groups in technology fields. Specifically, the benchmarks were focused on increasing participation and degrees in science, engineering, and mathematics from 1995 to 2000 by 15 percent for undergraduate degrees and 50 percent for graduate degrees in these fields. Missouri then developed a number of strategies to enable the attainment of these benchmarks,

- Early warning initiatives
- Tutorial services
- Support groups
- Mentorships
- Co-curricular activities
- Articulation agreements from 2-4-institutions.

(*Source: 1999 Report on Progress Toward the Statewide Public Policy Initiatives and Goals for Missouri Higher Education: Blueprint for Future of Missouri Higher Education:, Coordinating Board for Higher Education, Missouri, April 15, 1999, Context for Statewide Goals and Public Policy Initiatives, http://www.mocbhe.gov/*)

Other states that have established similar efforts include Florida (its 2+2 articulation program and commitment to increasing enrollment for first time college-going students); Indiana with its Merit-Aware model: increasing diversity while removing race as an explicit criterion in admissions screening; Georgia's "Admissions Policy Direction" providing admission based on standards for academic excellence, P-16 Initiative for "seamless educational opportunities"; PREP-Postsecondary Readiness Enrichment Program, a safety net are a few examples (Source: State Higher Education Executive Officers (SHEEO), Recent Policy Developments Affecting Diversity in Postsecondary Education Programs: A Review of Activities in Selected States, Updated Oct. 99. See Access and Diversity: Links to Web Sites and Key Reports).

QUALITY/PRODUCTIVITY BENCHMARKS

Institutions set quality and productivity benchmarks in three different ways. The categories are 1) based on inputs, 2) based on process, or 3) based on outputs. There are advantages and disadvantages attached to each category. Here are examples of quality/productivity benchmarks:

- Input benchmarks
  - Number of faculty
  - Admission standards
  - Size of budget
  - External research funding

- Process benchmarks
  - Time to degree
  - Retention rates
  - Class size ratios
  - Remediation activities

- Output benchmarks
  - Graduation rates

- Pass rates on professional exams
- Employment rates among graduates
- Total degrees awarded

South Carolina presents one interesting example of a state that has adopted a list of quality/productivity benchmarks dealing with,

- Mission focus
- Quality of faculty
- Instructional quality
- Institutional cooperation and collaboration (internal and external)
- Entrance requirements for students
- Graduates' achievements
- "User friendliness"
- Research spending.

A recent development is to link funding to campus performance, either in terms of performance budgeting or performance funding. Thirty states have at least one of these programs. *The level of state budgets linked to performance funding ranges from 1 to 6%.* As of 1999, 23 states established performance budgeting with campus performance as one factor: CT, FL, GA, HI, ID, IL, IN, IA, KS, LA, ME, MA, MI, NE, JN, NM, NC, OK, OR, TX, VA, WA, WV and 16 states have a program of performance budgeting: CA*, CT, FL, IL, KS, LA, MO, NJ, NY, OH, OK, SC, SD, TN, TX, VA. South Carolina has had these measures longer than other states. However, they are an example of how it is easier to adopt than to implement these kinds of measures. (*Source: Change, Nov/Dec 99, article by Joseph C. Burke & Andreea Serban "Performance Shouldn't It Count for Something in State Budgeting?" See also "Performance Funding and Budgeting: Popularity and Volatility - The Third Annual Survey, Joseph C. Burke, Director, and Shahpar Modarresi, Research Associate, Public Higher Education Program, The Nelson A. Rockefeller Institute of Government, State University of NY, Albany; See also Rockefeller*

Institute's Web site [http://rockinst.org/higheduc.htm] for case studies being developed on Missouri, South Carolina, Tennessee, and Ohio for book being edited by Dr. Joseph C. Burke, Director of the Higher Education Program at the Rockefeller Institute of Government.)

"South Carolina's performance funding effort is more recent than those of Tennessee and Missouri but is much more far reaching in its intent." The guidelines originated with the state legislature, driven in part by a business task force with the operative plan devised by the Commission on Higher Education. (Source: Profiles of states from manuscript of William Zumeta, Daniel J. Evans School of Public Affairs, University of Washington, Seattle, manuscript excerpts March 1999.)

The common characteristic for all quality/productivity benchmarks that reward results is that institutions are rewarded for helping to achieve statewide goals, e.g., increased minority graduation rates or improved graduation rates in specific fields such as engineering or teacher training.

The question is, what should Texas do? Texas should consider adapting the available benchmarks (To get more detailed information on what other states are doing, see: "Performance Funding Indicators: Concerns, Values, and Models for Two- and Four-Year-Colleges and Universities" by Joseph C. Burke, Director, Higher Education Program, The Nelson A. Rockefeller Institute of government, SUNY, Albany, 1997; SHEEO website www.sheeo.org and for state agencies links http://www.sheeo.org/agencies.htm and for South Carolina details: http://www.che400.state.sc.us/ or those of the Missouri program, see http://www.mocbhe.gov/).

In doing so, however, it will be important to establish benchmarks that measure Texas's goals for higher education. A system of benchmarks, in place, will have the value of making public the extent of progress by the higher education sector toward the agreed upon goals.

However, existing measures useful for tracking goals are insufficient. The fundamental problem is that none of the present measures allow assessment of the value added to the student's progress by the class, instructor, or institution. And, unless one has measured the "value added" to the student's progress, one cannot then evaluate

the contribution of the institution. In other words, in what ways and how did the students change as a function of their education experience? In order to do this one would need, on the input side, to develop controls such as SAT scores (or equivalent measures), social/economic characteristics of the students, and the amount of institutional resources going to support the program being measured. On the output side, there are some measures that already exist, such as the percentage of graduates passing certification tests, scores on postgraduate admissions tests (GREs, LSATs), as well as other exit tests and surveys. These measures may be a useful place to start, but they are insufficient. More valid and reliable sets of "value added" outcome measures need to be developed. They can only be developed by the institutions of higher education, in partnership with entities such as the Texas Higher Education Coordinating Board who, in turn, draw upon assessment specialists for expert assistance.

Why should the Coordinating Board consider value-added measurement? First, with clear information that benchmarks the value-added provided by academic programs, department leaders, deans, and university central administrators can more effectively develop suggestions that lead to continuous improvement of the quality of their academic programs. Eventually, after a period of internal development by institutions, much more appropriate public comparative benchmarking and accountability measures can be developed. Most crucial, too, is the potential, created by development of the value-added measurement approach, for development of new incentive systems to reward faculty. Now, Texas higher education institutions, like all others, have in place only measures of scholarly research that faculty feel comfortable with. But the research criteria are not relevant to the vast majority of the faculty employed in higher education institutions. Most of the institutions in the Texas higher education sector would benefit greatly if the reward system for their faculty was based to a much larger extent on the extent to which the instructor, department, or college adds value to the student's progress. Adopting a value-added approach also has the potential benefit of allowing the creation of a new vision of excellence for community

colleges and four year institutions in Texas that will determine how well Texas responds to the access challenges it faces.

The movement to adopt value-added measures in private higher education is underway. *(The Annapolis Group of 75 independent liberal arts colleges is focusing on establishing measures to define value added outcomes for its institutions.)* The Coordinating Board could take a leadership position for public higher education in recommending that value-added measures be implemented. This would, in our view, be a major step forward that would enable progress toward the ambitious goals the Coordinating Board will recommend for Texas higher education.

D. THE DELPHI EXERCISE

BACKGROUND

The Delphi Method was developed at RAND from studies on decision making that began in 1948. The seminal work, "An Experimental Application of the Delphi Method to the Use of Experts," was published in *Management Science* in 1963 by T. J. Gordon and O. Helmer. The primary rationale for the technique is the age-old adage "two heads are better than one," particularly when the issue is one where exact knowledge is not available. It was developed as an alternative to the traditional method of obtaining group opinions—face-to-face discussions. Experimental studies had demonstrated several serious difficulties with such discussions. Among them were: (1) Influence of the dominant individual. The group is highly influenced by the person who talks the most or has most authority. (2) Noise. Studies found that much "communication" in such groups had to do with individual and group interests rather than problem solving. (3) Group pressure for conformity. Studies demonstrated the distortions of individual judgment that can occur from group pressure.

The Delphi technique was specifically developed to avoid these difficulties. In its original formulation it had three basic features: (1) anonymous response—opinions of the members of the group are obtained by formal questionnaire; (2) iteration and controlled feedback—interaction is effected by a systematic exercise conducted in several iterations, with carefully controlled feedback between rounds; (3) statistical group response—the group opinion is defined as an appropriate aggregate of individual opinions on the final round.

Procedurally, the Delphi technique begins by having a group of experts respond on a subject of interest. Their responses are tabulated and fed back to the entire group in a way that protects the anonymity of their responses. They are asked to revise their own answers. This constitutes a second round of the Delphi. Its results are tabulated and

fed back to the group in a similar manner and the process continues until convergence of opinion, or a point of diminishing returns, is reached. The results are then compiled into a final group response.

One of the surprising results of experiments with the technique was how quickly in the successive Delphi rounds that convergence or diminishing returns is achieved. This helped make the Delphi technique a fast, relatively efficient, and inexpensive tool for capturing expert opinion. It was also easy to understand and quite versatile in its variations. By 1975 there were several hundred applications of the Delphi technique reported on in the literature. Many of these were applications of Delphi in a wide variety of judgmental settings, but there was also a growing academic interest in Delphi and its effectiveness.

In 1975, H. Sackman, also of RAND, published the first serious critique of the Delphi technique. His book, *Delphi Critique,* was very critical of the technique--particularly its numerical aspects--and ultimately recommended "that ... Delphi be dropped from institutional, corporate, and government use until its principles, methods, and fundamental applications can be experimentally established as scientifically tenable."[11]

More recent studies have concluded that Delphi does have potential in its original intent as a judgment-aiding technique, but that improvements are needed and those improvements require a better understanding of the mechanics of judgment change within groups and of the factors that influence the validity of statistical and nominal groups.

In the meantime, it is generally conceded that Delphi is extremely efficient in achieving consensus and it is in this direction that many of the more recent applications of the Delphi method have been used. Variations, such as the policy Delphi (Turoff, 1975), the decision Delphi (Rauch, 1979), and the adversary Delphi (Helmer, 1994), generally retain the anonymity of participants and iteration of responses. Many retain specific feedback as well, but these more qualitative variations

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[11]Sackman, Harold, *Delphi Critique*, Lexington Books, Lexington MA, 1975, p. 74.

generally drop the statistical group response. Whatever its limitations, Delphi is still a popular technique for collecting expert opinion. Literature searches show over 1000 applications of the Delphi method worldwide. Application areas range from the original purpose of technology forecasting, to measuring culinary learning, to predicting tourism, to assessing government performance, to quality assurance in podiatry, to projecting the futures of the food industry, business gaming, health care administration, and hypnosis.

APPROACH

The Delphi method was used in this research to collect expert opinion on the major issues that should concern planners today about the future of higher education in Texas. The specific form of the Delphi was one RAND has used before to identify issues in the future.[12] It posits a time traveler who will be available to the participant. The time traveler knows everything there is to know about the future, but is mute (ie., can only nod yes or no). The participants are asked what yes-or-no questions they would like to ask of the time traveler.

By requiring the participant to ask yes-or-no questions, the participant's specific concerns about the future can be discerned (as opposed to asking a question such as, "what's the world like?"). By invoking the time traveler, the participant is encouraged to think more specifically about the future. Indeed, in previous uses of this technique, the early rounds typically contain questions of more immediate concern, while the later rounds reflect more completely the broader perspective of the future. By feeding back each round's questions (anonymously) to all the participants, the subsequent rounds show strong evidence of convergence to a stable set of fundamental questions about the future.

Participants were given specific instructions for the Delphi and it was conducted in three rounds. The specific instructions for the first two rounds are shown below. For the third round, participants were

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[12]See, for example, Dewar, James A. and Morlie H. Levin, *Assumption-Based Planning for Army 21*, R-4172-A, RAND, 1992.

asked to respond with six questions rather than the 10 that were specified for the first two rounds.

SPECIFIC INSTRUCTIONS

Following is the exact text of the first round instructions for the participants:

Thank you again for agreeing to participate in RAND's modified Delphi exercise in support of our work for the Texas Higher Education Coordinating Board. To refresh your memory, the purpose of this exercise is to identify the most important issues facing Texas Higher Education in the coming 10 years. While there are several means for identifying important issues, the modified Delphi is particularly effective at getting people out of their "inboxes" and thinking several years into the future. In this exercise we are asking you to put yourself in the following situation:

> You have it on unimpeachable authority that a time traveler will appear to you early in the new millennium. That traveler comes from 10 years in the future and knows everything you could possibly want to know about the situation surrounding higher education in Texas in the year 2010. You will get to ask that time traveler 10 questions about that future. The single drawback to this extraordinary situation is that the time traveler is mute. S/he can only nod yes or no to your questions.

For each round of the Delphi exercise we would like you to submit the 10 questions you want to ask that time traveler about higher education in Texas in 2010. You may consult with anyone you like. The one restriction we ask you to observe is that you avoid contingent questions (e.g., "If the answer to question 3 is yes,...").

You may take as much time as you want on this exercise. That said, you have been chosen for this exercise knowing that you are a very busy person. You should be able to complete this exercise in less than an hour. After each round, we will send all of the responses (without

attribution--an important aspect of the Delphi process) to each participant. We will then ask you to revise your questions if you wish (based on the knowledge of what others have said) and resubmit them. This process will continue for three or four rounds at which point your commitment of time and energy is completed.

PARTICIPANT SELECTION

Participants were chosen from four different stakeholder groups, business leaders, education leaders, political leaders, and community leaders. An extensive list of possible participants in the Delphi exercise was compiled through a series of interviews in Austin. Key staff at the Texas Higher Education Coordinating Board (Commissioner Don Brown, Deputy Asst. Commissioner David Gardner, Susan Brown and David Gill) gave recommendations as to who should be contacted in Austin. Subsequent interviews with staff in the Offices of the Governor, the Lieutenant Governor, the Chairman of the Texas Senate State Education Committee, the Comptroller, the Legislative Budget Board, the Texas Workforce Commission, and the State Office of State Occupational Information Coordinating Committee all yielded further suggestions for the list. In addition, RAND and CAE research staff added names of their own contacts within the state.

Specific individuals contacted included:

- John H. Alexander, Senior Budget Analyst, Office of Budget and Planning, Governor's Office;
- Jeff Cole, Office of the Comptroller of Public Accounts;
- Laura Deviney, Higher Education Team Manager, Texas Legislative Budget Board;
- Chet Dombrowski, Financial Assistant, Senate Education Committee;
- Richard C. Froeschle, Executive Director, State Occupational Information Coordinating Committee;
- Juliet Garcia, President, University of Texas, Brownsville;
- Mark Hughes, Director, Labor Market Information, Texas Workforce Commission;

- Ron Lehman, Commissioner Representing Employers, Texas Workforce Commission; and
- Wanda J. Mills, Executive Director, Council of Public University

Presidents and Chancellors

- Diana Natalicio, President, University of Texas, El Paso; and
- John Stevens, Executive Director, Texas Business and Education Coalition.

A total of 347 contacts were generated for the master list. Of these, 20 were selected in each of the four arenas of business, politics, education, and the community. Contacts were selected if they were nominated by several people, and care was taken to include representation from a variety of state regions, as well as minority groups.

RESULTS

In all, 33 people participated in one or more of the three rounds of the Delphi. The primary results were derived from the people who took part in the third (and final) round.

Round 3 Results

Twenty-four people took part in Round 3 of the Delphi–6 from business, 5 from politics, 12 from education and 10 from the community. By the third round the participants were asking questions that were generally only minor modifications of those from previous rounds. This allowed us to group the answers by general question and display them in three different ways. The first display is by the top questions (issues) from each of the four stakeholder groups.

The top questions from the *business* community were:

- Do college graduates have work-ready skills that minimize retraining in the workplace?
- Are there strong links with local, state and national business and industry Curriculum Advisory Groups that encourage proactive development of new techniques, courses, fields of study and research?

- Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?

The top questions from the *political* leaders were:

- Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?
- Has the percent of students requiring remediation decreased?
- Are graduate and professional educational opportunities available in all major geographic regions of the state?
- Will tenure, as we know it, endure?

The top questions from the *education* community were:

- Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?
- Has Texas implemented a statewide taxing structure to address the service area responsibilities of community colleges?
- Has Texas developed a program of incentive funding for colleges and universities based on performance?
- Have Texas Higher Education institutions demonstrably improved their "teacher education" programs and achieved a substantially higher level of certified teachers needed in public schools?

The top questions from the *community* leaders were:

- Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?
- Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years?
- Does the state system which holds institutions of higher education accountable for student outcomes have indicators that monitor and examine the numbers of minority pupils who are admitted into the

Texas public college and university system who go on to graduate either from within or outside that system?

- Has Texas developed a program of incentive funding for colleges and universities based on performance?
- In collaboration with the Texas Education Agency, did the Texas Higher Education Coordinating Board, with the support of the Texas Legislature, produce a workable plan to absorb the statewide growth in demand over the past decade for access to educational opportunities of high quality at the associate, baccalaureate, master's, doctoral, and first professional degree levels?

The second display is by overlap among groups. That result is shown in Figure D.1.

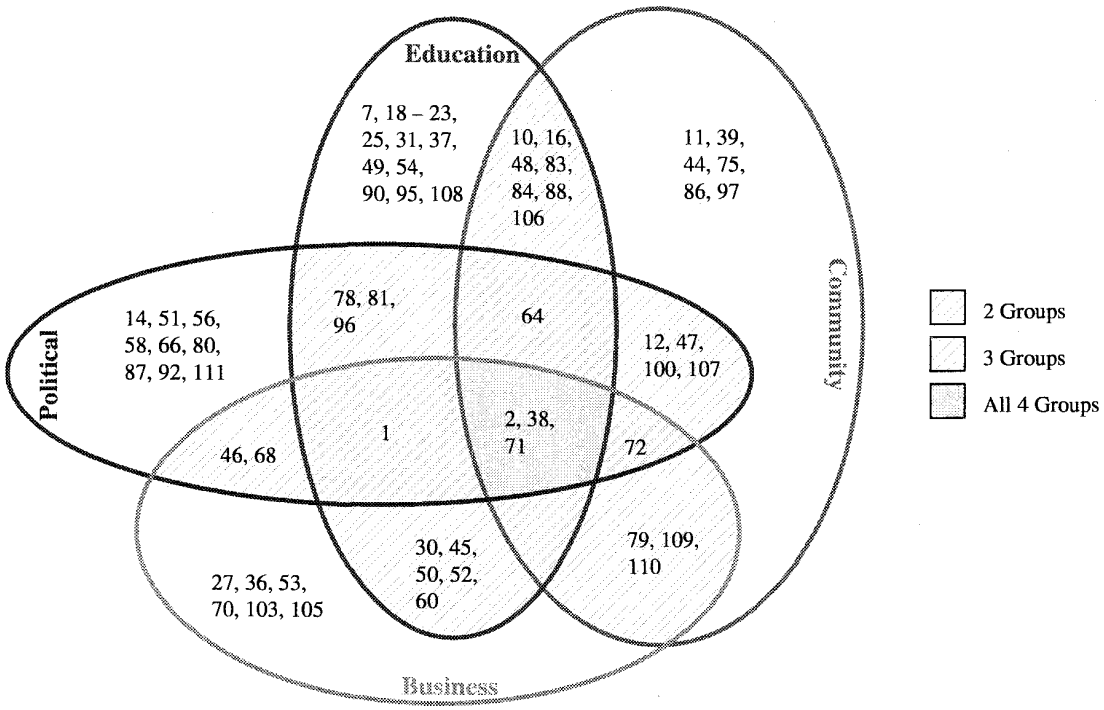

Figure D.1–Final Round Questions From Each Stakeholder Group

The numbers in Figure D.1 are the numbers of the questions that made up the responses for the third round of the Delphi. The questions themselves can be found in Table D.1. The number of questions in each of the overlaps of the ovals in Figure D.1 are shown in Figure 1 of the main text.

The final display is by overall "popularity" of question asked. The most frequently asked questions were:

- Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?
- Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly

equivalent to the percent of that ethnic group in the general Texas population?

- Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years?
- Has Texas implemented a state-wide taxing structure to address the service area responsibilities of community colleges?
- Are all Texans who want to pursue a higher education degree able to secure the financial means and academic preparation to attend college?
- Has Texas developed a program of incentive funding for colleges and universities based on performance?
- Do the graduates being produced by Texas Higher Education reflect the occupational needs of the state's industries?

The results from Round 3 of the Delphi are not "statistically significant." That is, they do not represent a statistically rigorous sampling of the stakeholder communities. Further, the participation among those who were selected was uneven. As a "sanity check" on the robustness of the resulting concerns, we looked at the "cumulative" results from all three of the rounds.

"Cumulative" Results

To derive the "cumulative" results, we looked at the latest responses from each of the participants in the Delphi process. For those people who participated in Round 3, those results were used. For those people who last participated in Round 2 or Round 1, those results were used.

In this case we show only the overlap among groups from these "cumulative" results and the overall "popularity" of questions asked. The overlap is show in Figure D.2. In the way Figure D.2 was formed, Figure D.1 is a subset of it in the sense that a given question will overlap at least as much in Figure D.2 as it did in Figure D.1. For example, in Figure D.1, question 1 overlapped in three of the four stakeholder groups and in Figure D.2 it overlapped in all four.

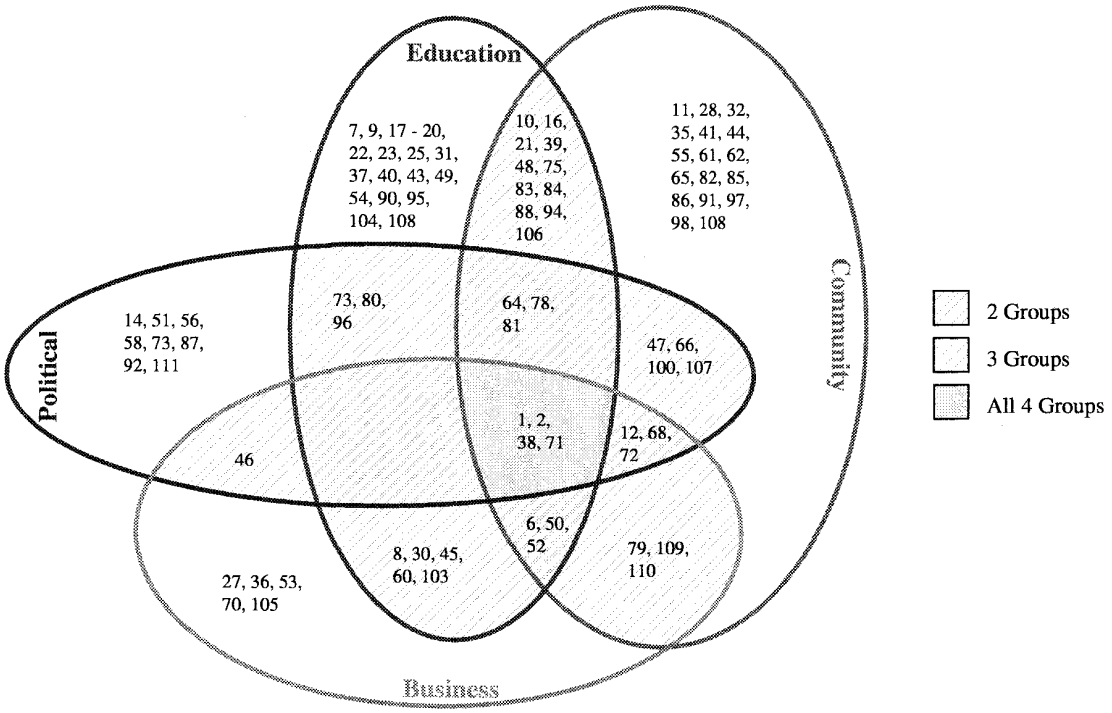

Figure D.2– "Cumulative" Questions from Each Stakeholder Group

In Figure D.2, there were more respondents (33 to 24) and more questions allowed for those extra respondents (10 to 6) than in Figure D.1. What is significant is how little the overlaps increased in going from Figure D.1 to Figure D.2. Questions that appeared in the lists of all four stakeholder groups increased from 3 to 4 and those that appeared in three of the four stakeholder groups increased from 3 to 9. This suggests that in the results from Round 3, those questions or issues that overlapped all four groups are, indeed, significant in their unanimity as concerns to all four of the stakeholder groups.

The most popular questions in the "cumulative" results were:

- Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?

- Do the graduates being produced by Texas higher education reflect the actual workforce needs of both public and private sector employers in Texas?
- Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years?
- Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?

All four of these questions also appeared in the most "popular" list from Round 3, which again suggests that the results of Round 3 reasonably represent those responses that we got from the stakeholder groups throughout the Delphi exercise.

Table D.1—Questions From Round Three

GOVERNANCE AND MISSION ISSUES

1. Is the Texas higher education system receiving national/international recognition for its contribution to the state's innovative capacity and economic growth?

2a. Are there systemic, ongoing mechanisms that create linkages between higher education and public elementary and secondary schools in a manner that increases the successful transition of students from K-12 schools to higher education institutions?

2b. Are there systemic, ongoing mechanisms that create linkages between higher education and public schools in a manner that increases a seamless relationship for students from K-16?

3. How many university 'systems' exist in Texas?

4. Will Texas Educational Systems have international locations?

5. Will higher education look significantly different in 2010 than it does now?

6. Have Texas universities been relieved of the burden of having to comply, uniquely among the 50 states, with the Fifth Circuit Court of Appeals' Hopwood decision, and may they now take race and ethnicity appropriately into account in making student admissions and financial aid decisions?

7. Have any of the public Texas community colleges or universities functioning in 2000 gone out of existence?

8. Has the Texas Legislature established an appropriate mix of expectations and incentives for community colleges statewide to give

significantly heightened emphasis to college transfer as compared to vocational/technical program opportunities for students?

9. Has the Texas Legislature established and adequately funded a Research University Fund, parallel to the Permanent University Fund, that has succeeded in establishing at least the University of Houston and Texas Tech University, and possibly other Texas universities as well, as recognized "Tier One" national research universities along with the University of Texas-Austin and Texas A&M University-College Station?

10. Does the state system which holds institutions of higher education accountable for student outcomes have indicators that monitor and examine the numbers of minority pupils who are admitted into the Texas public college and university system who go on to graduate either from within or outside that system?

11. Have the detrimental effects of the Hopwood decision been overcome at both the undergraduate and graduate level?

12a. Are graduate and professional educational opportunities available in all major geographic regions of the state?

12b. Are undergraduate, graduate, and professional educational opportunities funded at equivalent levels in all major geographic regions of the state?

13. Has the number of reports which colleges and universities are required to file with the state declined?

14. Currently, two of Texas' 35 public universities are recognized as flagship institutions. Maintaining that ratio, has Texas fallen behind her peer states in her ability to deliver quality higher education and produce progressive research?

15. Are the majority of the services traditionally provided by Student Services Divisions being contracted?

16. Has Texas implemented a state-wide taxing structure to address the service area responsibilities of community colleges?

17. Has the inequity in capital funding between universities funded by the Permanent University Fund and those supported by the legislatively funded Higher Education Fund been permanently resolved through a long-term plan and funding commitment by the Texas Legislature?

18. Will the Texas Higher Education Coordinating Board exist in 2010?

19. Has the role of the Texas Higher Education Coordinating Board become less regulatory and more leadership oriented?

20. Will regional accreditation (such as SACS) continue to be viable in the higher education community in Texas?

21. Has the organizational structure of Texas higher education been significantly changed?

22. Has local control of community colleges, as it presently exists, continued in the State of Texas?

23. Has the Legislature mandated full transfer of all Associate Degree credits from Texas community colleges to Texas public universities?

24. Is the Texas Higher Education System contributing to the innovative capacity of the state's public education system?

25. Has the process for transferring credits between universities been streamlined/better coordinated between colleges/universities?

CURRICULUM ISSUES

26. Will Education provide life-long career mapping and adult learning services to graduates?

27. How do universities and education bureaucracies respond to the very rapidly shifting and evolving skill and training needs that (will) characterize the "Information Age"?

28. Has Texas higher education focused on training for high technology jobs to the detriment of preparing students for life long learning?

29. Do states have a statewide higher education placement examination or individual placement exams?

30a. Has distance learning reduced the need for traditional classroom instruction?

30b. Has distance learning either reduced the need for traditional classroom instruction, or expanded the learning options?

31. Are any Texas community colleges authorized to offer baccalaureate degrees?

32. Has the number of "years to graduation" for students in higher education been reduced by using assessment instruments or procedures which grant academic credit for "demonstrated competencies" rather than for "seat time" in required courses?

33. Does the Texas Academic Skills Program exist?

34. Have there been any significant changes in athletic programs that will affect student enrollment, funding, and/or academic programs of colleges/universities?

35. Has sufficient funding and support been provided for the expansion of high school programs designed to assist students entering scientific and technical fields, such as TexPrep and TechPrep?

ECONOMIC ISSUES

36. Are there more students eligible for financial aid from state and federal programs?

37. Is Texas providing free tuition and fees for all qualified higher education students?

38. Are all Texans who want to pursue a higher education degree able to secure the financial means and academic preparation to attend college?

39a. Has available financial aid and scholarship support kept pace with increases in tuition and fees at public universities in Texas?

39b. Has available financial aid and scholarship support kept pace with increases in tuition and fees at public two-year colleges and universities in Texas?

40. Did the Texas Higher Education Coordinating Board succeed in devising through its Formula Advisory Committee a truly cost-based and biennially updated funding formula for the operation of universities, differentiated appropriately by disciplinary groupings and weighted by levels of instruction from lower division to doctoral/first professional, that was accepted by the Texas Legislature?

41. Has the Legislature or the THECB incorporated outcomes measures in formula funding allocations?

42. Will the economic condition of Texas and Texans improve over the next ten years?

43. Has the Texas Legislature recognized and acted appropriately on addressing the need to permit public universities to retain 100 percent, rather than the current 50 percent, of the indirect cost recovery income they earn through externally sponsored research and training programs?

44. Is the percentage of Texas public college and university non-need scholarship/financial aid awarded to minority students enrolled in the Texas public college/university system equal to or greater than the non-need scholarship/financial assistance awarded to non-minority pupils enrolled in that system in the year 2010?

45. Has the State Legislature provided full funding for the community college formula?

46a. Did Texas increase funding for the TEXAS grant program to enable all eligible students the opportunity to attend college?

46b. Has the state's financing of colleges/universities been restructured to facilitate enrollment by making the cost of a college/university education more affordable to all students?

47a. Are institutions of higher education in the border region and other remote areas of Texas still funded below parity with per capita expenditures for higher education in Central and East Texas?

47b. Are institutions of higher education in the border region and rural areas of Texas still funded below parity with per capita expenditures for other higher education systems?

48a. Has Texas developed a program of incentive funding for colleges and universities based on performance?

48b. Are all higher education institutions funded sufficiently and efficiently through performance funding so that students in all parts of the state have equal opportunity to be successful?

49. Did the Texas Legislature provide sufficient funding to enable institutions of higher education to partner with public schools to improve college participation?

50a. Will the state legislature become aware of how significant the contribution of higher education is to economic growth, and therefore, support higher education more steadily?

50b. Does the State of Texas continue to fund higher education at approximately the same ratio as in 2000?

50c. Has the Texas legislature increased by at least 50% its per capita financial support of higher education?

50d. Have real per capita appropriations on higher education in Texas increased over the past 10 years?

50e. Has Texas acknowledged the critical importance of higher education to the future vitality of the state by systematically improving state funding for all higher education components?

51a. Are all higher education institutions funded sufficiently and efficiently through performance funding?

51b. Are all higher education institutions funded sufficiently and efficiently through performance funding or some combination of formula funding with outcome measures?

INTERACTIONS WITH THE BUSINESS COMMUNITY

52. Will institutions of higher education reach out to the communities in which they sit in an effort to become a part of the solution rather than a part of the problem vis-a-vis community issues and problems?

53a. Are graduating students generally perceived by hiring businesses as being "ready to work productively" on Day 1 of their employment"?

53b. Do college graduates have work-ready skills that minimize retraining in the workplace?

54. Will the need for some type of post-secondary education and/or training to be competitive in the labor market increase?

55a. Are students required to have related work experience in their discipline prior to graduation (e.g. internships, co-op programs, summer jobs, etc)?

55b. Are a variety of career exploration opportunities available to interested students throughout their middle school and high school years?

56. Are community and technical colleges working with secondary schools to deliver vocational/technical programs that are aligned from grades 8-14, and that equip students with the technical skills needed to meet workforce demands?

57. Does the current (2010) labor market still value basic skills (reading, writing and computation) training over more focused technical training?

58. Will graduating students have valid performance "predictability" measures cross-walked to industry performance standards?

59. Have curricula kept pace with or led advances in technologies used by businesses (e.g., computers, manufacturing systems, finances, Human Resource systems, etc)?

60. Are there strong links with local, state and national business and industry Curriculum Advisory Groups that encourage proactive development of new techniques, courses, fields of study and research?

61. Are other states or countries seeking to replicate the mechanisms that Texas higher education institutions have developed to

encourage the transfer of technology from the state's higher education institutions to the state's businesses?

62. Have institutions, industry and businesses worked as partners to create easy-to-implement processes for matching students up with pre- and post-graduation job opportunities?

63. Do college curricula encourage students to work in multi-discipline teams to solve business-related problems?

64a. Do the graduates being produced by Texas Higher Education reflect the occupational needs of the state's industries?

64b. Does Texas produce an adequate number of sufficiently skilled graduates to meet the needs of Texas industries?

64c. Do the graduates being produced by Texas higher education reflect the actual workforce needs of both public and private sector employers in Texas?

65. Have Texas higher education institutions improved their national ranking in terms of royalty income generated by the transfer of technology from the state's research institutions to the state's businesses?

66. Does Texas have a well-publicized, statewide Internet-based job matching and training program?

67. Has the business sector expanded its offering of non-credit educational offerings compared to the year 2000?

MEASURES OF QUALITY & ACCESS

68. Is the percentage of minorities employed at the upper echelons of Texas college and university administration (Presidents, Vice Presidents, Provosts) proportionate to the minority student enrollment at Texas colleges and universities in the year 2010?

69. Have alternatives to admission criteria used prior to the year 2000—i.e. SAT, ACT, class rankings—been identified and used?

70. Have Texas SAT and ACT admissions scores reached the national average?

71a. Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years, such that student bodies of undergraduate, graduate and professional schools reflect the state's population?

71b. Has the gap in educational attainment between minorities and non-Hispanic whites in Texas narrowed during the past ten years?

72a. Is the percentage of undergraduate, graduate, and professional degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?

72b. Is the percent of undergraduate and graduate degrees earned by members of each major ethnic group in Texas roughly equivalent to the percent of that ethnic group in the general Texas population?

73a. Has the baccalaureate graduation rate of minority students at Texas public universities achieved parity with that of non-minority students?

73b. Have the minority enrollment, retention and graduation rates at Texas institutions shown any improvement?

74. Did graduate degrees available in South Texas (South of San Antonio) colleges/universities increase after the year 2000?

75a. Is undergraduate enrollment more representative of the statewide population demographics?

75b. Has Texas substantially increased the number and percentage of minority students who attend college?

75c. Is student enrollment in Texas Colleges/Universities more representative of the state's population . . . i.e., ethnicity, socio-economic status.

76a. Is the racial and ethnic makeup of the Texas population what was projected 10 years ago?

76b. Is the racial makeup of the Texas population that what was projected 10 years ago?

77. Has the number of international students in Texas increased significantly?

78. Are the majority of high school graduates in Texas still completing only the "minimum high school curriculum" rather than the "recommended high school program" which requires additional courses in math, science, and communication skills?

79a. Do community colleges continue to have a relatively large (30%) percentage of their students taking developmental ed courses?

79b. Has the percent of students who are required to take one or more developmental courses upon entering Texas higher education been reduced from the 50% level in the 1990's to 25% or less in 2010?

79c. Are the community colleges and the 4-year institutions still doing remedial education?

80a. Has the percent of students requiring remediation decreased substantially?

80b. Has the percent of students requiring remediation decreased?

80c. Over the next ten years will there be less students entering higher education in need of remediation?

81. Has the Texas Legislature provided an appropriate mix of expectations and incentives to sharply reduce, if not eliminate entirely, the need for remedial/developmental courses in universities,

shifting the offering of such courses to community and technical colleges?

82. Are community colleges in Texas still permitted to award college credit for courses taught in a high school even though students do not demonstrate college-level competency on a standardized assessment such as the Advanced Placement Exam of the College Board?

83a. Have the college-going rates of Texans reached the national average?

83b. Has Texas substantially increased the percentage of high school graduates who attend college?

83c. Have effective linkages and/or responsive strategies been implemented by Colleges/Universities to increase the number of high school graduates who continue into higher education and attain a college degree?

84. During the next ten years will the trend of more and more university bound students taking the first two years at community colleges continue?

85a. Has Texas substantially increased the rate at which students complete the baccalaureate degree within six years of their admission to college?

85b. Is the average graduation rate for full-time students under five years?

86a. Did the Texas Higher Education Coordinating Board, with the support of the Texas Legislature, produce a workable plan to absorb the statewide growth in demand over the past decade for access to educational opportunities of high quality at the associate, baccalaureate, master's, doctoral, and first professional degree levels?

86b. In collaboration with the Texas Education Agency, did the Texas Higher Education Coordinating Board, with the support of the Texas Legislature, produce a workable plan to absorb the statewide growth in

demand over the past decade for access to educational opportunities of high quality at the associate, baccalaureate, master's, doctoral, and first professional degree levels?

87. Have testing and placement of students become a local decision with statewide benchmarking and implications?

TECHNOLOGY ISSUES

88. Has research indicated that the new technology significantly increased educational opportunities and learning for students?

89. Are web-based virtual universities increasing the number of college graduates?

90. Has the percentage of higher education services delivered through electronics increased significantly since the year 2000?

91. Do Texas higher education institutions still rank in the top 10 nationally in terms of start-up companies created for the purpose of transferring technology from the state's research institutions to the state's businesses?

92. Does Texas have a quality secondary school technology education system?

93. Will resident students have the opportunity to supplement their studies via accessing distance learning courses from a competing institution?

94. Has enrollment in distance education programs caused a decline in enrollment on Texas public university campuses?

95. Will "the virtual college of Texas" be a pervasive deliverer of courses to students in Texas?

96. Has the percentage of students enrolled in higher education via some type of distance learning technology gone above 15% of total enrollments?

97a. Will distance education--as a part of the enterprise of higher education--continue to expand?

97b. Will distance education--as a part of the enterprise of higher education--continue to expand and serve the needs of the students in all regions of Texas?

98. Has the increased use of distance learning provided more Texans a quality higher education in a more cost-efficient manner?

99. Will distance education bifurcate learners into "haves" and "have-nots", with those having money and leisure able to afford time on campus, and those without either money or leisure having to settle for instruction via distance learning technology?

100. Has Texas fully implemented the concept of the "virtual college" as a means of delivering quality higher education to placebound students, especially working adults?

TEACHERS AND FACULTY

101. Has instructional technology diminished the role of the faculty?

102. Will teaching excellence rise to the level of research excellence as a criterion for promotion and tenure?

103. Are Texas higher education institutions able to offer attractive salaries and benefits sufficient to lure the nation's most talented and prestigious faculty?

104. Has the implementation of post-tenure review policies for faculty members been successful at the majority of public universities

throughout Texas, particularly at the state's major research universities?

105. Is the public and K-12 system satisfied with the quality of graduates from our teacher training institutions?

106a. Has Texas demonstrably improved its "teacher education" programs and achieved a substantially higher level of participation in these programs?

106b. Has Texas Higher Education institutions demonstrably improved its "teacher education" programs and achieved a substantially higher level of certified teachers needed in public schools?

107a. Will tenure, as we know it, endure?

107b. Does tenure exist for faculty?

107c. Has tenure been abolished by law?

108. Is the Texas Higher Education System responsive to the ever-increasing professional staffing needs of the public education system?

ACCOUNTABILITY

109a. Is there an accountability system in place for the performance of public colleges and universities?

109b. Has an accountability system, which holds Texas' Colleges/Universities accountable for results, been developed and implemented?

110. Does the Texas higher education accountability system in the year 2010 incorporate significant fiscal consequences for persistent minority under-representation in recruitment, retention, or graduation rates?

111. Are all universities able to file clean annual financial reports?

E. DATA SOURCES

The data used in this analysis include detailed population estimates and projections, projections of labor market supply and demand, records of enrollment and graduation in Texas public institutions of higher education, and statistics on higher education participation and degrees granted in the 10 most populous U.S. states. The model this study used to generate projections of education statistics relied mainly on demographic (population) data and records of graduation and enrollment in the higher education system.

MANIPULATION OF DATA USED IN MODELING

The first step in modeling participation and graduation rates was to create a spreadsheet displaying past rates of participation, advancement, dropout, returning after absence, transfer between territories and institution, and graduation. These spreadsheets displayed these rates by gender, race/ethnicity, institution type, class year, territory, and engineering/non-engineering/non-major status. In the case of participation, the rates were broken down by territory of school attended. In the case of transfers, they were broken down into territory or institution-type *from* which students transferred and territory or institution-type *to* which students transferred.

In most cases, these rates were generated by merging enrollment records from one year (1997) with enrollment or graduation data from a second year (1998). Thus advancement rates represent tabulations of the percentage of students in various categories who were, for example, classified as first-year students in 1997 and as sophomores in 1998. Dropout rates are tabulations of the percentage of students in various categories who were present in 1997 data but not present in 1998 data. Graduation rates were generated by tabulating the percentage of students in various categories who were enrolled in 1997 and graduated in 1998. Transfer rates were tabulating by examining the territories and institution-types of those present in the 1997 data, and then tabulating

the percentage of those whose institution-type or territory in 1998 differed from their institution-type or territory of 1997.

Participation rates and rates of returning to school were generated by tabulating the number of students (by Texas territory of residence) enrolled in 1997 who were first-time students or returning to school after an absence of a year or more, and then dividing by the total population of various territories. In other words, the participation rate of territory 1 would be the number of first-time students in 1997 in Texas who were residents of Territory 1. Students returning after an absence were identified by a method similar to that described in the previous paragraph: those who were enrolled in 1997 but not in 1996, provided they weren't first-time students in 1997, were counted as having returned after an absence.

Inasmuch as the model relies on advancement, dropout, transfer, and graduation rates experienced between 1997 and 1998, its central assumption is that the rates observed between these years are representative of rates as a whole, and that these rates will remain constant in the near future. In all the above cases, students who were residents of other states or other nations were excluded, such that participation and other rates reflect only the rates of students who were legal residents of Texas.

POPULATION ESTIMATES AND PROJECTIONS

To estimate and project demographic changes in Texas, population estimates and projections were obtained broken down by race and ethnicity, gender, age, and county. Population estimates for the years 1990 through 1999 were obtained online from the Bureau of the Census, U.S. Department of Commerce, at http://www.census.gov/. Population projections for the years 2000 through 2015 were obtained by request from the Texas State Data Center at Texas A & M University in College Station. All projections used in this project employed the state's 1.00 scenario, which assumes that the trends in the age, sex and race/ethnicity net migration rates of the 1980s will characterize those occurring in the future of Texas. This scenario is the most-requested series for projection data.

Population estimates and projections were used to find participation rates and project these into the future for various segments of the population.

LABOR MARKET SUPPLY AND DEMAND

Detailed estimates of labor market supply and demand broken down by the 28 Texas Workforce Development Areas were obtained online from the Labor Market Information department of the Texas Workforce Commission at http://www.twc.state.tx.us/lmi/. Specifically, Texas Workforce Commission data display the number of persons employed in various occupations, and project employment growth ten years into the future (1996-2006). A five-digit code identifying each occupation (Occupational Employment Statistics, or OES, code) was used to match these labor market estimates and projections with data on coursetaking. Using the so-called data "crosswalks" obtained online from the National Occupational Information Coordinating Committee (NOICC) Crosswalk Data Center (NCDC) at http://www.state.ia.us/ncdc/xw_xwalk.html, OES codes were matched with the Classification of Instructional Program (CIP) codes used in Texas to identify areas of study in the Texas higher education system. Additionally, occupations were grouped into four broad categories: (1) engineering occupations requiring a bachelor's degree or higher, (2) engineering occupations requiring an AA degree or certification, (3) non-engineering occupations requiring a bachelor's degree or higher, and (4) non-engineering occupations requiring an AA degree or certification. Occupations for which no degree or certification was required were omitted from the labor market analysis. These classifications were created using information on educational requirements of various occupations obtained from the Texas Workforce Commission.

RECORDS OF ENROLLMENT AND GRADUATION

Electronic enrollment and graduation records obtained from the Texas Higher Education Coordinating Board were the primary basis of determining past rates of participation, graduation, advancement, and transfer between institution type and territory. Enrollment and

graduation records obtained from Texas included data files from 1994 to 1998. These data are reported annually by Texas institutions of higher education, including both public universities and community colleges, in state-mandated data reports. Enrollment or student data is reported by higher education institutions on the 12th day of classes for the Fall and Spring terms, whereas graduation data reflects all degrees conferred in a given fiscal year.

The enrollment data files contain 23 variables; in this study, only the following of these variables were used:

- Institution code (FICE), a numeric code identifying the institution of higher education
- Student identification number
- Gender
- Classification, the class-year of the student, which in Texas is determined by credits completed and thus does not necessarily match the number of years of college completed
- Date of birth, used to obtain the age of the student
- Residence, a code identifying the legal residence of the student, whether Texas county, other U.S. state, or foreign country
- Ethnic origin, which is recorded as either (1) white non-Hispanic, (2) black non-Hispanic, (3) Hispanic, (4) Asian or Pacific Islander, (5) American Indian or Alaska Native, (6) International, or (7) other. In this study, all students classified as Asian or Pacific Islander, American Indian or Alaska Native, International, or other were reclassified as white non-Hispanic for simplicity's sake. These groups accounted for less than 2 percent of the total population of students in the study.
- Major area of concentration, identified by Classification of Instructional Program (CIP) code. Students classified in CIP codes with the prefixes "14" and "15" (engineering and engineering-related technologies, respectively) were coded as engineering majors, while others were classified as non-

engineering majors. Because many institutions did not update students' CIP code after students selected a major, some students were classified under the CIP prefix "99," indicating no recorded major choice.

For the graduation data files, the above variables were extracted, plus one other variable identifying the level of degree conferred. For graduates of public universities, this variable is coded as follows: (1) associate, (2) baccalaureate, (3) master's, (4) doctoral, and (5) special/professional. For graduates of community and technical colleges, the variable is coded: (1) associate, (2) certificate, (3) enhanced skills certificate. In this study, graduate degrees were omitted, and certificates and enhanced skills certificates were recoded as associates--thus in this study "AA" refers to any degree or certificate conferred by a community or technical college.

Using maps and other materials provided by the Texas Higher Education Coordinating Board, institutions were grouped according to the Carnegie Classification of higher education institutions. The three institution types are: community and technical colleges, regional universities, and research institutions (with Texas A&M, UT-Austin, the University of Houston, and Texas Tech University classified as research institutions). Also using these sources, institutions were grouped by geographic territory.

COMPARISON STATISTICS FOR TEN MOST *POPULOUS* STATES

Data on higher education enrollment, participation, graduation, and funding were obtained from the 1999/2000 Almanac issue of The Chronicle of Higher Education, published August 27, 1999.

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