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**GRADUATE  
RESEARCH  
CENTER**

**INCORPORATING  
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THE GRADUATE RESEARCH CENTER, INC.

“The purposes for which this corporation is formed are educational and civic; that is to say, this corporation is formed to support and encourage the advancement of knowledge in the pure and applied sciences. . . .” —From the Charter of the Graduate Research Center, Inc.

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**Graduate Education  
In the Southwest**

*A*

*Development Plan*

for the

*Graduate Research Center*

*of the*

*Southwest*

**A Preliminary Study**

**March 29, 1961**





*Journal of the*  
**GRADUATE RESEARCH CENTER**

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## PURPOSE

THE PURPOSE OF THE GRADUATE RESEARCH CENTER OF THE SOUTHWEST IS TO ACT AS A FOCAL POINT AROUND WHICH SIMULTANEOUS MEASURES CAN BE INITIATED VOLUNTARILY TOWARD THE CREATION OF A SIGNIFICANT AND DISTINGUISHED GRADUATE ACADEMIC PROGRAM IN THE REGION.

## FOREWORD

The preliminary study presented herewith had its inception in conversations with Mr. J. Erik Jonsson early in 1958 when he outlined to me the serious problems facing the intellectual and economic growth of the Southwest in this technological age. Mr. Jonsson pointed out that many of the leaders of the Southwest community realized the imperative need for the generation of an intellectual and scientific climate in the region to ensure its healthy development. To achieve this climate, the graduate education in the region must be augmented.

The idea of advancing graduate education in the region by direct financial support for research and graduate faculty is of course obvious. To accomplish this, and to overcome certain local problems, a group of public-spirited citizens had set up the Graduate Research Center at Southern Methodist University. The purpose of this initial Center was to encourage the graduate effort at S.M.U. by direct broad support of graduate activities. This experimental effort had the strong leadership of President Willis Tate and Dr. Claude Albritton, Dean of the Graduate School of S.M.U.

Among the community leaders supporting this effort were the distinguished members of the Board of Trustees of the S.M.U. Center listed on the inside of the cover page. The Board recognized that distinguished graduate training could not be accomplished without research facilities well beyond the present capabilities of the region. It realized, moreover, that a substantial enhancement in the qualities of existing faculties was required if graduate education were to flourish in the region. The Board accordingly visualized a partnership between the community represented by business, industry and finance on the one hand, and the universities on the other, as a means of achieving the desired objectives. The problem was to determine the *modus operandi* of such cooperation.

This Board invited me to sit with them from time to time to evaluate the effectiveness of their efforts and to explore the basic regional problem in greater detail. It soon became evident that the problem was much more complex than mere requirement for direct support. As rapidly as faculty were qualified or found for the graduate school, they came under intense pressure to go to the more scientifically and technologically advanced regions of the country.

Thus the mortality of graduate faculty positions was too great to anticipate success with financial support of graduate schools as the sole measure. Broad measures must be taken on a regional base to create the scientific-intellectual climate that could neutralize the intense competition from the already technologically advanced regions of the country.

The challenge appeared so great that on December 1, 1960, I decided to devote my major effort to its development. In this I have had intimate cooperation from Mr. Jonsson and from many other leaders in the community. In particular, Mr. McDermott, Mr. Green and Dr. Tate have given liberally of their time, and I have benefitted from discussions with Mr. Karl Hoblitzelle, Mr. Eugene McElvaney, Mr. Stanley Marcus and the late Mr. Fred Florence. The administration of S.M.U. has cooperated intimately and has graciously provided housing and facilities to make possible the initial organization of the Graduate Research Center of the Southwest and to assist in the present study.

During the course of this study, which was initiated in April, 1960, many leaders of universities and of the Southwest community have been consulted. Likewise, many industrial leaders have entered into discussions of the relation of applied research facilities which might be organized in juxtaposition to the Center. In particular, Mr. Dean McGee of Oklahoma City, President of the Frontiers of Science Foundation, and Mr. James E. Webb, formerly President of the Foundation, have been most helpful in consideration of the regional problems that are posed. It is a matter of regret that time has not permitted more extensive conversations with leaders throughout the Southwest. We genuinely hope that these deficiencies will be remedied in the forthcoming months.

During the course of the study, it has been widely discussed with a number of prominent educators and national leaders outside of the region. One respected President of an outstanding university in the Northeast, after careful study, comments typically:

I think the general idea is good, and as I went through the pages, one after another of my most important reservations were answered. . . . I find very appealing the broad concept of this center as a means of supporting [the work of] the universities of the Southwest, encouraging graduate study, providing facilities without which it would be impossible to draw first-class people to these academic institutions, and finally the idea of critical size, which is indispensable to a successful operation.



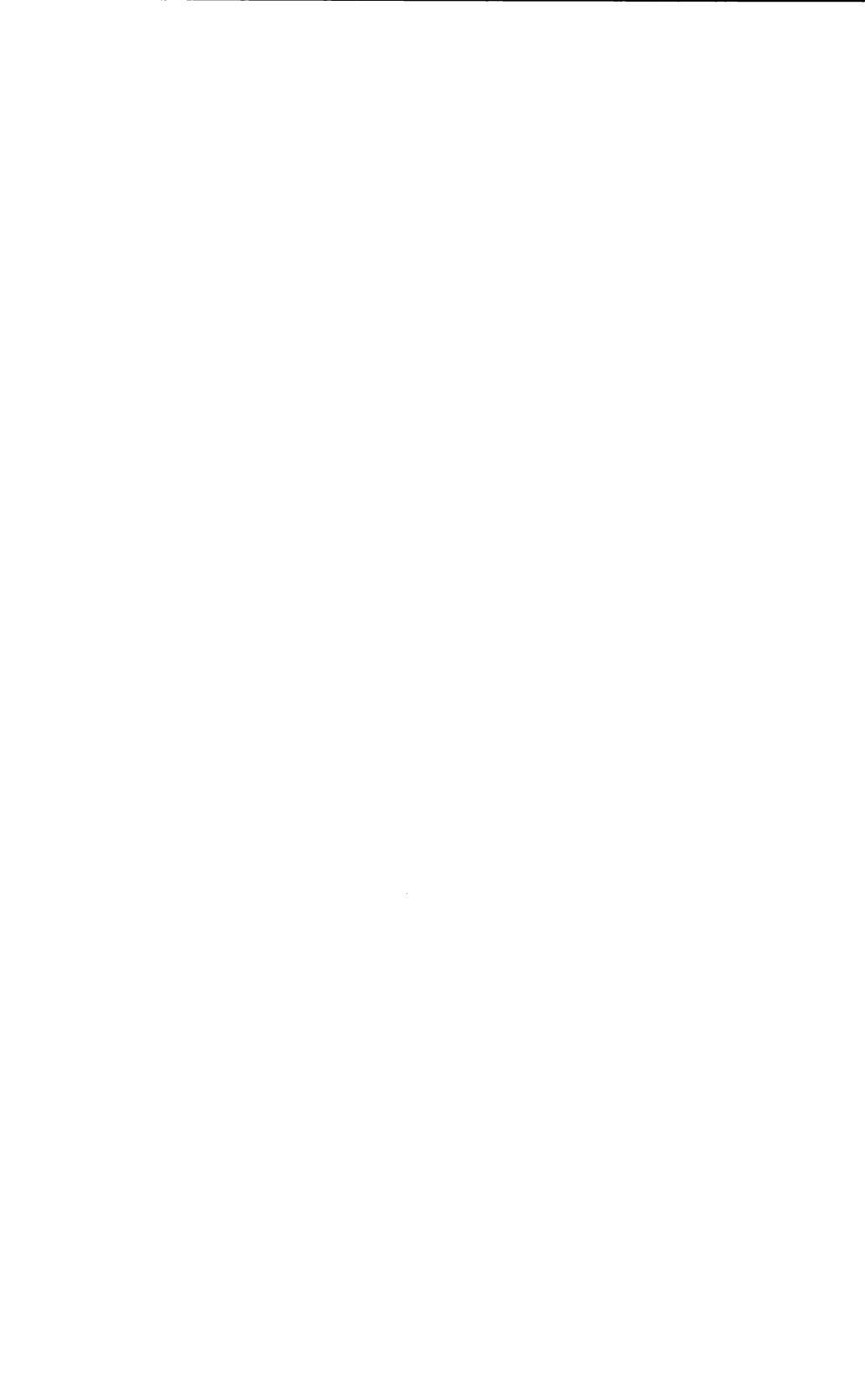
And now the fundamental question still remains. That is, simply, is the time ready, have conditions matured to the point where the idea is actually feasible, even with energy and drive? I have no reservations about the support that will be received from local industry and from outstanding citizens [of the region]. I have no question, either, about the sincerity and effectiveness of the support that will be received [from the leaders of the universities of the region]. The willingness is there, but I am not so sure whether as yet there are really adequate academic resources. . . . Obviously there are a lot of problems. This you know better than I. Nonetheless, I think it a highly interesting idea, and I stand ready to give whatever assistance that I can.

The questions raised here—Is the time right, and are the academic resources adequate to trigger the critical response?—penetrate, of course, to the heart of the problems ahead.

In part, their answers must come from the sustained response of the community, not just in monetary support, but in a deep belief in the capabilities of its people and a resolute determination for accomplishment. In part the answer will come from the academic dynamics in time whereby improved opportunities will encourage men to rise to greater heights of scholarship. My own association with the people of the Southwest gives me confidence that both questions can and will be answered affirmatively.

In my conversations and studies I have been deeply impressed by the breadth of vision and understanding of Southwestern leaders of the universities and of the community alike. These men have grasped the underlying values of our rapidly evolving civilization and are determined to bring them to the people of the region. There can be no doubt that this momentum is increasing. The purpose of this study is to focus the effort through sound planning and mutual help.

L. V. BERKNER, *President*  
GRADUATE RESEARCH CENTER  
of the Southwest



# Graduate Education in the Southwest

## I. THE PROBLEM

The founders of the American political system clearly believed that the secrets of nature must be better known so that they might be used to advance the welfare of all our people. ... From the very outset of our republic the government of the United States has sought to encourage Science and learning.

DWIGHT D. EISENHOWER  
Washington, 1959

In the growth of any geographic area, its development proceeds through a succession of major phases. Among these are pioneering settlement and organization of government, enrichment and basic capitalization of the area through development of natural resources and basic education, and finally mature industrial development solidly founded on the growing skills and advanced education of a rapidly growing population.

The growth of the Southwest is a clear demonstration of this evolutionary succession. The era of pioneering in the Southwest was a long one extending from the Spanish and French suzerainty to its merger with the U.S.A. This long pioneering effort left the region with a rich tradition of the history of its struggle toward settlement and a free and stable government. This early history has left its people with a deep-seated custom of self-sufficiency that has insured an economic independence that will not be readily surrendered.

The rich natural resources of the region have ensured a healthy unfolding of the second phase of its development. Unparalleled wealth in oil, agriculture, minerals and climate, has encouraged the growth of the capital structure of the region with rapidity in the late 19th and early 20th centuries. This development of the Southwest, coming at a time of rapid national advancement of transportation and communications, has been at a rate almost unparalleled over the earth. Out of its resources, the region has developed a sound capital structure to support a rapidly growing population.

This capital structure has led naturally to the mature phase of industrialization that is essential for the needs and opportunities of the expanding populations. Moreover, the tradition of the people

demands that their capital structure be retained and enlarged, and not drained away, so that the Southwest does not evolve into an economic colonial of any distant metropolis. Already substantial industry has been established in the principal centers of population of the Southwest.

This development of the Southwest in the mature phase of social and economic growth is evidenced by the evolution in the attitudes of its people. Speaking on the occasion of the Danforth Foundation grant to found the Humanities Council at S.M.U., Dr. Albert C. Outler of S.M.U. observed:

The East was in intellectual ferment 100 years ago, the Midwest at the beginning of this century. The West Coast is now a mobile culture. ...

But here, west of the forests and east of the Rockies, is stirring the most dynamic socio-economic-cultural revolution in the country. ... The Southwest is alive with change including a new kind of cultural awakening among the people.

(Dallas *Morning News*, Jan. 21, 1961)

The industrialization of the Southwest arises in the middle of the most striking economic revolution of history—the technological revolution of the 20th Century. Whereas before, industry has grown slowly out of simple mechanical ideas, the 20th Century has produced a fundamental change. In this century man has discovered how to exploit the secrets of nature for his benefit and advantage through advanced scientific research and technological development. Such research and development are yielding a whole new range of products and processes that provide health, leisure, and unbelievable speed of transportation and communication; the emergent opportunities assure a measure of freedom and dignity beyond the imagination of earlier generations. These benefits are derived from the advanced technological industry which is itself derived from the forefront of scientific and intellectual skills.

This 20th-Century industry, emerging from the new technology, has tended to concentrate its roots in the northeastern, northern and far western regions of the United States. This was in part simply the evolution of the traditional industry of those areas to the new technological forms—but only in part. The new industry of the Far West has been almost wholly a creation of modern technology where little industry existed before.

The key to the situation seems to lie in the location of centers of advanced education—particularly doctoral and post-doctoral edu-

cation. Modern technological developments require the most advanced intellectual skills for their conception and progress. Without such skills industry of today cannot compete or even begin. Even the most basic and elementary industries are bowing to new, better and more complex processes which originate from the skills and discoveries of scientific and engineering personnel of advanced training.

Thus, the concentration of modern industry in close proximity to the high scientific skills in graduate schools is not surprising—the obvious relationship of advanced scientific education to healthy industrial development on a technological base is self-evident from an examination of the statistics.

TABLE I.

TOTAL U.S. DOCTORATES (PH.D.) 1957-58 <sup>1</sup>		
<i>Region</i>	<i>Numbers</i>	<i>Percent</i>
Northeast	3299	39
North	3055	36
Far West	1257	14
Southeast	519	6
Southwest	417	5
Total	<u>8547</u>	<u>100</u>

Of these, about 56% are in the natural and life sciences and engineering and about 44% in the social sciences and education.<sup>2,3</sup>

The comparison of doctorates granted within certain individual states is of special interest.

<sup>1</sup> Based on data from first 100 universities. The contribution of the remainder is negligible in its effect on the resultant statistics.

<sup>2</sup> The annual production of doctorate degrees is simply one measure of total effort in graduate education. Other measures, such as total population of graduate schools, would be appropriate but since this is roughly proportionate to doctoral graduates annually, the doctoral-graduate measure is used in this study.

<sup>3</sup> In Table II, no attempt is made to separate degrees in natural and life sciences and engineering from those given in recognition of other pursuits of learning. To do so, beyond the approximate percentages given above, is very difficult since specialization in various major and minor subjects cannot be wholly evaluated on an objective base.

TABLE II.  
DOCTORATES GRANTED 1957-58

Order	State	Number	Number/million population
1.	New York	1299	84
2.	California	845	81
3.	Illinois	722	83
4.	Massachusetts	577	127
5.	Pennsylvania	468	43
6.	Michigan	439	73
7.	Indiana	415	85
Total first seven states		4765	
% of total U.S. '57-'58		56%	
Average for U.S. ....			48

TABLE III.  
DOCTORATES GRANTED IN SOUTHWEST 1957-58

1.	Texas	215	23
2.	Louisiana	92	30
3.	Oklahoma	71	31
4.	New Mexico	16	19
5.	Arkansas	14	8
6.	Arizona	9	8
Total Southwest		417	22
% of total U.S. '57-'58		4.8%	

From these statistics and similar analyses one can derive a variety of useful conclusions:

- (1) There is almost 1-to-1 correspondence between the number of doctoral graduates and the level of industrial development on a technological base in the mid 20th Century.
- (2) A leading industrial state produces 75-85 doctoral graduates per million population per year.<sup>4</sup>
- (3) The six southwestern states together produce about the same number of doctorates (417) as the seventh state. (Indiana, 415).<sup>5</sup>
- (4) The southwestern states produce appreciably less than one-third as many doctorates per million of population as the

<sup>4</sup>Of special interest is Massachusetts at the exceptional level of 127 doctors/million population/year or 50% above the average industrial state. This is due to the extraordinary contributions of Harvard and MIT. Likewise, surprisingly, Pennsylvania at 43 is below the national average of 48 and half of the average industrial level, indicating unusually limited academic opportunity in this industrial state.

<sup>5</sup>Data for 1958-59, and 1959-60 may produce slight variations in the Tables, but study of partial figures already available for those years does not indicate significant variations from the basic conclusions. (See NSF Report, Science Doctorates of 1958 and 1959)



seven leading states and only one-half as many doctorates per million of population as the national average.<sup>6</sup>

Several collateral comments are in order:

- (5) It is not true that southwestern men generally travel away from the area for their doctoral education. Some certainly do. But in the entire U.S. less than 1000 graduates annually at the doctoral level travel more than 500 miles from their homes for their training. Of those who travel to other regions for advanced education, many never come back and are lost to their home region.
- (6) According to Scientific Manpower Report No. 3 of National Research Council, the achievement of the Ph.D. per 1000 high school graduates is 11.23 in New England, and 5.73 in Arkansas, Louisiana, Texas and Oklahoma, or about half of the northeastern rate. The figures give total Ph.D.'s granted to high school graduates from the Southwest at institutions both within and outside the region.<sup>7</sup>
- (7) The rate of doctoral degrees granted in the U.S. is increasing no faster, and perhaps not as fast as the population (compare with U.S.S.R.). This is significantly traceable to the lag in graduate education in the Southwest and Southeast.
- (8) The disparity in doctoral training in the Northwest, North and Far East compared to that in the Southwest appears to be increasing at this time.
- (9) With the surplus of untapped intellectual capabilities in the Southwest, the rate of doctoral training could be multiplied by 3 to 5 times without lowering the national standards of doctoral achievement.<sup>8</sup>

The lack of sufficient graduate educational facilities to provide the trained brainpower to advance the complex technology on which modern industry is founded, has put a severe handicap on the South-

<sup>6</sup> If the southwestern states produced doctoral graduates at double the present rate (50 instead of 25) the national average would rise above 50/million population/year.

<sup>7</sup> Scientific Manpower Report No. 3, 2 Feb. 1961, "The High School Backgrounds of Science Doctorates," by Lindsley R. Harmon, Office of Scientific Personnel, NAS, NRC.

<sup>8</sup> The relative productivity index of Ph.D's, from among those high school graduates judged from high school intelligence-test scores, is about .7 in the Southwest as compared to a national norm of 1.0 and about 1.70 for the Middle Atlantic area. This ratio must be further modified with respect to southwestern graduate activities by migration of graduate students out of the area and lack of migration of similar numbers into the area at this time.

west at the time of its development toward industrial maturity. Pitted against this handicap is the spirit of a people with a proud historical tradition of mastering overwhelming difficulty in the face of adversity—a people with access to their initial capital which is still conserved.

There can be no doubt that to close the now everwidening gap between graduate training in the Southwest and in the Northeast, for example, a wide variety of measures must be undertaken simultaneously. Taken together these measures might be described as those steps required to create the intellectual climate which can attract men of great scientific ability to work and to teach in the region.

Dr. W. Gordon Whaley, Dean of the Graduate School of the University of Texas, has expressed the problem forcefully in the following words:

The mind ... ranks first on any list of resources. ... In our time, the development of man's mind has become forbiddingly competitive. ... So far as we are concerned with the real core proposition, the superior development of the mind, the South ranks in second-, third-, and fourth-rate categories. ... The South is ... disastrously behind the Northeast, the upper Midwest, and California. To be sure, we have made some progress relative to where we stood a few years ago. But the race is one in which those who *have*, and who *have had* for the better part of a century, can make twenty-five feet of progress while the *have-nots* are struggling to make five. Instead of gaining, I sincerely believe the South tends to fall behind in its dealings with that most valuable single resource, the intellect.<sup>9</sup>

Basically, the problem is regional in character. Certainly one great institution, such as Harvard in the Northeast, can serve as a focus of excellence, creating academic standards around which the rest of the region can rally. Certainly the generation and encouragement of one such academic center in the Southwest is an objective to be sought.

But it is doubtful whether such a center can flower without strong academic activity throughout the region. After all, Harvard is in a setting of intensive academic activity, surrounded by M.I.T., Boston College, Boston University, Brown, Tufts, Northeastern, Wellesley, Williams, Massachusetts, and Rhode Island. In the immediately associated region are Columbia, New York University, Cornell, Rutgers, Brooklyn Polytechnic Institute, City College of New York, Fordham, Queens, Connecticut, and a host of other first-rate gradu-

<sup>9</sup> "The South Will Likely Fail", *The Graduate Journal*, Supplement, 1960.

ate institutions. In the midst of this intellectual complex is the Brookhaven National Laboratory with its incomparable research facilities which supplement those of the universities. Brookhaven, offering advanced research opportunities, provides a professor in the region with the tools to conceive advanced research projects beyond the capabilities of his own university.

Likewise, this intellectual complex in the Northeast, with its flow of trained scientific leaders, has generated widespread industrial scientific research, both for the benefit of the community and for the advantage of general scientific progress.

Thus, the brilliance of a Harvard has been created in an atmosphere of regional intellectual excellence. Such an intellectual atmosphere is required if the potentialities of the Southwest are to be brought to fruition. One cannot escape the conclusion that to capture this atmosphere, the whole of the Southwest region must join in the effort.

To mobilize such a concerted effort, a group of public-spirited citizens has created the Graduate Research Center of the Southwest. *The purpose of this Center is to act as a focal point around which simultaneous measures can be initiated voluntarily toward the creation of a significant and distinguished graduate academic program in the region.* The principle underlying the activity of the Center must be *diversity*, in which each college and university within a community acts independently and voluntarily in its own self-interest. That self-interest, however, is best served as it furthers and supports the enlightened interests of the region. This occurs when there are opportunities for joint efforts out of which can arise the intellectual atmosphere in which each group can best thrive. One of the Center's goals is to provide opportunities for such cooperation.

The general objective of the Center, therefore, is to enlarge the reservoir of intellectual skills at the graduate and post-doctoral level in the Southwest through specific measures of assistance and encouragement to the universities of the area and to their facilities to the end that the economic welfare and growth of the region is assured of development in its mature phase.

But the intellectual objectives of the Southwest cannot be restricted to regional interests alone. The Southwest, along with the rest of the nation, faces the cold-war threat of the communist coun-

tries. This threat is the more dangerous as a consequence of rapid technological change arising from the power of science in the hands of men who really understand the content of science in its full implications. The Russians have turned a powerful effort toward the scientific education of all qualified students. Estimates indicate that in 1959 the number of university graduates in the U.S.S.R. exceeded those in the United States. Thus, the communist nations are making a conscious effort to capture a suzerainty in science and, with it, a position of world leadership out of a technological superiority.

Thus the spearhead of this threat to our national position is intellectual in character, for doubtless the nation which can best turn science to its advantage can also acquire the leadership which exploitation of nature's laws so obviously confers.

In the face of the conscious effort of communism to turn science to its advantage, the United States cannot afford to react with only a small proportion of its population in the Northeast, North or Far West. Every region has a responsibility to the nation, and the Southwest with its outstanding resources of men and material should play a major role.

A parallel objective of the Center, therefore, should be to provide within the Southwest an atmosphere of scientific leadership which will strengthen the United States' position among nations, which will enlarge the body of graduate scholars faster than the population growth, and which will improve generally our national scientific posture.

Out of these broad objectives can be refined a specific and measurable objective, the achievement of which can fulfill the more general criteria just described and which can clarify the specific measures to be undertaken.

*The specific objective of the Center is to focus the effort for generating capability within the region to produce within the next 15 years a total of about 2,000 doctoral graduates annually in all fields of learning while at the same time improving the quality of education. In its initial efforts, the Center will concentrate its energies on the physical and life sciences and on engineering.*<sup>10</sup>

<sup>10</sup> The objective of 2,000 doctoral graduates from the Southwest in 15 years (1976) can be justified as follows: During this interval, the population of the U.S. will grow by one-third to 240,000,000. If the national average of 48/million population/year remained constant, this would lead to 11,400 doctoral graduates, with 550 from the Southwest. To raise the Southwest to the present level of the leading industrial average would require

## II. ELEMENTS OF THE PROBLEM

Now apply your mind, I pray to a true reasoning; for truth wondrously new is struggling to reach your ears, and a new view of creation to reveal itself. . . .

LUCRETIVS

*Concerning the Nature of Things*  
55 B.C.

The measures necessary to achieve the objective of a strong Southwest graduate activity are not simple. In absence of competition, the task would be immense. But the Southwest is already surrounded by scientifically advanced regions that offer intense competition for the services of brilliant men who must become the teachers and the scientific leaders in our technological society. This competition is not merely one of salary levels. Scientists and engineers find it difficult or impossible to retain their creativity away from great centers of learning and centers of advanced research. In the present era when broad synthesis of ideas from diverse sciences is so essential to creative scientific progress, the scientist and scholar fears atrophy of his skills and creativity if removed from the atmosphere of advanced research opportunity among his fellows. Therefore, to achieve its objective, the Southwest must break a vicious circle.

Moreover, the doctoral graduate who does his graduate work in the Southwest at the present time properly feels that he must study at the great research centers of the Northeast, North and Far West to round out his education and to find larger opportunity. In this situation he is often captured and lost to his home region. The problem therefore extends beyond the doctoral level and into the level of post-doctoral training and opportunity.

In analyzing this problem, we should not forget that *formal* graduate education in the world is as yet quite recent in its origin. Its growth has come with the explosive progress of science after the mid-19th century. The first doctoral degree in the U.S. given in recognition of scholarly pursuits is said to have been granted by

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multiplication by  $3\frac{1}{2}$  or 1,925 doctoral graduates per year. (This increase above normal expectancy from the Southwest would raise the national average from 48 to 52.) The number 1,925 is probably conservative since an active advanced educational program, with resultant industrial stimulation, would probably cause the population growth of the Southwest to exceed the national average over this interval. Likewise, the rate of production of doctoral graduates in the industrially advanced states is likely to increase more rapidly than the increase in their population, thereby raising the standards for the Southwest to achieve.

Harvard College in 1873,<sup>11</sup> and the great graduate school of John Hopkins was founded in 1876. Not until 1890 did doctoral graduates from American universities appear in noticeable numbers, and the really significant upturn in doctoral training awaited the 1920's. Thus advanced graduate education in the United States is scarcely more than 70 years old.

Basically, training for the doctoral degree follows the ancient tradition of the attachment of three to seven students to a great teacher—the graduate professor—who is renowned in the field of knowledge to which the student aspires. The elements of graduate education include: formal courses that are collateral to the desired field of knowledge; advanced colloquia on the principal subjects of study; conduct of original and creative research under broad guidance of the professor; completion of a thesis or dissertation arising out of the research; and completion of individual examinations, oral and written, under a qualified board of examiners to demonstrate the student's scholarly grasp of knowledge.

The objective of the doctoral degree is demonstration of the student's creative capability to add and extend human knowledge. In particular, the doctor's work prepares him in the techniques of research and in critical and creative thinking.

In the sciences the student must examine critically all aspects of an original scientific problem, demonstrate a mastery of experimental and other techniques applicable to that problem, and exhibit a grasp of the theoretical development of the problem. To do so, he must have facilities and instrumentation to enable him to carry on his research.

Even more exacting requirements fall on the professor. His objective is to qualify the student for intellectual pursuits, not as the professor has known them in the past, but in the form that the student will face in the future. Therefore it is imperative that the professor continue his own experimental and theoretical researches both to advance the frontiers of knowledge, and also to avoid the gradual dulling of his perception and capabilities as a teacher. This means that the graduate faculty should spend about half time on creative research.

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<sup>11</sup> Authorities do not agree on this point. According to W. C. Eells (*School and Society*, January 28, 1961) Yale granted three Ph.D's in 1861. Eells takes this date as the beginning of graduate education in North America. But in any event, the beginning is within the century.



At this juncture it is well to emphasize the distinctions between undergraduate and graduate training. Those responsible for the development of graduate programs inevitably must recognize the sharp differences between the procedures and structure of undergraduate and graduate programs within the university. An effective graduate school is essentially a community of scholars with whom the graduate student becomes intellectually associated more intimately than in the undergraduate situation. Ideally each member of the graduate faculty is selected on the basis of competence and distinction in his specific field. Further, his competence cannot remain static, but must be constantly renewed by research, with its corresponding contribution to the advancement of knowledge. Usually the graduate student is attracted to a professor by virtue of the latter's acknowledged command of a particular field of learning. The professor, for his part, selects those students he deems capable and then seeks to motivate them toward the desired graduate attainment.

Another aspect of the graduate community is the intellectual interaction among the students themselves. This is an important ingredient of the educational process at all levels, but assumes much greater significance at the graduate level. Formal courses naturally constitute a necessary part of graduate work, but equally vital to an effective graduate program is the aura of a community of scholars working with a sense of excitement in the pursuit of new knowledge.

From these considerations, it is apparent that the graduate school must necessarily be different in its structure and organization. When acting in their graduate roles, the members of the graduate faculty have responsibilities quite distinct from those in the undergraduate departments, and their activities are usually organized and funded through the office of the Graduate Dean. Obviously broad, competent judgment is mandatory in electing individuals to the graduate faculty. This again requires carefully designed procedures for making selections on the basis of the individual's distinctive abilities and accomplishments.

With the training of doctoral students in appreciable numbers toward the end of the last century, a demand appeared for facilities for advanced research commensurate with the compass of the scientific problems that were then appreciated. In response to this growing need, the great privately endowed foundations were established

at the turn of the century. The Rockefeller Foundation, the Carnegie Institute of Washington and many others were created to provide research facilities and opportunities to scientists and scholars that would supplement the facilities offered by the universities. As a typical example, the Mt. Wilson Observatory at Pasadena was founded by the Carnegie Institution. Later, the Carnegie Institution with the Rockefeller Foundation constructed the Mt. Palomar Observatory. These facilities provided to the astronomers of the world the first really large telescopes and the most advanced facilities in astronomy then available. The foresight of these institutions led to remarkable advances in astrophysics, and indeed to physics generally. Southern California became a Mecca for astronomers throughout the world, and advanced scientific skills were generated at California Institute of Technology and at other institutions in the region. From these skills grew the Jet Propulsion Laboratory and the broad atmosphere that generated the Space Technology Laboratory and a whole series of new space industries in Southern California.

Out of many such examples we have learned that the interaction of the great research laboratories with the faculties of the universities creates the atmosphere in which modern technological industry originates and can flourish.

With the advent of World War II in 1940, it was evident that the country's needs for scientific research had surpassed the capability of private endowment to support alone. Science had advanced until the atomic bomb could be foreseen, radar was definitely in sight, and a whole variety of new military applications from science were predictable.

Consequently, the government entered the scene with the establishment of the great national laboratories. These laboratories were organized around groups of scientists in the vicinity of academic centers where ample supplies of scholars with ideas were available. Among these were the Radiation Laboratory, Berkeley; the Radiation Laboratory, MIT; the Argonne National Laboratory, University of Chicago; and others. The wartime success of these laboratories is a matter of historical record.

The tradition generated by these laboratories was continued and enlarged after the close of the war. The Radiation Laboratory, Berkeley, became a center of post-doctoral research for faculty and scholars

along the West Coast and indeed throughout the World. The Brookhaven National Laboratory was founded in 1946 under Associated Universities, Inc., a new university sponsored by nine Ivy League universities, and drew its initial faculty from the dissolution of the Radiation Laboratory, MIT. In the subsequent years, Brookhaven became a leading research center which supplemented the facilities of the surrounding universities.

The evolution of the national laboratories, in their relation to the universities of their surrounding regions, is so important that it justifies careful examination. As a typical example we might examine the Brookhaven National Laboratory for its significant characteristics.

The objective of the Brookhaven National Laboratory is to supplement, not duplicate, the research opportunities of the universities. Its purpose is to provide facilities to visiting faculties which are not available at their universities, but are necessary to the advancement of their research. Moreover, Brookhaven provides opportunity to attack long and difficult scientific problems continuously and with adequate staff and equipment.

In general, its specialized facilities are not suitable for any one university campus. Indeed, the great 33-billion volt accelerator is unique in the world. Its cost of \$32 million is an investment requiring continuous operation to justify. Consequently, no one university could supply the very large staff of scientific specialists and operators who must work around the clock without completely warping its other educational activities. Such a facility would "run the university" rather than the "university running the facility." As a co-operative venture, however, with a few faculty members from each of many universities, such a facility can be employed with efficiency and effectiveness. Brookhaven has become a university for professors.

This points up one important characteristic of an effective national laboratory. A great national laboratory has an effective influence in supplementing research opportunities for faculties of colleges and universities over a radius of 500-700 miles, and is therefore *regional* in character. Not many such laboratories are needed. The economy of the situation dictates that laboratories of similar objectives should not be too closely spaced. Moreover, such a regional research facility requires cooperation from faculties of a substantial number of accessible colleges and universities to utilize its facilities to full advantage,

and to ensure the availability of the minimum critical number of research visitors at any one time.

The facilities at Brookhaven include a variety of nuclear accelerators, nuclear reactors, and other specialized facilities which augment those of the universities. The faculty comprises some 350 to 400 men of professional rank who are highly qualified to direct independent research projects and are supported by a staff of about 2,000 technicians and workers. These facilities, with their staff, are the basis for collaborative arrangements with the faculties of more than 100 colleges and universities in the Northeast region.<sup>12</sup> Collaboration has developed along a variety of lines:

- (1) On the average, more than 200 man-years of time spent by visiting professors annually at the specialized facilities of the laboratory provides for a wide range of the most advanced researches. Since visitors often prepare specialized equipment before coming and work up their results after leaving, the estimated amount of time probably should be doubled to be representative of the actual research opportunity thus made available to visiting scientists. Compensation for costs and salaries of visitors ranges from full compensation by the university to full compensation by the Laboratory as appropriate in each individual case.
- (2) From 100 to 150 post-doctoral research workers known as research associates are appointed by the Laboratory for 2-year terms (once renewable) to provide opportunity for post-doctoral research training. Such training qualifies the scientist for duties as an associate professor or as a leader of scientific research in industry.
- (3) An average of 50 graduate students, who are acceptable to the Laboratory and who require the facilities of the Laboratory for their work, are in residence each year. Their research is done either under their own professor, who must spend a substantial interval at the Laboratory, or under a senior member of the laboratory faculty who is appointed as a visiting professor at the student's university and who sits on the student's examining board.

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<sup>12</sup> The regional importance of a great academic research facility such as Brookhaven in no way diminishes its national and international importance. Such a center attracts large numbers of visiting scientists from universities throughout the U.S. and indeed the whole world. Nevertheless, the greatest influence of the facility is exercised over the regional area.

- (4) Opportunity is provided for group research on advanced and continuing problems, with collaboration of professors from several universities and the resultant cross-fertilization of ideas.
- (5) The summer program brings several hundred scientists from world-wide sources into close proximity at the Laboratory for intimate discussion and collaboration. This program has produced at least one Nobel Prize in physics.

The opportunity for advanced research and intimate collaboration of scientists provided by laboratories such as Brookhaven has generated an indispensable contribution to graduate education in the modern university. With access to such a facility, university faculty members are more content to remain at their universities, since the means for the most advanced research is immediately at hand. The professor at the small liberal arts college is afforded the opportunity to break his sense of isolation and to feel an intimate sense of collaboration with the most distinguished scientists of our time.

Following the innovation of the great academic research centers as essential elements of graduate education, other additions to federal support of graduate education have appeared.

The most recent step in providing opportunity for doctoral training has been the institution of grants by the National Science Foundation. The NSF was established in 1950 to provide support in neglected scientific areas for professors and graduate students and for their researches. This program has steadily grown to include aid to universities in providing equipment for research projects and to students at the graduate level through loans and grants.

In addition, operation of research facilities and subsidy of personnel under contract or grant are possible through a number of other Government Departments. The principal agencies are the National Institute of Health, Department of Defense, Department of Agriculture, the Atomic Energy Commission, and to some extent the National Aeronautics and Space Administration. These agencies sponsor research in the interest of: (a) keeping their own development programs in close coupling with the most advanced science; (b) aiding in the production of scientists of advanced training to assist in achieving their own objectives.

Finally, the growth of the major industrial research laboratories

in the vicinity of our great graduate institutions has had a major impact on both the University and on the community. While the impact of the University on industry is immense, the inverse reaction of highly technological industry on the University cannot be ignored. Indeed, there is substantial and growing evidence that a faculty, to be in the forefront of advancing thought, cannot be entirely removed from the rapid industrial advances presaged by industrial laboratory activity. Therefore, the relation of the industrial laboratory to the University is an essential element of the problem.

This relationship has been well stated by Dr. Ronald McFarlan, past-president of the Institute of Radio Engineers. When speaking before that Institute, he summarized:

- (1) Universities provide the main, if not only, sources of highly talented and trained young men, and it is from the graduate schools that most of the really good graduates now enter industry.
- (2) Universities provide the educational facilities and opportunities needed to keep the engineering staffs of industry up to date relative to new scientific techniques and tools, and also help discover promising new areas for technical investigation.
- (3) Universities make it possible to increase the stature of engineering staffs, by enlarging the number of staff engineers with advanced degrees. Such staffs can compete more successfully with other industry in attracting top-quality engineering graduates. A large concentration of brains accompanied by a strong interest in education and the universities is an industrial asset of great value.
- (4) Consulting activities by faculty members make available to industry a wide range of outstanding and specialized scientific and engineering skills to help in the solution of research and development problems. However, not all of the benefits from academic consulting in industry flow from the campus to the industrial laboratory. Much of value can and is carried back from industry to the university by the academic consultant. And I am not referring to per diem fees. Not only are the creative ideas from university research fed into industry, but advanced and creative



thinking can be fed back from industry into the educational system.

- (5) Good universities provide an atmosphere of intellectual independence and creative thinking that are vitally important to industry, especially in electrical fields such as the new and rapidly growing areas of electronics. Large concentrations of able academic scientists and engineers placed in geographical proximity with their equally able industrial counterparts can produce very rapid economic growth in the areas concerned. One has only to look at the Boston-New York-Philadelphia electronic axis, or its San Francisco-Los Angeles counterpart to substantiate this statement.

To summarize, the principal elements of modern graduate training in the United States include:

- (1) The University, which must provide a sufficient number of graduate chairs to create opportunities for the appropriate range of training by distinguished mentors. These professors must have about one-half of their time for research and the facilities to permit the high quality of work of which they and their students are capable. Each professor can supervise three to seven doctoral students, graduating one to two doctoral graduates per year, with provision for regular absences at two- to four-year intervals for continuing research at great research centers.
- (2) The private foundations, which are a fruitful source of research equipment, specialized facilities and scholarships.
- (3) The generous support by private individuals and corporations through endowment and augmented operating funds that enhance research and teaching opportunities and provide that margin of cost which catalyzes the release of other forms of support.
- (4) The research center, or national laboratory, which is essential to satisfy the requirements for advanced research opportunity for faculty and post-doctoral students by supplementing the opportunities offered by the universities.
- (5) The National Science Foundation, the National Institute of Health, the Atomic Energy Commission, and other

government agencies which are potent sources of financial support for the student and for the professor at the university and at the research center.

- (6) The procedure of judicious exchange of faculty on a carefully arranged basis which can vastly enlarge the range of doctoral training in the region through close collaboration between the university and the research center.
- (7) The proximity of the industrial research laboratory in the region, not only to effectuate the transition of ideas into realities for human welfare, but also to catalyze the students and faculty to the creative thinking that underlies our rapidly changing society.

### III. THE 6-POINT DEVELOPMENT PLAN GRADUATE RESEARCH CENTER OF THE SOUTHWEST

It would be very undiscerning to suppose that a period of greatness could arrive as a mere accident, a specially brilliant galaxy of exceptional minds just happening to be born at one particular epoch. . . . A period of greatness must be attributed to environment rather than accident; if an age shows one particular form of greatness, external conditions must have encouraged that form.

SIR JAMES JEANS  
*Growth of Physical Science,*  
1951

If the Southwest is to multiply its graduate education and take its place among the leading regions of the U.S., it seems evident that each of the above mentioned elements of modern graduate education must be developed.

Therefore, the development plan should be based on a six-point program. Each point is essential and supplements the others in ultimate achievement of the final objectives:

- (1) The development of mutual plans with the universities of the Southwest Region to provide graduate faculties and facilities over the next 15 years in order to achieve the objective, already stated, of 2,000 doctoral graduates annually.
- (2) The development of a center of scientific research in the vicinity of Dallas (which is central to the Southwest Region) which will provide access for faculties of science

and engineering and for scientists of industrial laboratories of the Southwest to a sufficient variety of the most advanced research devices for both individual and collaborative research.

- (3) The generation of mutual help between the Center and the universities to the end of providing sufficient research facilities and personnel on the university campuses to meet the planned enlargement of graduate programs.
- (4) Collaboration in development of industrial research laboratories for scientific research in the Southwest through encouragement of close relations among the universities, the Central Research Facilities of the Center, and industrial scientific activities.
- (5) The provision of inter-faculty exchange arrangements to make possible the easy movement of faculties of the universities and of the Center among one another as needed for faculty access to research opportunity and for enhancement of the student opportunities of the region.
- (6) The cooperation of the Center with the liberal arts colleges of the area toward developing a sufficient number of qualified graduates of suitable academic attainment to man the growing graduate programs of the universities.

Each of these points will now be developed in considerable detail so that the real character of the development plan can be fully understood.

#### IV. REGIONAL PLANNING FOR GRADUATE DEVELOPMENT

##### (Point 1)

The task of American education is infinitely greater, more difficult and more challenging than that of Soviet education. It is greater because, in addition to the training it must provide on a very large scale in the rapidly expanding fields of modern technology, it is the goal of American education to afford enlightenment ... and to encourage the maximum realization of individual capabilities and satisfactions.

ALEXANDER G. KAROL  
*"Soviet Education for Science  
and Technology"*

To achieve the objective of 2,000 doctoral graduates annually from

the Southwest by 1975 clearly requires voluntary regional planning among the institutions that can develop such training.

Fortunately, the Southwest has not lagged in its undergraduate opportunities, and the proportion of undergraduate students to its population is about the same as for the U.S. as a whole. Consequently, there is a rich foundation already in existence on which graduate education can readily be constructed.

Institutions now giving graduate training in one or more fields of science and engineering are listed in Table IV; Table V shows those institutions now in the process of developing graduate activity ultimately leading to the doctor's degree in science and engineering; Table VI lists liberal-arts colleges that now or ultimately will produce graduates with training sufficient for matriculation in graduate schools.

TABLE IV.

INSTITUTIONS OF THE SOUTHWEST GRANTING THE DOCTORAL DEGREE  
IN THE SCIENCES AND ENGINEERING

Agricultural and Mechanical College of Texas  
 Arizona State University  
 Baylor University  
 Louisiana State University  
 New Mexico Institute of Mining and Technology  
 New Mexico State University of Agriculture, Engineering and Science  
 Oklahoma State University  
 Rice University  
 Texas Technological College  
 Tulane University  
 University of Arizona  
 University of Arkansas  
 University of Houston  
 University of Oklahoma  
 University of New Mexico  
 University of Texas

TABLE V.

INSTITUTIONS OF THE SOUTHWEST IN THE PROCESS OF DEVELOPING  
DOCTORAL TRAINING<sup>13</sup> IN THE SCIENCES AND ENGINEERING

North Texas State College  
 Southern Methodist University  
 Texas Christian University  
 Texas Woman's University  
 University of Southwestern Louisiana  
 University of Tulsa

<sup>13</sup> This is a purely preliminary estimate that must be revised after consultation with the southwestern institutions.

## TABLE VI.

## FOUR-YEAR COLLEGES ACCREDITED BY REGIONAL ASSOCIATIONS

*Arizona*

Arizona State College

*Arkansas*

Agricultural, Mechanical and Normal College

Arkansas Agricultural and Mechanical College

Arkansas College

Arkansas Polytechnic College

Arkansas State College

College of the Ozarks

Harding College

Henderson State Teachers College

Hendrix College

Ouachita Baptist College

Philander Smith College

Southern State College

*Louisiana*

Centenary College of Louisiana

Dillard University

Grambling College

Louisiana College

Louisiana Polytechnic Institute

Loyola University

McNeese State College

Newcomb College

Northeast Louisiana State College

Northwestern State College of Louisiana

Notre Dame Seminary

St. Mary's Dominican College

Southeastern Louisiana College

Southern University and A &amp; M College

Xavier University of Louisiana

*New Mexico*

Eastern New Mexico University

New Mexico Highlands University

New Mexico Western College

*Oklahoma*

Bethany Nazarene College

Central State College

East Central State College

Langston University

Northeastern State College

Northwestern State College

Oklahoma Baptist University

Oklahoma City University

Oklahoma College for Women

Panhandle A & M College  
 Phillips University  
 Southeastern State College  
 Southwestern State College

*Texas*

Abilene Christian College  
 Austin College  
 East Texas Baptist College  
 East Texas State College  
 Hardin-Simmons University  
 Howard Payne College  
 Huston-Tillotson College  
 Incarnate Word College  
 Lamar State College of Technology  
 McMurry College  
 Mary Hardin-Baylor College  
 Midwestern University  
 Our Lady of the Lake College  
 Pan American College  
 Prairie View A & M College  
 Sacred Heart Dominican College  
 St. Edward's University  
 St. Mary's University of San Antonio  
 Sam Houston State Teachers College  
 Southwest Texas State College  
 Southwestern University  
 Stephen F. Austin State College  
 Sul Ross State College  
 Texas College of Arts and Industries  
 Texas Lutheran College  
 Texas Southern University  
 Texas Wesleyan College  
 Texas Western College (of the Univ. of Texas)  
 Trinity University  
 University of St. Thomas  
 Wayland Baptist College  
 West Texas State College

The objective of 2,000 doctoral graduates annually forecasts some 6,000 or 7,000 doctoral candidates in residence, involving some 1,500 professors on the doctoral graduate faculties of the region. To this must be added the students and professors required to satisfy the needs for the master's degree and for other graduate and post-doctoral objectives.

In laying the plan for regional academic development, not all institutions will desire to participate to the same extent. An early

problem is to determine to what extent individual institutions desire to develop their programs over the next decade within feasible limits.

For this purpose, the Center must conduct a study to ascertain the reasonable level of planned growth of capabilities of southwestern academic institutions over the next 1½ decades, recognizing the impact of the development of the central facilities of the Center over the next five years. This planning should be done initially without reference to specific availability of funds or personnel beyond the first three to five years, since it must be assumed that measures to find facilities and men can be developed on the basis of a sound plan.

The basis for individual institutional planning might well be contained in a memorandum developed after careful study by Dean Albritton, Dean of the Graduate School, S.M.U., and Dr. Brannen, Assistant to the President for University Affairs, GRC, and shown in the Appendix. This calls for a rather specific development plan for five years (1961-1965) and a more general plan for the subsequent 10 years (1966-1975).

Planning of this character has already been undertaken by many leading universities of the United States, and a considerable measure of such planning already exists within many institutions in the Southwest. Highly developed academic forecasts are now considered imperative for the future growth and emphasis within an academic institution in view of its responsibilities to the community, and in the face of growing population pressures. Such a plan provides the basis for sound and orderly future growth.

In drawing such a plan, each university and its faculty must ask and answer some really fundamental questions:

- (1) What should be the image of the university 5 and 15 years hence?
- (2) What should be the evolution of emphasis in the proportion of graduate to undergraduate education, and what does transformation of this proportion into numbers and facilities mean with respect to limitations on:
  - (a) The size of the faculty of the colleges and the graduate school,
  - (b) The numbers of resident undergraduates, and
  - (c) The numbers of graduate students?

- (3) Into what areas of knowledge can the university reasonably extend its efforts in light of existing faculty skills and a logical extension of those skills at a rate that does not diminish the level of scholarship?
- (4) What will be the needs of the community for advanced education in the several branches of knowledge, recognizing that in this technological age, education must lead and not follow community needs if the community is to prosper?
- (5) How well do existing facilities support this plan, and what growth of facilities will be required to effectuate these plans, and at what rate?
- (6) What costs will be involved for faculty and facilities, planned over each of the 15 years, and what should be the logical origin of the needed support from private, state and federal sources?

Southern Methodist University has agreed to do a trial study from which experience in developing such plans can be acquired. On the basis of this initial trial, other academic institutions of the region will be asked to cooperate in developing 5- and 15-year plans.

The objective should be the completion by the end of 1961 of the "Southwest Regional Plan for Development of Graduate Education in the Era 1960-1975." This plan cannot be binding on any institution, but it will provide a powerful means of estimating and acquiring financing, personnel and facilities at a balanced rate so that the mutual assistance among institutions can be maximized. A Technical Advisory Committee of about 10 members representing typical institutional situations will be needed in the final synthesis of the regional plan. This Committee might well be appointed about the beginning of the autumn semester 1961.

It can be anticipated that such a plan must be revised annually and will steadily improve in its quality and character. After completion of the first annual plan and preparation of elements of the second, there may be need for annual regional academic planning conferences to discuss the regional emphasis on each great field of knowledge, looking particularly toward enlargement of opportunities in neglected disciplines of learning.



V. THE CENTRAL RESEARCH FACILITIES OF  
THE GRADUATE RESEARCH CENTER

(Point 2)

The first drudgery of settling new colonies which confines the attention of people to mere necessities is now pretty well over; and there are now many in every province in circumstances that set them at ease, and afford leisure to cultivate the finer arts and improve the common stock of knowledge.

BENJAMIN FRANKLIN  
Philadelphia, 1743

An essential element underlying a flourishing growth of graduate research in the region is a central research facility designed to provide advanced opportunity beyond the capability of most universities to provide. This need arises out of a number of aspects of the problem.

(a) Very large specialized facilities can be operated economically only when accessible to a number of faculties.

(b) Individual universities have an enormous task ahead building their basic research establishments. Therefore, to make the region immediately attractive intellectually, very advanced facilities should be available to the faculties of a region.

(c) Industrial health of the region requires that advanced research facilities be available and accessible as quickly as possible.

To meet this need, the Graduate Research Center of the Southwest will organize Central Research Facilities in the Dallas-Ft. Worth area. This location has been selected because of its excellent facilities for communication and transportation which put it within about an hour transportation-time to most of the educational activities of the region. The organization of the Facilities follows the prospectus of a study completed in June 1960.

The primary activity of the Central Research Facilities of the Center will be basic scientific research of a character and continuity generally beyond the capacity of the universities to conduct. The objectives of such research will be to undertake problems in areas of science not well developed in the national scene. An equal activity will be the furnishing of opportunity to faculties of universities to engage from time to time in problems of research which the Central Research Facilities of the Center can uniquely provide. A further activity will be the lending of assistance to universities of the region by providing faculty assistance and special research facilities for en-

largement of student opportunity for education and research toward graduate degrees. The Central Research Facilities will also offer opportunities to industry of the region for advanced basic research with specialized facilities.

As a fully accredited academic institution, the permanent staff of the Central Research Facilities of the Center will be organized with the usually recognized titles of the academic hierarchy, commencing with Research Professor and given in recognition of the person's professional competence, standing and achievement in his field of special learning, and his stature and maturity in the scientific community. Through assumption of regular academic titles, interchange of staff between the Center and other academic institutions, and selection of student supervisors in accordance with academic custom will be facilitated.

Academic titles above the level of Assistant Professor will be granted only after review of the candidates' qualifications by a formally organized Committee of Peers appointed by the President, and election by the Board of Trustees of the Center after reviewing the recommendations of the Committee and of the President.

Ranks of Research Professors and Research Associate Professors will automatically qualify for permanent tenure, a status which is supported by the permanent funds of the Center.

*Research Opportunities for Other Institutions.* In fulfillment of its purpose, the Center will arrange, with approval of its Board, formal agreements extending for one or more years between its Central Research Facilities and other universities and institutions whereby a number of members of the faculty of an institution may expect to be in residence to carry on research at the expense of the Center during each year of the agreement. This will permit that institution to augment its faculty correspondingly over the interval. Such a faculty member, when in residence at the Central Research Facilities of the Center, would be designated as "Visiting Professor," or whatever lower rank corresponded to his university appointment.

Upon completion of suitable agreements between the Center and a university, the institution concerned will be known as an "Affiliate" of the Center.

The Center will cooperate with affiliate and other institutions in joint planning of enlarged research opportunities and of graduate

faculties with the objective of creating sound and scholarly opportunities for an ever broadening scope of graduate training of students in the sciences and engineering in the region.

Under "affiliate" agreements, the Central Research Facilities will be free to accept only those individuals who in its judgment can contribute significantly to the purposes of the Center. No institution by virtue of its affiliation with the Center may designate a member of its faculty to the Center without advance consent and agreement by the Center. Research faculty coming for residence at the Central Research Facilities of the Center will be considered only on the merits of their individual capability and not by virtue of any institutional privileges.

Central Research Facilities of the Center, with the consent of the university concerned, may employ a faculty member as a research consultant with compensation for designated intervals.

The Center will encourage the establishment of industrial research laboratories for the conduct of applied research at the immediate perimeters of the Central Research Facilities of the Center, or in the general region. Proximity of these laboratories to the Center will encourage post-doctoral educational activities which will assist in creating and maintaining the high intellectual level of research and scientific activity in the area, and will serve to encourage economic development through advancement of the scientific skills and resources of the region.

*Organization of the Administration.* The Central Research Facilities will be organized as an operating division of the Graduate Research Center of the Southwest. The activities of the Central Research Facilities will be conducted under authority of the Board of Trustees and through the administrative organization of the Graduate Research Center of the Southwest.

*Organization of the Central Research Facilities of the Center.* The Central Research Facilities of the Center will be organized into a number of divisions, departments, or laboratories as appropriate. These divisions, departments, or laboratories will be organized around research objectives that cross the lines of the traditional disciplines of science. Therefore, organization of general departments of physics, chemistry, biology, etc., *will be avoided*. On the other hand, a department or laboratory may embrace some or all disciplines of science as

necessary to encompass a broad research objective. Likewise, a division may be formed to operate a facility in the interests of several laboratories. Thus, it is initially planned to have the following Laboratories:

- Laboratory of Earth and Planetary Sciences
- Materials Research Laboratory
- Laboratory of Molecular Sciences
- Laboratory of Radio-physics and Electronics
- Reactor Division

The research emphasis will be oriented toward fundamental research. In organizing for such fundamental research, work will be generally oriented toward broad objectives of knowledge or techniques, but research activity will not be rigidly controlled within these limits. While applied research will be recognized and accepted in cases of transition of discoveries or models into industry, and in certain educational engineering activities, the administration of the Center will specifically avoid domination of the Center by problems of applied science. The Center will, however, encourage transition of new ideas into industry wherever possible so that these may benefit the nation. The Center is authorized to hold patents directly or through a subsidiary agency and may benefit from license under such patents for furtherance of its non-profit research. The Center will not indulge in commercial developments or manufacture.

The operations of the Central Research Facilities will be directed and managed by the Director of the Central Research Facilities of the Graduate Research Center, who is directly responsible to the President of the Graduate Research Center for all aspects of the operations of the Central Research Facilities.

Each Laboratory of the Center will be headed by a Research Director who is a professor appointed by the President with the approval of the Board upon the recommendation of the Director of the Central Research Facilities. Directors and Chairmen of Departments will be responsible to the Director of the Central Research Facilities and through him to the President for the functioning of their departments on a scholarly and significant level.

Laboratory Directors or Department Chairmen will hold tenure as research professors, but not as department heads, and added reimbursement for assumption of departmental responsibilities will be evaluated and paid as an amount separate from their tenure salaries

as research professors. The Directors will be expected to enter into some aspect of active research of their laboratories or departments.

Each laboratory, department or division will act within a capital and operating budget approved and controlled by the Office of the Controller. The laboratories or departments will be granted wide leeway within their budgets to achieve their research objectives.

The Director of the Central Research Facility, the Laboratory Directors and the President will form a committee with selected members of the staff to plan the long range objectives of the Center and to lay specific plans with universities and institutions for affiliation with the Center and for interchange of faculty and students with the view to maximizing the justifiable graduate output of the universities of the region. This "Committee of the Center" will establish and review scholarly standards of the Center and ensure that students carrying on research at the Center are supervised and trained in accordance with high academic standards.

As a preliminary objective, each laboratory or department will have at least four tenure chairs in addition to that of the Chairman, occupied by Research Professors or Associate Professors of the Center. In addition to appointees to the regular chairs, Visiting or Adjunct Research Professors or Associate Professors may be appointed for limited tenures. Assistant staff in the non-tenure grades of Scientist (Assistant Professor) and Assistant Scientist (Instructor) may be appointed for specified terms not to exceed three years. Visiting Scientists (below the grade of Associate Professor) and Research Associates (post-doctoral research students) may be appointed for terms not to exceed 3-years. Technical Assistants of the various grades may be appointed for indefinite tenure.

Students in residence at the Center to satisfy research requirements for advanced degrees *may not* be appointed as assistants to regular research projects to satisfy their thesis requirements. Such students when working on thesis research may be appointed only as Junior Research Associates and shall be permitted to work only on the selected research project for thesis purposes and only under properly qualified faculty supervision.

All faculty will be expected to teach advanced courses of their choosing at the Center or at another university of recognized standing to the extent of at least three semester hours annually or its

equivalent measured over any two or three years. This teaching requirement will be fulfilled by mutually acceptable arrangement between the Center and the university concerned and will usually be without cost to the university. When undertaking such teaching, the faculty member will be fully responsible to the university for the maintenance of the academic standards of the course and examinations related thereto. The teaching requirements can be waived in individual cases only by the President. In addition, members of the faculty of the Central Research Facility will be expected to attend a reasonable number (two to four) of scientific meetings of recognized academic and professional standing annually at the expense of the Center in order to maintain their scientific qualifications. Faculty members will present papers on completed research at such meetings as appropriate.

The Center will further conduct regularly scheduled and pre-announced colloquia on advanced subjects by qualified lecturers for the faculties of the Center and of the universities and institutions of the region, and for qualified members of industrial organizations, to explore exhaustively any aspect of science not ordinarily offered in university curricula.

*Financing.* The work of the Center will be financed through three sources of funds:

- (a) Basic endowment, the principal and earnings of which are depreciated through regularly budgeted expenditures and which must accordingly be renewed from time to time.
- (b) Regular annual contributions from private sources.
- (c) Contracts or grants from government and private organizations or foundations for oriented research objectives of broad scientific nature.

The general financial objective of the Center will be to achieve a balance of 30% private funds and 70% contract and public funds.

The Center will develop its land and basic facilities from private funds according to a master plan to ensure its institutional character. Special facilities for research may be erected on the properties of the foundation with government funds, but title to such facilities should eventually revert to the Center under appropriate contract arrangements.

The basic overhead costs of the Center, including administration, maintenance, posts of tenure and the basic minimum of research and related capital equipment, shall, as a matter of policy, be met from proceeds of the endowment. Such costs will generally *not be met* from contract funds, so that the institutional character of the Center is ensured and so that the pressure of contract necessity will not warp the purposes and direction of the Center. Under this rule the Center can achieve a reputation for complete objectivity and impartiality befitting the high standing of an advanced academic institution.

Visiting and adjoint professors and research associates, as well as occupants of certain non-tenure posts of high scientific standing, may be maintained from regular annual private contributions. Research oriented toward broad objectives, including the supporting staff required and special facilities, may be provided in this manner.

Contracts or grants for broad research objectives will support direct costs for the personnel, equipment and facilities required for discharge of such contracts even though such personnel will bear additional responsibilities for the broad educational purposes of the Center.

Overhead charges derived from contract research will generally be reserved in a special fund for catalyzing new projects or researches judged by the staff to have significant content. This "seed" reserve is essential to development of new horizons for the Center, and will be administered under the policies of the Trustees upon recommendation of the policy "Committee of the Center." Any receipts from patent sources will be added to this reserve.

The basic endowment of the Center will be \$20,000,000 to provide for buildings and the privately financed portion of the operations over the first five "founding" years. The Center will seek to increase this endowment, as a result of its recognized performance, by an additional \$40,000,000 at the end of five years.

Endowment will be used to capitalize the Center in three ways:

- (a) For buildings and capital research equipment
- (b) For named chairs of tenure (for which an endowment of \$250,000 to \$500,000 will be required to perpetuate the Chair for 15 to 20 years. This endowment with its earnings

will be expended at a predetermined rate for salary, secretarial services, travel and research support).

- (c) For basic operations and other tenure posts as specified heretofore.

Annual contributions of \$1,000,000 should be solicited to maintain an adequate institutional faculty and supporting staff and to relieve drain on the endowment.

*Growth of the Central Research Facility.* To show calculated growth, the total costs and personnel complement are presented in Table VII. These calculations are very elementary, based on the following laboratory experience.

- (1) No allowance is made for cost of land for the campus.
- (2) In a large laboratory the total budget, less capital expenditure items, divided by the number of scientists qualified to direct independent research is about \$40,000. This figure is based on costs of already operating laboratories of this type.
- (3) The ratio of supporting personnel for each scientist is about 3.2 to 1.0.
- (4) Floor space allocation is about 1000 sq. ft. per scientist and includes allowance for supporting personnel, equipment, stockrooms, etc.
- (5) Laboratory space is calculated at \$30 per square foot, including architect-engineering cost and furnishings.
- (6) Laboratory construction costs are scheduled one year in advance to provide timely housing, and no construction allowance is scheduled for the fifth year since this is applicable to subsequent years.
- (7) In the first year, allowance for a full year is made for maintenance and administration and one-half year for all other personnel to allow for build-up. In subsequent years, costs are calculated on average number on site throughout the year.
- (8) No provision is made for the cost of a high-flux experimental nuclear reactor or related facilities, which will be needed for a wide variety of research activities.

The calculation is adjusted to expend the entire \$20,000,000 initial endowment over the first five years to provide maximum growth



over this interval. This level of activity is deemed necessary to assure a central research facility of sufficient capability to meet the educational requirements of the Southwest at the professional level. At the end of five years a stable position of 30% private funds, 70% contract funds is achieved. Under this arrangement, the institutional character of the Center is fully protected through ownership of basic facilities and private origin of funds for all tenure positions and basic research operations and direction.

TABLE VII.  
ESTIMATED RATE OF GROWTH OF CENTRAL RESEARCH FACILITIES OF THE GRADUATE RESEARCH CENTER  
(Expenditures in \$Million)

PURPOSE	SOURCE	1961	1962	1963	1964	1965	TOTALS
Institutional Research and Teaching	Endowment	\$0.5	\$0.8	\$1.1	\$1.3	\$1.3	\$5.0
Visiting and Non-Tenure Staff	Annual Contributions	0.2	0.4	0.5	0.7	1.0	
	Endowment	0.3	0.6	0.9	1.7	-----	3.5
Contract Research	Contract Sources	0.5	0.9	2.1	4.5	5.4	
Administration	Endowment	0.2	0.3	0.4	0.5	0.6	2.0
	YEARLY TOTALS	1.7	3.0	5.0	8.7	8.3	
Research Equipment	Endowment	0.5	0.75	0.75	0.5	0.5	3.0
	Contract Research Equipment	0.1	0.2	1.0	2.0	2.5	
	Buildings	1.8	1.5	2.1	1.1	-----	6.5
YEARLY TOTALS	2.4	2.45	3.85	3.6	3.0		
TOTAL ENDOWMENT							\$20.0
Scientific Staff		32	60	110	180	220	
Supporting Staff, etc.		80	200	360	600	700	

Under the adjusted growth plan shown, at the end of five years, the Center would have the following appearance:

Senior Named Endowed Chairs (16 Year Life)	12
Unnamed Tenure Chairs (Professor and Associate Professor)	33
Visiting Professors	25
Scientists	150
Research Associates (1-2 Year Appointments)	50
Foreign Visiting Professors	10
Technical Staff, Maintenance, etc.	640
Total Research and Supporting Personnel	920
Research Students	60
Total Personnel	980

Land	----
Buildings	\$ 6.5 million
Annual Operating Budget	8.3 million
Annual Capital Equipment Budget	3.0 million
Total Annual Budget	\$11.3 million
Annual Funds Required from Endowment and Subscription	3.4 million
Annual Contract and Contract Equipment	7.9 million
Annual Funds Required for 2 New Named Chairs per Year	.6 million
Endowment needed for perpetuity	40.0 million

The levels of administration costs are predicted on the needs for contract recruitment, personnel recruitment, planning for arrangements with universities, etc.

Under this plan, about 600 semester hours of professional effort per year would be available for advanced, specialized lectures at universities, together with research for about 60 graduate students who could be supported at the Center.

*Future Development.* At the end of five years, the Center should have earned its place in the community. This place should justify the added endowment and annual contributions indicated for its perpetuity.

However, additional growth should be contemplated to a level of about 450 total scientists and 2,000 total personnel. About 15 years should be allowed for this total growth. These final levels are perhaps optimum, based on present research operating practices.

## VI. MUTUAL HELP

(Point 3)

"Beyond question the university graduate school is the most effective device we have for the cultivation of the intellectual powers of a potential scientific investigation."

GLENN T. SEABORG, Nobel Laureate  
Former Chairman, U. S. Atomic  
Energy Commission  
Chancellor, University of  
California

"No one would think of defining a university leaving out basic research as one of its foundation stones."

LAWRENCE M. GOULD  
President, Carleton College  
Trustee, Ford Foundation

If the planned growth of graduate education is to be achieved, the universities must play a major and specific role in fulfilling the whole plan. Quite clearly, expansion of the body of graduate facilities, graduate student bodies and the supporting facilities for teaching and research in the universities will require very extensive support of each university and institution participating in the Southwest Regional Graduate Plan. The actual extent of the necessary support cannot be estimated until completion of the first 15-year plan for the region.

In the fulfillment of the Regional Plan, individual cooperating institutions must look to local, private and public as well as federal sources to finance their growth. The question arises, therefore, to what extent the influence and prestige of the Graduate Research Center can be successfully employed in achieving the necessary financial goals of each institution. The following factors are worthy of consideration:

- (a) The association of a university with the Central Research Facilities of the Center and the availability of these facilities to the faculty to enlarge their research opportunity are added motivations for support of faculty and research at the university to aid the faculty of the university better to qualify for extension of their research at the Center. An institution that can demonstrate potential strength through association with the Center will have more com-

elling reasons to exploit that strength by receipt of added support.

- (b) The qualification of the development plans of the institution as a part of the recognized 15-year plan of the southwest region for graduate development should provide a powerful impetus for financial support of the facilities, faculty and objectives of the institution.
- (c) Through the regional development of the scientific and technological atmosphere growing out of the co-operative plan of the Center, the logical need for and effective utilization of further support in the region should be more readily demonstrable. Moreover, the consequent industrial development will broaden the base of such support.
- (d) The Center, through a variety of non-financial devices, must be prepared to aid fund raising campaigns and development of research opportunities which may prove useful to the institution concerned and which are justifiably directed toward fulfillment of the 15-year plan. The prestige of the Center and its broad knowledge of research opportunities should be valuable.
- (e) In particular, the 15-year plan can be widely publicized, and its value to the public can be demonstrated so as to give value to local efforts or campaigns for its fulfillment.

In certain instances, the university cannot, for a variety of reasons, appeal to a sufficient base for adequate support of its graduate plan. Two examples can be cited:

- (a) Institutions growing from religious origins, whose appeal within a community of diverse backgrounds may necessarily be narrow, but whose academic capabilities are very great.
- (b) State-supported institutions, whose graduate opportunities are limited by public resources for undergraduate expansion, and whose state officials do not fully appreciate the imperative community need for graduate academic opportunity.

In such instances, the Graduate Research Center should be prepared to form an associated organization or an "Associate Graduate Research Center" at the invitation of the university, on the campus

of the university and governed by its own local board, to augment the research and faculty opportunities. Such an associated center, sponsored by the Graduate Research Center and loosely coupled to it through inter-locking board memberships, can overcome some of the otherwise formidable problems of local financial support.

The first measure in this direction has been successfully developed by the Graduate Research Center of S.M.U. which is affiliated with the Graduate Research Center of the Southwest. As a result of cooperative effort with the administration of the Graduate Research Center of S.M.U., support has been initiated for several research activities, grants catalyzed for others, and substantial research facilities are now being erected on the campus of S.M.U.<sup>14</sup>

The advantage of local Boards for beneficial support of such activities is obvious.

The relationship of such local university centers to the Graduate Research Center of the Southwest can provide many advantages to growing institutions just embarking on significant graduate programs.

The use of the Graduate Research Center relationship with affiliated university centers in this way should be subject to certain formalities to ensure a quality of research commensurate with the name of the Center, and to provide assurance to donors that the funds subscribed are employed toward the significant advancement of graduate education and research by students and professors. Such formalities should be embodied in an agreement that includes:

- (a) Interchange of Board members.
- (b) Annual reports for research sponsored.
- (c) Annual financial reports.
- (d) Mutual consent on timing and scope of fund raising measures.
- (e) Approval of high level academic appointments of associated centers by the Graduate Research Center of the Southwest.
- (f) Review and evaluation of research programs of the associated center by visiting committees appointed by the Graduate Research Center of the Southwest.

On the other hand, the director of the associate center should be integrated into the university faculty. Through federation of the

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<sup>14</sup> The Graduate Research Center of S.M.U. was the original Graduate Research Center from which the concept of the Graduate Research Center of the Southwest originated. S.M.U. has provided the basic facilities for the conduct of this study.

associate centers with the Graduate Research Center of the Southwest, high standards can be encouraged, additional support for research and facilities generated, and the autonomy of the university can be retained.

## VII. INDUSTRIAL COOPERATION

### (Point 4)

I put the ploughs to work throughout all Assyria and heaped up grain in greater quantities than any of my fathers.

Ancient Inscription in the Temple of Adad at Ashur by King Tiglath-Pileser

The first draft of this study included only five points. In discussing the Development Plan with industrial leaders, however, the importance of industry and of industrial scientific research to the creation of an attractive scientific atmosphere became evident. Indeed, in reviewing the climate of intellectual activity in the Northeast, the importance of industrial research and the presence of a strong group of industrial scientists stood out as an essential element of that climate.

The interplay of industrial scientific research, and the scientists and engineers participating in it, with the universities and with the Center has a number of facets:

- (1) Men can more readily be attracted to advanced scientific training if numerous examples of the opportunities afforded to such men are apparent in the community.
- (2) Industry by itself cannot afford to establish really first-class industrial scientific laboratories in an intellectual vacuum. The presence of first-rate universities in the region is imperative to attract industrial scientific leaders.<sup>15</sup>
- (3) Industry can participate usefully in the facilities of the Center to solve certain scientific problems which are beyond the capacity of its own facilities, but the solutions of which are essential to formulation of more advanced attacks on difficult technological problems.

<sup>15</sup> During this study, numerous examples were found in plans of local industry to establish research laboratories outside the region in order to tap intellectual resources that could not be found in the region. Only a radical change in intellectual climate can reverse this trend.

- (4) University faculties can benefit greatly by knowledge of and association with industrial scientific activities in maintaining an awareness of the current relation of science to technology.
- (5) All elements of the scientific community can usefully contribute to local scientific discussions, symposia and colloquia for greater mutual benefit.
- (6) The solution of certain scientific problems can be accelerated by joint collaboration of the communities of academic and industrial scientists.
- (7) Scientific discoveries having obvious technological benefits can enjoy more rapid transition into tangible uses in the presence of a strong community of industrial scientists.
- (8) The local community can reap the benefits of science more quickly and directly if close relations between the university and industry can be generated and enlarged.

In the course of the study, one important southwestern industrial research leader stated the case so clearly that his letter is quoted below:

One of the prime purposes of the creation of the Graduate Center is to develop the latent industrial capability of the Southwest. It would appear to follow, therefore, that industry should be permitted to participate to the fullest extent in helping to achieve this purpose.

Industry today is engaged in expanding the amount of basic research done in its own laboratories. This expansion is a competitive necessity. Industry is acquiring a considerable potential in scientific talent and facilities which conceivably would be of great assistance to the Center. Accordingly, I would suggest inclusion of the industrial basic research laboratories, along with the universities of the Southwest, in the program for the Development Plan. One point of the program discusses the provision of inter-faculty exchange arrangements between the Center and the universities. I think it would be desirable to arrange similar provisions for interchange with outstanding members of the staff of the area's industrial basic research laboratories.

The advanced technology created in the Center, to be effective, must be readily absorbed by industry. Because of the relatively small size and lack of technical depth of many of the Southwest's industries, it may well be that the Center should ultimately plan for a certain amount of engineering assistance to aid in the transition of scientific discoveries and emergent developments into the channels of industry.

In connection with regional planning, it is suggested that the Technical Advisory Committee be enlarged to include at least two industrial members to assist in formulating the regional plan. These members should be from those industries which possess technical strength and which have placed emphasis on basic research. Also in this vein, under Organizations of the



Administration, the Board of Trustees should include among its public members representatives from industrial research organizations, basic or applied, located in the Southwest area. This action is undoubtedly contemplated in the draft, but perhaps it should be spelled out to emphasize the important role which industry will play in the development of the overall plan.

From the above comments, you can see that I am concerned about industry's role in advancing scientific progress and capability in the Southwest. I feel that industry, in the years ahead, will not only increasingly exploit the progress of basic science, but it will also become more and more a close knit partner with the great research centers and universities. Competition in industry has pushed industrial laboratories to perform basic research well in advance of the universities in many instances of which you are familiar. Talent, equipment and dollars available to industry will continue to accelerate this trend. Therefore, it seems to me that if we are to develop a great scientific complex in this part of the country, industry must also play a major and specific role in fulfilling the whole plan in conjunction with the universities.

We have a doctoral fellowship program now underway. Many other members of industry in the Southwest have similar programs. I can visualize readily the boost which the Graduate Research Center will give to these programs, for the Center should improve the opportunity of candidates to obtain degrees from local universities actively affiliated with the Center. A large number of outstanding, qualified candidates for a doctor's degree are potential in industry's ranks at the present time.

Similar points have been made by several other southwestern industrial leaders during discussions of the Development Plan.

Quite clearly, the existence of a regional plan for improvement of graduate education, and of the Graduate Research Center to catalyze that plan, can serve as a stimulus for a substantial enhancement of industrial research activity in the region. This is an essential element in the generation of the intellectual climate that is so necessary to the solution of the whole problem. .

The intimate dependence of the community upon this intricate relationship of science and industry, of the university and the industrial research laboratory, is succinctly summarized by the comment of that intensely practical man, the former speaker of the House of Representatives, Joe Martin, a great Republican, when he remarked, "The old country"—and he refers to Massachusetts—"we Americans might almost call it, went through hard times when we lost the textile mills to the South. Today New England is sprouting modern new industries like plastics and electronics. Splendid research laboratories are rising where until recently forests and untillable lands existed. These industries and laboratories require work-

manship of the highest skill. They pay better wages than the textile plants ever did. To provide the brains to manage and staff these highly specialized enterprises"—remember, this is Joe Martin—"New England colleges and universities are turning out talent which is unsurpassed in any other region."

### VIII. INTER-FACULTY EXCHANGE (Point 5)

Now there are four chief obstacles that hinder every man, however learned, from grasping the truth . . . namely submission to ignorant authority, influence of customs, popular prejudice, and concealment of our ignorance.

Friar ROGER BACON  
*Opus Majus*, 1266

The development of a strong graduate program in a region involves more than groups of isolated faculties at isolated universities. Human knowledge is broad and it advances rapidly. To provide coverage of that knowledge, the universities face a series of critical problems for which solutions must be available. These solutions can be derived at least in part from the variety of evolutionary measures that have emerged among more advanced academic institutions.

No university, however large, can hope to cover the whole body of knowledge within its own faculty. Consequently, in individual universities, distinguished graduate schools will emerge in distinct fields of knowledge, and the student will migrate to the university that can best teach in his specific field of interest. It is important that, among a substantial group of universities in any region, graduate schools should emerge to cover more nearly the whole of human knowledge. Duplication among universities in many fields of knowledge is essential, but it is particularly vital that the academic opportunities in the region as a whole should leave no important areas of knowledge or of research untouched.

As a consequence of this objective, the universities of the region should have the means and opportunity to work for the benefit of the student with the full resources of the region in their support.

One aspect of this attitude is the development of easy exchanges of professorships among universities, and between universities and the Center. A variety of devices can be adopted to ease the problems of the individual professor in moving to other facilities for a limited

interval. These involve policies relating to continuance of retirement payments, expenses, and the like. In general, interchanges should be established as a regular procedure so that when necessary they can be arranged with a minimum of administrative red tape and not involve almost forbidding difficulties. With regularized procedures, the professor should know in advance what he can expect when he considers or accepts an interchange appointment.

Interchanges achieve a variety of desirable objectives:

- (1) The visiting professor can bring to the faculty knowledge of certain specialties not resident in the faculty. Thus a number of interchanges each year can greatly broaden the capabilities of any one graduate faculty. In particular, visiting professors from the Center can bring to the university a variety of advanced specialties.
- (2) The visiting professor can move temporarily into the facilities, locale and atmosphere needed at any time to advance his researches most effectively. This is the regional opportunity so important in creating the environment that encourages a faculty member to remain in the region.
- (3) Since research is a required objective of graduate education, and his own and his students' research will occupy at least half of the professor's time, interchanges become an important factor in providing access to most significant research opportunity. Generally, among the universities of the region, a certain surplus of graduate faculty coupled with interchanges is essential to permit the proper conduct of significant research.
- (4) The most serious problem facing an individual member of the graduate faculty is maintenance of his intellectual skills over a sufficiently broad front in the face of rapidly expanding knowledge. Likewise, teaching coverage of any subject must necessarily change radically over a lifetime to meet the growth of knowledge. Among the means available to the professor to meet this challenge are scientific literature, and scientific and professional meetings. But in a rapidly moving world these are not enough. Frequent semesters away from the university in research centers and as visiting professors are becoming essential elements in

the maintenance of teaching skills. To some extent, the older concept of the "sabbatical year" is being replaced by more frequent visiting opportunities without cost to the professor. When the plan is followed on an adequate scale, the university on the average gains as much as it loses in professional time, but really gains much more through broadened horizons it acquires from the visiting professors and through the revitalization of its own faculty members through their experiences while away.

- (5) Exchanges have perhaps their greatest impact on the smaller liberal arts colleges where individual faculty members suffer from a measure of isolation.

The Graduate Research Center can play a vital role in encouraging exchanges.

- (1) Through its central facility it can provide research opportunities that supplement those at the universities. The professor can feel that he has adequate opportunity to achieve his objectives in his own region.
- (2) From its faculty at the central facility, it can take part in exchanges that bolster the breadth of university capabilities.
- (3) Through its juxtaposition to the universities it can aid in encouraging exchanges and in establishing acceptable standards that will minimize the administrative problems involved.
- (4) With its facilities it can establish summer programs such as those at the Brookhaven National Laboratory in many fields of intellectual endeavor which will encourage re-sharpening of professorial skills and interaction among leading scientists in advancing and synthesizing knowledge.

## IX. COOPERATION WITH LIBERAL ARTS COLLEGES

(Point 6)

Our time is rich with inventive minds, the inventions of which could facilitate our lives considerably.

ALBERT EINSTEIN, 1950

There is a large number of very excellent liberal arts colleges in the Southwest Region (see Table VI, pages 103, 104). These represent

an indispensable source of strength in developing an adequate program of graduate and post-doctoral education in the region. At least one of these colleges now stands near the top of the national list in its record of graduating doctoral candidates for matriculation into the graduate schools of the nation. There is every indication that with better communication between the universities and the liberal arts colleges, the contribution of the latter to the future strength of graduate education can be steadily enhanced.

Thus while the liberal arts colleges not offering doctoral training do not enter directly into the Southwest Regional Plan for Graduate Education, their indirect contribution is undoubtedly indispensable and of growing importance. In every region, the graduate universities are finding that limitations on the size of their undergraduate bodies are necessary if the standards of graduate education are to be maintained and raised. Such limitations place an added responsibility on the liberal arts colleges to extend the scope and to raise the level of the undergraduate training they offer for all who qualify, and to supply the universities with highly qualified graduate matriculants. Only in this way can every student find the highest opportunity for which his talents qualify him.

The Graduate Research Center of the Southwest can encourage these liberal arts colleges in a number of ways, primarily through assistance rendered to their faculties. The opportunity for faculty members of the liberal arts colleges to overcome their sense of isolation through participation in research programs of the Center, participation in summer programs and similar activities, cannot be underestimated. Through constant renewal of their skills and confidence out of close collaboration with scientific leaders in the region and the nation, the attitudes of the teachers and their students can be reinvigorated, and the programs of the liberal arts colleges can be made to present an ever more exciting opportunity.

#### X. THE GRADUATE RESEARCH CENTER OF THE SOUTHWEST

A theory is more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended its area of applicability.

ALBERT EINSTEIN  
*Autobiographical Notes*

Out of this study, the role of the Graduate Research Center of the Southwest can now be visualized. This role breaks clearly into two parts:

- (a) To act as a focus and a catalyst in development and guidance of plans and actions in a complete regional attack on the problem of enlarging the opportunity for graduate education in the Southwest. This is a staff function.
- (b) To construct, staff and develop the Central Research Facilities of the Center to supplement the research facilities at the universities and at industrial laboratories so that scientists and faculty of the region have access to advanced research opportunities. This is an operating function.

The responsibilities of the Center set forth in this study fall naturally into these major areas of activity. Consequently, this indicates the basic organizational pattern of its activity.

More broadly, certain generalizations essential to a rapid, planned growth of graduate education in the Southwest can be stated:

- (1) The growth should be planned over the southwest area and executed incorporating the six-point program set out above.
- (2) The Graduate Research Center of the Southwest can be the focus of such planning.
- (3) The Graduate Research Center of the Southwest can be an essential element in creating an atmosphere of sophisticated scientific progress that attracts scientific leaders to the region and holds them.
- (4) Nevertheless, in the regional sense, diversity must be the rule, with major strength derived from the planned progress of individual institutions advancing under their own local leadership and with the full measure of academic freedom.
- (5) In the spirit of diversity, the region can gain immeasurably by mutual help, cooperation, and the employment of a number of reasonable organizational devices through which the full strength of the region can be mobilized for joint action.

The organization of the Graduate Research Center of the South-

west is patterned after the preliminary study of June, 1960, which is quoted below with slight modification.

*Purpose.* In recognition of the urgent need for a sufficient number of individuals with advanced graduate training to ensure the future economic, social and political welfare of our region and our nation, and in recognition of the responsibility that each geographic region of the nation bears to the people of the region to offer adequate opportunity for advanced scientific and technical education and research for a sufficient number of individuals at graduate and post-doctoral levels, and in further recognition of the responsibility of each region to encourage and conduct scientific and other research, the character and continuity of which may be beyond the capacity of individual universities to maintain in order to advance the storehouse of knowledge on which the geographic region must draw for its economic and political health, the Graduate Research Center of the Southwest is founded as a non-profit educational and research institution with its principal offices in Dallas, Texas. The Graduate Research Center of the Southwest shall establish central research facilities and shall initiate other measures in support of graduate research and education in the Southwest Region for the purpose of:

- (a) Initiating activities toward the enlargement of opportunity for academic studies and activities at the graduate level in the Southwest Region;
- (b) Providing outstanding opportunity for advanced and continuing research, primarily scientific in character, on important aspects of natural phenomena with particular reference to those disciplines of human knowledge that have heretofore been underemphasized or inadequately developed;
- (c) Providing laboratories and staff to organize and engage in such researches and to enlarge human knowledge by free publication of the results and conclusions when not contrary to requirements of the national security;
- (d) Providing opportunities for visiting scientists, professors, and advanced students from universities and institutions at home and abroad to engage in advanced and significant researches requiring the special instrumentation, facilities, and staff relationships that can be offered by the Center;
- (e) Encouraging through formal and informal agreements the

interchange of staff and advanced students for purposes of research and teaching between the Center and the universities and institutions of the Southwest Region and elsewhere;

- (f) Providing to the universities the opportunity to enlarge their graduate faculties by virtue of the vacancies created by regular exchange arrangements and to make faculty posts of the region more attractive by virtue of the advantages offered by the Center;
- (g) Increasing the teaching competence of the region at graduate levels through creation of opportunities for the faculty members of the Center to spend some portion of their effort in teaching in the fields of their special competence at the universities of the region; and
- (h) Encouraging transition of scientific discoveries and emergent developments into channels of normal industry where they may be available to all.

*Character.* The Graduate Research Center of the Southwest is an academic institution chartered under the laws of the State of Texas for the purpose of advancing knowledge in the basic sciences.

The faculty, by rank and academic attainment, must be fully qualified to supervise graduate and post-doctoral research and to enter into advanced academic discourses. To ensure maintenance of these standards and to orient the academic climate of the Central Research Facility toward fundamental intellectual activities, the Graduate Research Center of the Southwest will be qualified to grant degrees but will not normally grant such degrees. It will employ its resources to supplement the academic resources of the universities of the region and elsewhere. It is in fact the intent of the Center, as determined by the founding Board, not to grant degrees. Research and training of advanced students will be done in close association with, and under the formal supervision of, universities and institutions at which the students are registered and from which they will receive degrees in recognition of their achievement in human knowledge.

The Graduate Research Center of the Southwest will be governed by a Board of Trustees who will be responsible for the formation and formalization of the policies under which the Center, its Central



Research Facilities and other activities will function, and for the financial health of the Center.

The Board will consist of not more than 41 members. Not more than 25 will be public members elected by the Board, and not more than 15 members will be presidents of institutions of higher learning elected by the Board. The President of the Center will be a member of the Board *ex officio*.

The Board of Trustees of the Center will be selected over a wide geographic area so that it is representative of the graduate academic interests of the southwest community, of the affiliated institutions of the Center, and of the broad economic and cultural interests of the region.

The Board will elect an Executive Committee of 10 members of the Board which will usually meet six times annually. The Chairman of the Board and the President of the Center will be members of the Executive Committee *ex officio*. The Executive Committee may act on any matter within responsibility of the Board except those matters specifically reserved to the whole Board by its own explicit action.

Decisions of the Board and Executive Committee will be made by a majority vote of a quorum of more than half the members of each body.

The President of the Center will be responsible to the Board for all executive action under the policies of the Center to effect the purposes of the Center. He will inform the Chairman of the Board from time to time concerning the activities and plans of the Center and annually will report formally to the Board on the progress and plans of the Center towards its objectives. He will act under a budget approved by the Board. He will from time to time bring to the Board plans for growth of the Center to increase its effectiveness.

The offices of Secretary and of Controller of the Center and such other staff posts as deemed necessary by the President shall form the Office of the President and report directly to the President in administering the affairs of the Center.

In its initial stages of organization, the activities of the Graduate Research Center of the Southwest will be implemented under two major divisions:

- (1) Division of Regional Graduate Cooperation

(2) Division of Central Research Facilities. (See Chapter V.) The Division of Regional Graduate Cooperation will work with the universities and their faculties entirely within a framework of voluntary cooperation to develop the Regional Plan and to provide a focus on those other aspects of regional cooperation which can advance the purpose of graduate education in the region. In general, it will function to carry out the responsibilities of the Graduate Research Center of the Southwest in effectuating the 6-point program, excepting only responsibilities directly relating to the Central Research Facilities. The ultimate success of the objectives of this study will rest in major part on the skill and vision of this Division of Regional Graduate Cooperation.

## APPENDIX

## TYPICAL OUTLINE OF A DEVELOPMENT PLAN FOR GRADUATE STUDIES

- I. Procedure and Policies Governing Expansion of Graduate Studies
  1. Structure and responsibilities of the Graduate School
  2. Procedure of referral for new programs
  3. Principle of university control (feasibility studies to be undertaken by whom?)
  4. Principle of distribution among disciplines
  5. Principle of economy (policy on duplication of programs already underway or in advanced stages of planning at other nearby universities)
  6. Principle of financial security (endowment of a specified amount in support of a program is or is not requisite to its initiation)
- II. The Situation in the Fall of 1960
  1. Present undergraduate enrollment and university budget (what portion of budget is allocated to graduate studies?)
  2. Graduate curricula and degrees (including table showing degrees awarded, 1950-1960, by fields)
  3. Graduate students (classification by major fields, source of undergraduate degrees, course load, and evening versus daytime)
  4. Graduate faculty (classification according to full-time, part-time and visiting. Biographical data for faculty members: date of birth, degrees, professional record, honors, research publications, texts over last decade and manuscripts in press)
  5. Student and faculty fellowships (distribution and value of fellowships by departments and source of funds)
  6. Research facilities (thumbnail descriptions of each facility, principal items of equipment, courses serviced, number of graduate students who could be accommodated, research in progress, source of support, grants over last decade)
  7. Library (appraisal of library resources by disciplines, use of library, rate of growth, acquisition budgets)
- III. Schedule for Development—September, 1960, to August, 1965
  1. Explicit statement of assumptions underlying plans (e.g., projected undergraduate enrollment and increases in undergraduate budgets)
  2. New graduate courses and degree programs (schedule)
  3. Anticipated enrollments and number of degrees granted by graduate fields (schedule)
  4. Expansion and support of graduate faculty (schedule and annual budgets by fields)
  5. Student assistance (annual budgets)
  6. Improvement of graduate research facilities (schedule and annual budgets)
  7. Development of library (annual budgets)
- IV. Schedule for Development—September, 1965, to June, 1975
  1. Projected undergraduate enrollment and increases in undergraduate budgets, 1965-1975

2. New graduate degree programs to be added, 1965-1975
3. Graduate student enrollment by June, 1975, and annual number of Ph.D.'s to be graduated in all areas
4. Number of graduate faculty by June, 1975
5. Student aid budgets, 1965-1975
6. Cost of graduate research facilities to be added between 1965 and 1975
7. Library budgets, 1965-1975