

# Report of the Mission to the Seven Universities of Chile

Prepared for the  
International Cooperation Administration

Washington, D. C.  
1960

**National Academy of Sciences—  
National Research Council**

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SEVEN UNIVERSITIES OF CHILE

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P R E F A C E

This report contains recommendations for strengthening certain aspects of scientific and technological teaching and research in the universities of Chile. It was prepared by the Mission which recently visited the seven Chilean universities, on behalf of the National Academy of Sciences--National Research Council of the United States, at the request of the Council of Rectors of the universities and the International Cooperation Administration (ICA) of the United States. The purposes of the Mission were to assist the Council of Rectors in determining the staff and other related needs of the universities, as required by their plans and to formulate recommendations in connection therewith. (See also page 117.) The visits were initiated in mid-June and terminated the latter part of July, 1960.

The seven universities visited were: 1) Universidad de Chile, Santiago, 2) Universidad Técnica del Estado, Santiago, 3) Universidad Católica de Chile, Santiago, 4) Universidad Católica de Valparaíso, 5) Universidad Técnica "Federico Santa María", Valparaíso, 6) Universidad de Concepción, and 7) Universidad Austral, Valdivia. In addition, members of the Mission visited the Departamento de Ciencias Básicas and the Estación de Biología Marina, the former at Valparaíso and the latter at Montemar, both units of the University of Chile, and the Universidad del Norte and other university branches located at Antofagasta.

The members of the Mission are moved to remark that the broad responsibilities entrusted to them could not be covered to their complete satisfaction in the time which they had at their disposition, limited as it was by other long-standing commitments. The program included in situ visits to all the universities named as well as to their principal faculties, schools, institutes, laboratories, and libraries. It also included general and specific conferences; numerous interviews with small groups or individuals on research and teaching problems; the discussion of new research and teaching proposals particularly related to the basic sciences; the examination of research and teaching laboratories; discussions concerned with various types of needs, such as equipment and personnel; and the study of general plans for future development.

The Mission received from the Council of Rectors, the universities and their respective authorities and representatives the most generous hospitality, friendship and cooperation. The Mission's approach was that of academic colleagues engaged in the discussion of common problems and emphasis was placed on the interest that all shared in the advancement of scientific knowledge. A friendly atmosphere for discussion prevailed at all times.

Individually and collectively, the members of the Mission, wish to record their warm appreciation for the many courtesies extended to them by their Chilean friends. They are deeply grateful.

The Mission expresses its sincere gratitude to the ICA staff in Santiago which helped in many ways by establishing an office with a secretary for the use of the Mission, arranging for conferences, meetings, appointments, transportation and hotel accommodations, and handling many other details that contributed to the full and effective use of their time.

The Mission was aided greatly by Dr. Harry M. Miller, Jr., the Academy's Project Coordinator, Dr. André C. Simonpietri, Associate Director of the Academy's Office of International Relations, and Mr. Louis G. Sleeper, University Projects Coordinator of the USOM, because of their extensive acquaintance with Latin American educational institutions and problems. The undersigned express to them also their grateful appreciation.

Finally, the Academy's representatives wish to record the profound impression made upon them by the magnificent spirit of their Chilean colleagues, despite the disastrous earthquake and other accompanying natural phenomena which shortly before their visit had caused such havoc and suffering in the area south of Santiago. Chile's will to look to the future, and to start rebuilding immediately, was a source of real inspiration to them.

Respectfully submitted,

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I. INTRODUCTORY REMARKS

A. GENERAL STATEMENT

The objective of the contract between the National Academy of Sciences (NAS) and the International Cooperation Administration (ICA) is to "bring about improvement of scientific facilities and capabilities in the seven Chilean universities so they can more effectively contribute to the further economic development of the country." The specific purposes as stated in the contract "are to aid the universities in improving or establishing scientific teaching and research facilities, developing a cadre of trained scientists and engineers well versed in modern concepts and methods, and establishing special research institutes to promote the development of national resources."

The above objectives and purposes are broad in coverage and worthy as to purposes; the problem is not so much a matter of funds and plans, important as these are, but rather that of successful integration of plans into a university system, where in most cases, policies, organization, faculty rights and privileges, and the students' relations to the professor and the classroom are anchored in the past. The contract is forward looking, but its applications by necessity are related largely to static educational systems, particularly in the case of the oldest institutions.

The universities in the United States differ from those in Latin America on the above point. Since the founding of Harvard, the American university, while holding to time-tested basic principles of education, has continually adjusted itself, administratively and academically, to changing

conditions. On the other hand, the Latin American university until recently has been guided by its centuries' old traditions in much of its organization, in its educational philosophies, and in the way in which the student mind is developed. Today many progressive changes have been introduced. Others are contemplated. It was and is the Mission's sincere aspiration to contribute to this development.

Speaking in broad terms, the Latin American university (including most of those in Chile) may be described as a loose aggregation of quasi-independent professional schools. While it cannot be said there is no over-all administrative system, it is evident that the individual Faculties\* constitute the centers of influence and academic control. The Rector is chosen by the members of the Faculties for a limited term, and he may or may not be re-elected. He is the official center of the university and his value relates primarily to his personal qualities of leadership, rather than to an over-all authority granted him by the governing council, or by law. He may have a great deal to say about the general distribution of funds, or on the development of a new educational unit, but he is on dangerous ground when he attempts to invade the area of traditional Faculty rights and privileges.

Faculties possess complete control of their own curricula, - so much so that courses in foundational sciences, such as biology, chemistry, mathematics and physics, are in most cases given within each particular school, and by members of the school's own Faculty. This involves much duplication of effort, since each school will require that the course content relate

\*Where capitalized in the report, this term refers to the controlling academic body of a School. otherwise the use is general.

to its own program. Basic science principles are sacrificed on the altar of a professional school's training purpose. The over-all university organization, embedded as it is in tradition, and frequently in law, has difficulty in breaking through this barrier even though the educational weaknesses involved be realized. It must be said, however that in several of the Chilean universities efforts are being made, and with varying degrees of effectiveness, to coordinate the activities of the several Faculties.

The Faculties are primarily professional teaching-training centers. This does not mean that the faculty member does no research, but that such research is the individual member's right and normally the Faculty will not interfere if there is no invasion of the teaching-training area. This tends to set research apart from teaching. Because of a general lack of common university administrative policies relating to planning, governing and controlling academic development, the Mission noted that many research activities seem to have originated within an interested group of Faculty members, or occasionally were initiated by the action of a single high administrative officer. This has resulted in a sporadic development of such research units, some of them with well-defined and worthy objectives, - The Institute of Mathematics and Physics at the University of Chile is an example.

#### B. THE TEACHING-RESEARCH PROBLEM

The "purposes" as outlined in the NAS-ICA contract relate to two primary considerations:

- 1) Basic research as a necessary foundation on which to build economic development, and
- 2) The basic educational program required if research and professional men of quality are to be developed.

The corollary here is that there should be the necessary development of teaching and research units, particularly in basic areas. Although, as evident below, organization is not a strong point in Latin American higher education, those aiding in the development of such units must recognize the existing situation and be more concerned with reasonable effectiveness in achieving goals than with the making over of existing administrative processes.

In most cases the research units arise sporadically and there is no set pattern covering organization or control. Institutes, Laboratories or Departments may operate within a single Faculty, be controlled by Faculties, or in a few cases be independent of Faculty control. Regardless of the Faculty-unit-professor relationship, however, the tendency still seems to be toward a separation of teaching and research.

The centering of academic control within the Faculties can and frequently does create difficulty in establishing a new research center, and particularly the formation of a unit outside professional school Faculty control. This difficulty is magnified if the unit be one concerned primarily with the teaching of basic subject matter. The notable exception to this latter are the four basic science teaching institutes at the University of Concepción, which provide basic courses for all the University's professional schools as well

as four-year programs for students majoring in the fields of the respective Institutes.

### C. RELATION OF THE SECONDARY SCHOOL TO UNIVERSITY TEACHING-TRAINING

There appears to be one commonly accepted conclusion relating to the student's secondary school experience - that he has become a reservoir filled with facts; important and unimportant facts, the meaning and interrelationship of which he has little or no comprehension. There has been little development of a critical evaluation of fact, nor has his curiosity been aroused, - at the end there is a certain residue of learning but little knowledge. If one looks at the legally approved curricula for the secondary schools, they appear excellent, but there is a great gap between the paper curriculum and its execution in the classroom. This is probably traceable to three causes:

- 1) Crowded classes
- 2) Faulty preparation of teachers
- 3) The inadequate stipends paid teachers as an hourly wage, which compels them to qualify in several subjects.

The end result of (3) above is that instructors must teach 36 hours per week to meet minimum family expenses. Thus, there is no time for discussions, - nor for much of anything but the bare presentation of facts, tested by an objective-type examination. Reasoning power is not developed. This is especially noted in basic science instruction. Practical, or laboratory, sessions, if any, are largely devoted to demonstrations, - the student looks

on and takes notes while the instructor demonstrates. The curricula are sound educationally, but the presentation is empirical. This is the student who enters directly into the complex world of techniques, skills and practices characteristic of professional school programs in Latin America. And here once again he faces the necessity of amassing more facts. At this beginning university level he has a deficient comprehension of basic science principles, and the nature of his professional program contains little that will correct this lack. Again emphasis is placed on the memorization of fact and on empirical procedures rather than on the development of a reasoning mind and a mastery of basic principles. He finally leaves the university as a fairly well-skilled technician, but not as a potential research scholar.

The above situation, standing in the way of attainment of the goals stated in the Contract, is further complicated by the extensive use of part-time professors. Low salaries all too frequently compel such staff members to teach in more than one university, or to engage in outside professional work in order to obtain sufficient income for a decent living. This crowding of their time weakens teaching and certainly dampens research desire, and activity, and even the possibility of such activity. It reduces the time available for personal contacts with the students. The scholar's urge becomes submerged in the struggle for a living wage.

It is very evident to the members of the Mission that the improvement of basic science research in Chile and its profitable extension into the area of industrial application will continue to be greatly handicapped until the above

major roadblocks to educational progress are removed. The problem is one of developing science scholars, - more and better; it is one which relates to the developing of the student's reasoning power, of exciting his curiosity, of stimulating a zest for research, - and the beginnings of these must be at the teaching level.

These above remarks, which emphasize weaknesses and obstacles are crucially important, but fortunately they do not represent the complete picture.

One need but look at the plan in operation at the Universidad de Concepción. Reference is made to the four basic science teaching-research institutes, - Biology, Chemistry, Mathematics and Physics. These Institutes present a full four-year program, each in its respective field, designed to turn out basically trained and educated scientists at what can be considered equivalent to the B. S. level in the United States. In addition, and with the approval of the professional schools, students from the latter are given entry into the Institutes' basic courses. The Institutes, being independent and responsible only to the Rector, exercise full control over course content and sequence. The professional school student profits by access to courses more basic than his school could (or would) present, and the professional school itself profits by the opportunity of building its program on a better science foundation. In addition to the above, the Institutes' programs are designed a) to correct high school deficiencies, and b) to develop an entirely new (for Latin America) approach to learning, one in which facts will take their

proper place and logical reasoning will be emphasized. They seek to turn out a thinking student, one in whom reasoning and curiosity are blended with experimental fact. The critical years in their programs are the first two, for these involve the student's transition from empirical to dynamic learning. During this period the teaching staff of the Institute must develop a new and appealing approach to knowledge. This charge on the Institute is not a light one, particularly so in that at present the instructional staffs are mostly of professional school origin and the older members will find it extremely difficult to shift to this new instructional approach. The younger members are more adaptable and it is this latter group which should receive the greatest consideration as candidates for teaching and research development under the faculty-graduate interchange programs. At this time, the interchange purposes should include further experience in teaching as well as in research, for without good teaching the student's zest for research will not be developed.

The situation at the relatively new Universidad Austral at Valdivia does not differ significantly from Concepción as to purpose, - that of providing a firm basic science foundation on which to build. Both believe in the union of teaching and research with emphasis on a soundly organized and well-taught sequence of basic science courses. At Austral of Valdivia, where little basic research is being conducted, the first two years are actually organized into a basic general college and from this students proceed to specialized technical or professional programs.

In addition to the two institutions above, members of the Mission found that in all universities visited, basic science programs were being discussed by individuals or within faculty groups. This is an encouraging symptom. Unfortunately, at this stage in the discussions, the trend (with few exceptions) is in the direction of creating a department of basic science within the framework of one or more professional schools, and this the members of the Mission regard as a questionable solution. It is clear, however, that the Concepción program - which was tailored specifically for Concepción - cannot be adopted in toto by the other universities. They must likewise tailor with reference to their own university form. The University of Chile and most of the others of the country are not only handicapped by organizational structure but by the scattering of school and other units over wide areas. This lack of physical contiguity makes the development of a common basic science center particularly difficult. The Universities of Concepción and of Austral (Valdivia), on the other hand, possess the advantage of a central campus. Regardless, however, of organization and physical distribution of university units, the important consideration is that independent control of courses, teaching methods, and course content be guaranteed.

#### D. THE APPROACH TO RESEARCH IN THE BASIC SCIENCES

Significant research contributions have been coming out of Chile for a substantial period of time in certain fields. Without question there is now

a broad awakening of the spirit of research within the universities of Chile. Much of the research underway is understandingly descriptive or applied in character. This is a natural and necessary first approach to scientific knowledge. There are some notable exceptions to this approach, however. In biology the Mission found individuals engaged with research problems which merit the highest commendations. Similar observations were made of research in chemistry. Here it was noted that student emphasis was placed on a research thesis in the last (fifth) year and that most of the students being trained as chemists spent much of their last year in laboratory research. Some of this latter was very good. In several areas the knowledge of research being done elsewhere, the grasp of fundamental problems, and the imagination demonstrated by the plan of attack was most convincing. These workers are not the average, however. They are individuals who have surmounted the countless obstacles which handicapped the development of a natural potential. This observation would lead to the conclusion that the weakness, as noticeable in the amount and quality of research in Chile, is not due to the absence of a high degree of research potential within the faculty groups, but rather to faulty exploitation of existing potentials. This goes back to a fundamental flaw in the teaching of science, flaws which prevent the construction of a solid foundation at the elementary level.

Granting that the primary requirement of a satisfactory basic science foundation can be laid down, it would be highly desirable that the superstructure should include provision for more research programs for professors and

advanced students. It is encouraging that the Mission found several good research programs of this sort in the basic sciences at the Universities of Chile, Concepción, and the Universidad Católica de Chile. (cf. Sec. II)

There is an axiom and a corollary revealed here:

- a) The development of industrial applications in Chile rests on a foundation of basic principles constructed by soundly trained and imaginative "pure" scientists.
- b) The development of "pure" scientists in the number and of the quality needed in Chile will require a careful examination of the present educational program, particularly with reference to the mastery of broad and basic scientific principles.

#### E. ENGINEERING AND TECHNICIAN INSTRUCTION IN CHILE

##### 1. Need to Consider Technicians Along With Engineers

In comparing training in engineering in Chile with that in the United States, the technician programs need also to be considered. The principal reason for this is that the ratio of technicians to engineers graduated each year is very different in the two countries, yet the work of the combined groups in industry is roughly the same.

The estimated numbers of 1959 graduates are as follows:

	<u>CHILE</u>	<u>U. S.</u>
Technicians	1,500	20,000
Engineers	226	36,000*

\* Some 15<sup>o</sup>/<sub>o</sub> of these will end up with M. S. degrees and 2<sup>o</sup>/<sub>o</sub> with doctorates.

	<u>CHILE</u>	<u>U. S.</u>
Ratio of Technicians to Engineers	6.6	.55
Population	8,000,000	180,000,000
Ratio of Population to Engineers plus Technicians	4,600	3,200

Technicians and engineers both can and generally do carry out what is normally considered engineering work in the United States. The discrepancy in their ratio is due to the fact and/or yields the result, that in Chile graduate engineers generally do not do production nor maintenance engineering, nor even much of the technological work. Instead, they prefer management positions, and can get them and are needed in them due to their scarcity. Also technicians are generally considered adequate for technical work, and are available for considerably lower salaries. On the other hand, in the United States bachelors are widely used in production, and M. S. 's and Ph. D. 's in research and development, and are considered necessary to achieve efficiency and economy in large companies. In other words, the better trained engineers in the United States go directly into technical work, and in Chile into administration. The Chilean situation, if translated to the United States, would amount to practically all Ph. D. 's in Engineering going almost automatically into management, and few other engineers doing so.

The lower ratio of engineers in Chile to technicians and to population is to a large extent maintained by tradition and by social structure. Only sons of well-to-do families normally find engineering training to be attractive

and financially feasible. Furthermore, it is generally believed that industry does not need substantially more engineers than it now gets in proportion to technicians and technical high school graduates. The ratios needed are sometimes quoted as 1 engineer to 8 technicians to 64 technical high school graduates. The actual ratio is roughly 1 to 7 to 100. Evidently, Chile is well supplied with industrial skilled labor. Since it would be difficult, and perhaps unnecessary to increase substantially the numbers of sub-engineering graduates, adherence to a formula and philosophy such as the above severely limits the engineering graduation rate.

The ratio of technicians and engineers graduating each year to the total population, is almost as high in Chile as in the United States. Furthermore, the ratio is increasing in Chile, and not in the United States. Thus, Chile may soon catch up to the United States' relative rate. However, the increasing rate means that in the past it has been considerably lower, and the total proportion of trained technical personnel in the country to the population is much lower in Chile. Furthermore, the average level of training is lower in Chile, due both to the much smaller ratio of engineering technicians, and the appreciably lower technical levels of the curricula. And finally, normal types of assistance available to U. S. engineers, such as library, abstracting and computing facilities, are much less prevalent and weaker. The over-all result thus is a considerably smaller relative engineering capability in research, design, development and production. However, eliminating the many basic or large scale

developments in the United States that utilize technical personnel and which do not need to be duplicated in Chile, and the lower civilian demand for manufactures, and relying on the fact that Chilean engineering is developing strongly, it is evident that there should be no pessimism for the future.

## 2. Engineering Curricula in Chile

The attached chart lists the engineering curricula now in operation in Chile, and the average number that currently graduate per year in each.

The curricula of the Universidad de Chile and the Universidad Católica de Chile (Santiago) are all officially designated Civil Engineering, with the branches indicated in the table being available as options. The word "civil" is intended to indicate a broad and administrative training, and the graduates of these two universities are more in demand for that type of position than those of other universities. These curricula are heavily loaded with courses descriptive of the principal industries in Chile. As an extreme illustration of this tendency, the sixth year of the Civil-Industrial program at the Universidad de Chile consists of 13 full-year courses totaling 25 lecture hours and 14 1/4 laboratory hours per week, at least half of them merely descriptive of such subjects as industries, law, planning, and industrial relations.

In addition to the above two, the curricula at the Universidad de Concepción and at the Universidad Católica de Valparaíso are all designated "classical" engineering curricula, as all are based normally on the Bachelor in Humanities as a prerequisite for admission.

The curricula at the Universidad Técnica del Estado and at the Universidad Técnica "Federico Santa Maria" are designated "technical" or "industrial" engineering curricula, as they are designed to give their own technical graduates an opportunity to go on into engineering. Their graduated engineers thus have a more applied and less theoretical preparation and viewpoint.

The Chilean engineer is probably equivalent to a one-year M. S. from the United States, on the average, although with less training in modern engineering methods and more in classical theory and descriptive technology (beyond High School, these curricula require six years in Latin America, or five years in the United States). One reason stated for the many descriptive courses is that the young engineer must very soon "earn his salary" in any company he goes with. But it is actually doubtful that descriptive courses are justifiable for this reason, since a good engineer should very quickly become profitable to his employer, even in a new field. Also, descriptive technology is frequently more emphasized by the typical part-time professor, who is a practicing engineer not in advanced technical work himself, but rather in management. These courses contribute to the heavy contact hour load which averages 36 per week instead of some 24 as in the United States. Thus, there is practically no time left for original thinking, reading or home work. In general, it would seem that most Chilean engineering curricula would profit from extensive revision, and that such revision might be difficult to achieve at present via the Faculties. However, some study of engineering curricula

is now underway toward eliminating descriptive courses, and toward having more basic shop work. When adopted, these changes will make the Chilean engineering degree more comparable to the United States degree in time and coverage.

One suitable general objective for an ICA program in the Engineering Faculties would be to facilitate the travel of young Chilean engineering teachers to the United States and U. S. teachers to Chile, to bring courses and laboratories in their field more up-to-date. Chilean activity and interest in the field itself should be a determining factor.

CIVILIAN ENGINEERING GRADUATES FROM CHILEAN UNIVERSITIES

(APPROXIMATE AVERAGE ANNUAL RATE FOR 1957-1959. - COURTESY JORGE VON BENNEWITZ)

ENGINEERING BRANCH	UN.CHILE (Stgo)	CATH. (Stgo)	UN. TECH. (Stgo)	UN. CONCEP. (Concep.)	UN. STA. MARIA (Valparaiso)	CATH. UN. (Valpso)	TOTALS	ESTIM. UNFILLED NEEDS
CHEMICAL	-	2	12	14	4	7	39	0
CIVIL	60	19	-	-	-	-	79	80
ELECTRICAL	17	-	18	-	7	-	42	0
PROCESS ("INDUSTRIAL")	13	3	-	-	-	-	16	0
MECHANICAL	-	-	20	Starting	8	-	28	0
MINERAL	-	-	3	-	-	-	3	0
MINES	13	-	6	-	-	-	19	30
TOTALS:	103	24	59	14	19	7	226	110
TOTAL NEW AP- PLICATIONS:	220	120	160	80	20	20	620	

(1) The Academia Politécnica Militar graduates a total of about 6 engineers per year who go directly to the Chilean Armed Forces. These are fully accredited chemical, electronic, mechanical, metallurgical and aeronautical. Civilian students are not admitted, to retain a necessary esprit de corps. Retirement or resignation generally transfers these to civilian practice for a number of years, however.

### 3. Need for Engineers in Chile

The table also shows present estimated needs for additional engineers per year. These are as follows:

- 1) Electrical: Remembering that engineers in Chile do administration primarily, it is not surprising that the government power system, ENDESA, is practically their only industrial employer. The present supply meets the needs.
- 2) Chemical, Industrial and Mechanical: The supply here is also entirely ample at present, though normally, without an austerity program on imports to maintain the currency, more would be needed.
- 3) Civil: A civil engineer is legally required to supervise any construction project, and twice as many graduates, or another 80 per year, would be immediately used.
- 4) Mining: Mining engineers are, percentage-wise, those in shortest supply, so that about 150% more are needed, or some 30 per year. The extreme shortage, plus the large number of Mining Technicians graduated each year, means that in the case of this profession possibly half of the engineering graduates came originally from Technician Schools.

Actually, these shortages are estimates made by a conventional though far-sighted Chilean engineer, and thus are appreciably influenced by the conventional image of suitable engineering work. Thus, if it were to become practice to employ Chilean engineers in factory operation, process development, technical sales and similar activities, a considerably larger number would no doubt be needed.

The capacity of the engineering schools in the upper classes is in general greater than the number of students, especially in the courses having few graduates

listed in the table. If this were not the case in the civil and mining fields, in which there are shortages of graduates, it would no doubt be possible to stagger laboratory sections, and to adopt other means to achieve fuller utilization of existing facilities. However, there are three other factors that limit production of engineers, all very effective in that action:

1) The students graduating from the Liceos (high schools) are not sufficiently grounded in the basic sciences, particularly as to the understanding which comes from personal laboratory work and other experiences. Alternatively, not enough of the Liceo graduates have learned enough science to be able to go into engineering without spending additional time in preparation. It is understood that this situation is improving, with laboratories and project-type work being gradually added in Liceos.

2) The principal engineering schools do what they can to find the best students by admitting a great many applicants to the common first year. After ability and motivation can be determined the poorer ones are failed. From the table it is seen, for instance, that at the University of Chile some 220 new students are admitted each year. To these are added about 110 who failed the previous year and are willing to repeat the whole first year. Thus 330 first-year students are handled right now in one shift, of whom maybe  $1/3$  will pass,  $1/3$  fail and leave, and  $1/3$  fail for the first time and return the following year. The first-year (common) program includes  $16\ 1/2$  hours of lecture work and  $11\ 1/2$  hours of laboratory per week. Evidently extensive laboratory facilities are needed for such a large class, on a scale unusual in Chilean tradition. It would seem that

this bottle-neck could be eased by either of two ways: (a) give extensive admission examinations to the engineering school (or take into account the Bachelor in Humanities comprehensive examination) and grant definite admission in advance to the first and second years to enough of the best students to insure a somewhat larger second-year class than is now the case and fewer returnees to the first year program. Some of the excess students could be failed out after the second year if they did not show up well by that time; (b) continue the present system, but admit more students to the first year by using double sessions, and announce an increased quota to the second year. Though the additional students would mainly be students with poorer records, some new good ones might apply due to the larger probability of their admission to the second year. This last procedure has recently been proposed by von Bennewitz to the Engineering School at the University of Chile, though not specifically with an announced increased quota to the second year.

3) Engineers in general, and more importantly Engineering Faculty members are not in favor of rapid increases in the numbers of engineers graduated. They feel that it is more important to maintain the quality and job status and social status of the engineer, which they feel would be adversely affected if the rate were to be increased more than 10% per year.

Another factor of uncertain effect is that the engineering schools up to now have also been producing the physical scientists. Since there were no science curricula, students with an interest in science were obliged to take an appropriate engineering curriculum. Some engineering graduates have also turned to science careers subsequent to graduation. The current initiation of science curricula will facilitate the education of science majors, and may somewhat increase the supply of engineers.

#### 4. Technical Education in Chile

As stated before, the technician program in Chile should be considered whenever the whole engineering picture in the country is being studied, since the technicians already do to some extent, and can and eventually will to a greater extent, meet "engineering" needs of the country.

The Liceos, particularly those outside of Santiago, have been rightly accused of not promoting inquiry, experimentation, and real learning. This situation is already improving significantly, however, as illustrated by many recent calls by Liceo students for technical bulletins at government agencies, improvements in laboratory facilities and courses, and excellent Bachelor's Degree examinations and grading techniques, emphasizing understanding and reasoning.<sup>(1)</sup> Thus the 12-year primary and Liceo program will eventually be a basic preparation for a technical education comparable to that of the United States high school. The normal preparation for the technician curriculum, however, is through a four- or five-year vocational (oficios) school, a terminal program for most of its students. No study of the vocational school curriculum was made, but it is evident that it

(1) Las Pruebas del Bachillerato. Faculty of Philosophy and Education, University of Chile (1959)

cannot compete with the two to three year longer Liceo program as sound preparation for a basic technician curriculum, and of course even less so for engineering.

Careful inspection of courses, laboratory equipment and experiment reports in the School for Technicians of the Universidad Técnica del Estado and discussion with faculty members, made it evident that the courses are generally of good content and quality, and reasonably comparable with U. S. technical institute and engineering school courses. The principal improvements that would be desired seem to be:

- 1) Advancing calculus from the second to the first year and using it in developing in the classroom and laboratory all of the courses in which it is applicable. This is being studied and probably soon will be carried out at the Universidad Técnica del Estado.

- 2) To the extent possible, which could be as much so as in the United States, the courses should emphasize not only the mechanical how of an experiment or of a design, but also the why, and the theoretical how, with quantitative prediction of deviations from simple laws.

This trend seems to be getting underway, and senior research theses are now carried out, which have a similar influence.

It would seem to be definitely worth-while in helping Chile to improve her engineering and industrial potential, to assist the Technical Schools as well as the Engineering Schools. Personnel exchanges would help spread item (2) above and further develop senior research. It would seem that reciprocal travel of several professors specializing in key laboratory subjects and working with a number of schools, would be very profitable.

In Chile the program might first include one or two months at the Technical Schools in Santiago, helping to up-grade laboratory procedures and thesis work, such as preparing instruction sheets. Then a tour would follow through the other technical schools located elsewhere in Chile with the completed experiment sheets, which would be explained, and employed where possible, and modified or new ones made, if necessary, depending on equipment available. The individual should be a U. S. Technical Institute or Engineering School professor, and the trip might well total three to six months.

The United States phase would call for a visit by a competent and well-established professor of the Universidad Técnica del Estado to several U. S. Technical Institutes and Engineering Schools to learn their best approaches in his particular field. He would then apply this added knowledge in his own course and give demonstrations to professors of other Technical Schools.

## F. PREVIOUS REPORTS ON SCIENCE IN CHILE

The Mission is familiar with the series of five special reports prepared for the USOM as mentioned in the background portion of this report (see page 119). In connection with those studies, it wishes to re-emphasize some of the points contained therein.

1. The Steere Report on "The Development of a Program of Scientific and Technological Research in Chile": The Mission feels that several points deserve continuing attention such as the importance of raising the financial and social status of the professors and the scientists, and permitting them to give their full time to teaching in one institution and in research. It is necessary to educate the public in science and its importance.

The suggestion of an organization of scientists in Chile to advise the government and to bring prestige to scientists is a good one. Although there are national research councils or the equivalent in some countries, there seems to be none in Chile. The matter is obviously one which, if implemented at all, must come from the spontaneous initiative of Chilean scientists themselves.

The importance of developing research in agriculture, mining and industry is obvious. Excepting some fields of agriculture, very little research is being carried out by institutions in these three important areas of national economic activity.

They must look to the Universities, and the Universities should accept this responsibility, while at the same time putting their chief

emphasis on basic research.

The Steere report emphasizes the importance of strengthening the teaching of basic sciences by centralizing this instruction and having it in charge of scientists rather than professionals in the applied fields. As stated in the present report, excellent initial progress has been made in this reform at the Universidad de Concepción and at Universidad Austral in Valdivia. A start has also been made at the Universidad de Chile. The Universidad Católica de Santiago has established a scientific commission which plans to develop and strengthen basic science teaching in a progressive fashion, initiating courses in one of each of the four fields each year.

2. The Krause Report on "University Facility Requirements to Meet the Technical and Scientific Needs of Chile": This report stresses the technical and scientific needs of Chile in developing its economic structure. It emphasizes the importance of strengthening the basic sciences, particularly in laboratory and field and providing more and better trained scientists for this teaching. It recommends also the expansion of engineering training into new fields, and particularly those which are of economic interest to Chile. Civil and chemical engineering have received the greatest attention this far.

The report recommends that post-graduate training and research be expanded.

The Mission supports these recommendations and agrees that Chile has the ability to produce outstanding scientists who will con-

tribute to the advancement of science and to the improvement of the national economy and the public attitude toward the research spirit.

SECTION IIREMARKS ON BASIC SCIENCES AND RESEARCH IN EACH OF THE SEVEN CHILEAN UNIVERSITIES

## A. UNIVERSIDAD de CHILE, SANTIAGO ( UNIVERSITY OF CHILE)

1. Appraisal of Teaching and Research in Biology

There is no common center for instruction in biology at this university, a situation true for all universities visited, with the exception of Concepción and Austral (a plan is being developed, with an expectation of early implementation, at the Universidad Católica de Chile, Santiago, (cf. also Sec. II, C, P.48). Courses in this subject are given in many places, particularly in professional Faculties such as Medicine (where it is found in several schools and departments), in Dentistry, Pharmacy, Philosophy and Education (Department of Biology), Department of Basic Sciences in Valparaíso, and the Faculty of Agronomy. The subject matter and the teaching in all these areas is slanted in the direction of what is assumed to be the best professional interests of the particular unit. There is no place where the student can obtain a basic, and at the same time, a comprehensive view of the entire biological field. The nearest approach is in the Department of Biology (Faculty of Philosophy and Education) where the classroom and laboratory teaching, in entomology particularly, is first class. But even in this Department there is a tendency to spread thin rather than to delve deeply. Moreover, teacher training is involved with an inclination to emphasize method rather than content. Unfortunately, this Department is located

several miles from the main university center and thus, in a practical way, serves only its own students. With but a few exceptions, all teachers of biology have had their academic origin in medicine, veterinary science, or pharmacy. It is to be expected, therefore, that both teaching and research would emphasize animal biology, usually in the direction of medical application.

The course given in the "Cátedra de Biología, Facultad de Medicina", labeled "General Biology" is essentially a course in cytology and genetics from the animal point of view. This course is addressed to students in medicine, dentistry, chemistry and pharmacy.

The members of the Mission encountered much interest in the development of a basic science teaching center, which would include biology, chemistry, physics and mathematics, serving all professional schools. Although it is reassuring to note that the professional schools are giving the proposal considerable support, they are, at the same time, arguing for professional school control. Without safeguards this could mean decision on course content by the professional schools. In order to make the program successful, there would need to be a firm agreement that the course content should be determined by the basic scientists rather than by the professional school authorities.

The research activities in biology under the general auspices of Medicine, Chemistry and Pharmacy are organized into five divisions: Cytology A, Cytology B, Experimental Zoology, Immunogenetics,

Population Genetics and Evolution. Considerable time was spent in discussing research problems and needs. These conversations revealed that much of the research was unusually good and would merit high praise for imaginative quality and as fine basic contributions to biological science. We were particularly impressed by the work of Dr. Osvaldo Cori and his wife, Aida Traverso-Cori, on the demonstrated existence of an enzyme in rat skeletal muscle responsible for the transfer of phosphate from 1:PGA to creatine without the participation of the ADP-ATP system; by the studies of Dr. Gabriel Gasic and his group on "the meaning of intercellular cementing substances in cell cohesion", and associated phenomena; by the research results obtained by Dr. Danko Brncic in his investigations on the genetics and evolution of Chilean species of *Drosophila*. These include taxonomic, cytological, ecological, and mutational studies in natural populations of the genus; by the research of Professor Gustavo Hoeckes, concerned with studies on gene action in the determination of anti-genic structures.

The research in biology, while excellent as to individual problems, is not broad in scope and basic research on plants is notably lacking, with the exception of a slight activity on marine algae at the Montemar Marine Station. However, much good research is being done in the area of animal biology and it deserves commendation and support. The spirit, the imaginative and the

investigative potential is here. It is apparent that this potential is handicapped by reason of a tendency to work in isolation, and in some cases by lack of modern equipment. It is also noted that the lack of a close association between teaching and research, and the failure of the instructor to inject some of his own research spirit into the teaching subject matter tends to leave the student unexcited and his native curiosity underdeveloped. The system does not seem to result in the production of many research-motivated graduates. One could conclude with some assurance that, even more than the need for equipment and technical assistance is the need for a change in the organization of teaching and research, - a change that would result in an enhanced interest in research on the part of the student and one that would give him a good basic foundation on which to build.

Estación de Biología Marina, Montemar (Marine Biology Station)

This station is approximately 15 miles north of Valparaíso, on the coast. The buildings have recently undergone extensive remodeling and extension, and from the physical and equipment point of view it is in excellent condition.

The research is largely descriptive in character, although a few investigations involving an experimental approach are underway. There is an excellent library, in fact an unusual one, well selected and extensive.

The problem here relates to the absence of men of scientific vision rather than to apparatus or more laboratories.

2. Facultad de Física y Matemática (Faculty of Physics and Mathematics)

There is a very active research program in physics, including work in the following:

Nuclear physics with a Cockcraft Walton accelerator

Crystallography

Crystal optics

Radiochemistry

Radiobiology

X-ray spectrometry

Solid state physics

Electron diffraction

Study of thin films

Thermal diodes and photo diodes including zone refining

Theoretical physics

There is good X-ray equipment, machine shop, and an excellent glass blowing shop.

The school has an excellent half-million dollar astronomical laboratory which is being built on a hill a few miles from the University. The buildings are nearly finished. They are being financed with the one-half of one per cent of government taxes set aside for apparatus

and buildings. The director of the astronomical laboratory is a very able scientist and administrator. He has support from the United States for five research projects. Research is being carried on now at the old site, but within a year the first class astronomical observatory should be in operation.

There is also a branch of the University of Chile carrying out physics research on solar energy in north Chile near Antofagasta. The emphasis here is on photovoltaic devices and the conversion of solar energy into electricity through solid state physics devices.

(See b), page 73)

3. Facultad de Química y Farmacia (Faculty of Chemistry and Pharmacy)

There are about 180 students in the first year and 60 in the third year and about 40 in the fourth, fifth and sixth years.

There is a rigid selection of entering students on the basis of examinations. The industries are eager to absorb the chemists who are graduated, about 10 per year. Research is going on in organic chemistry, and physical chemistry and in pharmacy. The Institute is handicapped by the fact that the organic chemistry, biochemistry and pharmacy is located in the Faculty's building and the general inorganic, analytical and physical chemistry are located in another building about two miles away in the Engineering Faculty complex.

There is a good research program in polyelectrolytes and

surface films.

A Fulbright professor is spending a year in the organic research laboratory.

4. Chemistry Center, School of Engineering in the University of Chile

A new center of chemistry has been organized recently which gives many of the courses also given in the Chemistry and Pharmacy Institute. Its emphasis is perhaps more along the lines of chemical engineering. Its research projects, although basic chemistry in character, are directed more toward subjects of industrial and practical interest. It is divided into two groups: industrial chemistry and extractive metallurgy. The research program and enthusiasm is good, the professors are on full-time appointment and they have time for research, the equipment is good and the laboratory is well-equipped with spectrographs and other apparatus.

The researches include:

Studies of copper aluminum alloys

Kinetics of the reaction of carbon with zinc oxide

Radio tracer experiments with copper iodide

Activity coefficients of copper in the presence of iron

Polarography

Recovery of zirconium

Cracking of propylene

Action of dyes

Polystyrene

Flotation of ores

Magnetic concentration of ores

Electrostatic concentration of ores

Recovery of copper from ores with iron chlorides

Bacterial oxidation of ferrous ion

Recovery of molybdenum, selenium and other elements

The beginning course in chemistry is good. A high standard American text is used which is regarded in the United States as fairly difficult for beginners. Each student does some glass blowing. This training is apparently given in most of the universities of Chile. American textbooks are widely used for teaching the sciences.

Physical chemistry is taught in cooperation with the Faculty of Chemistry and Pharmacy. Each course is under a different professor, but the two professors and their classes use the same laboratory and equipment. There are about 40 students taking physical chemistry - divided into two groups. This is a step toward centralization and elimination of duplication.

This chemistry center unit includes the general and inorganic, organic, analytical, and physical chemistry laboratories that give the courses in the engineering school. When chemical engineering is started, the teaching duties will increase correspondingly.

The Center is temporarily directed by Carlos Díaz (see 8 below). His five-year plan includes expansion to 43 full-time pro-

fessors, said to be a minimum. This includes five to six to be sent abroad for training each year, and some others coming to the Center. The estimated total cost for the five-year plan would be \$1,320,000, including salaries, library and other expenses calculated at the present going rate of spending.

This Center when complete would duplicate similar facilities in the adjacent Chemistry Department at the Faculty of Chemistry and Pharmacy. Arguments that present courses or staff in the Chemistry Department are inappropriate, or that engineering students "would not go" to the Chemistry Department are inadequate to justify any sizable duplication of effort and equipment. It is to be hoped that the two laboratories can be combined, or at least that they will cooperate closely enough so that their needs and activities can be completely coordinated, possibly by an individual with a double appointment. If only one of the groups can be supported, it should probably be the Chemistry and Pharmacy Faculty, but in topics, fields or ways that would make it suitable and attractive also to the engineering school for basic chemistry courses and research theses.

#### 5. Hydraulics Laboratory

This is an excellent building with good standard model test facilities, including several models of flumes and dams.

The full-time staff is: Roberto Muñoz, director; Hernan Ibañez and Ventura Ceron; engineers and two technicians and four workers. Three part-time theses and ten spare-time theses are underway.

Some of the hydraulics lecturing and all of the hydraulics laboratory work in the engineering school is done by the staff.

The laboratory would like to improve its program through arrangements with Colorado State College, which have already been explored, in order to give better and more advanced work. An ambitious five-year expansion plan, with a total net building and construction cost of \$387,000, has also been prepared.

Recommendations:

The Mission recommends the following:

United States Specialists to Chile: the support of approximately one-man year in Chile of Colorado State professors and the sending of Hernan Ibañez, or his equivalent, to Colorado State for one year; and alternatively, two man-years of Colorado State staff to be supported in Chile.

6. Materials and Testing Institute (IDIEM)

This is a testing laboratory established in 1910, which performs routine materials testing work required by the government and financed by industry. The staff is in charge of the laboratory work and many courses in this field in the engineering school.

Its full-time staff is entirely competent and includes Arturo Arias, director and Professor of Mechanics; Gunther Joseph, in charge of the metals laboratory; Hans Meisel on nitrate bitters studies for Lautaro; Juan Grawen in charge of spectroscopic analysis and others.

The five-year expansion plans include the following:

Construction materials work - \$190,600 over a five-year period,

to become self-supporting thereafter.

Textiles and Paper development - \$194,000 over a five-year period; may become self-supporting thereafter. This laboratory would also do research to develop wood and paper technologies.

General research equipment: spectrograph, spectrophotometer and ultrasonics facility. Many student theses are carried out in this Institute.

Director Arias suggested that nine staff members go to the United States to visit laboratories active in their several specialties.

Recommendation:

Chilean Specialists to the United States:

First year - Gabriel Rodriguez Jaque, chemist, for six months in techniques of electron microscopy for research purposes, at RCA laboratories or equivalent.

Second year - Juan Figueroa Vera, metallurgist, for one year in a university experimental station employing thermal and magnetic analysis methods.

United States Specialists to Chile:

Dr. Gomez Millas has separately made a previous request for 3 U. S. professors to assist the IDIEM.

7. Institute of Electricity (IEE)

This is a well-equipped testing and research laboratory like IDIEM, although somewhat smaller. The staff is well-integrated with the engineering school. A number of student theses are being carried out under IEE staff supervision. The main weakness is in the field of electronics.

Headed by a competent director, Joaquin Cordua, the IIEE has a staff of 10 engineers and 7 technicians. Their five-year program includes 36 new staff members (22 engineers and 14 technicians) for the present three divisions of Machinery, Electronics, and Computers.

They recommend that five staff members be sent to study in the United States for one year each over the next two years, and that two visitors come from the U. S. to assist in special lines.

Recommendation:

The Mission recommends that arrangements be made for:  
United States Specialist to Chile

One U. S. Professor of Electronics to work at IIEE for one year, starting August, 1961.

Chilean Specialist to the United States

That arrangements likewise be made for Bartolomé Dezerega Salgado to go for one year to Stanford, or an equivalent university, to research on microwave circuits, starting August, 1962.

8. Institute of Metallurgy

This institute was founded in 1945 as a Mineral Engineering teaching laboratory. It has equipment in grinding, sizing, concentration and flotation. The full-time technical staff consists of five engineers, one analytical chemist, and several assistants, mostly hired in 1959 and 1960. Three courses are taught. Research and development problems have been carried out on copper loss in slag, SO<sub>2</sub> oxidation from converters by ferric sulfate, heat losses, dissolving of copper with bacterial aid, flotation of oxidized ore, and

dissolving of copper with ferrous chloride. Other suitable problems include sulfur recovery, nitre by-products, low-grade manganese, and coking of coal.

Mineral engineering should certainly be assisted in Chile. The acting director of the Institute is Carlos Diaz, young and energetic, and with bold ideas. His five-year plan would expand the staff to twenty engineers and eight technicians and have a total cost of \$869,000 including a new building. No financing has yet been arranged for continuing the present staff and work levels.

No trips by Chileans to the United States are requested yet. A several month visit by Prof. Herbert H. Kellogg, of Columbia University in the middle of 1961 has been requested. Some funds providing special laboratory equipment before his visit would also be desirable.

#### Recommendation

The Mission recommends approval of the trip by Prof. Herbert H. Kellogg as requested. He should also spend a week or more at Concepción visiting and collaborating with the metallurgy staff there, and possibly elsewhere.

#### 9. Structures Laboratory

The Structures Laboratory is relatively small and possesses clever and largely original teaching devices, mainly electrical and mechanical analogs designed by the staff to represent the effects of structural changes such as beam bending, earthquake stresses, and similar effects. Some measuring of stresses in vessel walls with strain

gages has also been done. The staff also has teaching assignments and handles some of the engineering courses in this field. The head is Joaquin Monge, who is in charge of the administration of the laboratory. The two division heads are technically competent. The laboratory is not as active in industrially or theoretically oriented research as would be desirable, but this is no doubt difficult to achieve in Chile.

This five-year development plan totals \$365,000, including current operating costs, and would continue or expand work presently going on such as in elasticity theory and strain analysis. It would also expand the present full-time staff of technical personnel from 4 to 15.

Recommendation:

No request has been received for fellowships or visits. The Mission recommends that should a request be made for one of the key technical personnel to spend one year in the United States at one or two materials research Centers (Cornell, MIT, Illinois, Columbia,) it should receive sympathetic attention.

10. Mining

Separate statements have been received from Professor Carlos Diaz, who is starting moves for the engineering school toward the establishment of a small Center of Mine Exploration, and Professor T. R. Leighton, Professor of Mine Exploration and former director of IDIEM.

Professor Diaz plans in five years a staff growing from one to five at a cumulative cost of \$100,000 to work on technical and

consulting problems in mining. Professor Leighton requests a United States professor for a brief course in modern methods. He also requests that arrangements be made for a young Chilean to spend a year at a U. S. institution and that arrangements also be made for him to visit the same institution for a period of approximately 2 months.

#### Recommendation

Considering the great importance of mining in Chile, the Mission feels that if funds are available it would seem reasonable to support one Chilean for one year at a good U. S. mining university, such as Pennsylvania State, Colorado or Missouri. This specialist should be acceptable to both Professors Diaz and Leighton. He should also work with the two professors upon his return.

#### 11. Earth Sciences

A School of Geology has been established and has been operating for two years. The Mission understands that the ICA plans to support this School for a total of five years, through the 1963 Academic year.

The School has been successful and every effort should be made to assist it, particularly insofar as the provision of American professors is concerned. The Mission understands that Stanford University, which provided three professors for the first two years, is in the process of discontinuing its contract with ICA because of the excessive administrative details. Thus, replacements will be needed.

For the period 1961-62-63, a geophysicist, a stratigrapher and an economic geologist are planned. A preference for specialists having the "West-Coast" (U. S. ) viewpoint has been indicated by the schools' authorities.

Recommendation:\*

The Mission recommends that the National Academy of Sciences either assist the ICA in finding replacements for the three geologists mentioned, in the understanding that the funds involved are separate from those in the present NAS-ICA contract; or that the NAS undertake the contract to continue operation of the School.

The Academy would probably feel that this type of operation should be carried out by a university. However, the Academy might consider such a contract as an emergency measure, provided that satisfactory administrative arrangements could be made with ICA.

**\*Editor's Note: Progress has been made toward the solution of this problem in order to assure continuity of the program.**

B. UNIVERSIDAD TÉCNICA del ESTADO, SANTIAGO (STATE TECHNICAL UNIVERSITY)

1. Biology

No basic instruction nor research in biology is included in the present curriculum.

2. Engineering and Technical

The School of Industrial Engineering was established in 1941, to permit good graduates of Chile's Technical Schools to continue beyond the classification of technicians and become engineers. Rector Horacio Aravena feels that it was unfortunate that the other engineering schools would not facilitate the admission of technicians to their programs, so that pressure by the technicians forced the creation of this somewhat different curriculum. Subsequently, in 1952, the eight Government Technical Schools were joined with the engineering school, creating the Technical University. At present, the University of Chile does admit technicians to its engineering curriculum, giving credit for any substantially identical courses passed. The result is, however, that even after three years of Technical School, the University of Chile finds that some first and second year course is lacking, and with conflicts bound to be present, the student is delayed some two years. The University of Chile is now considering the offering of certain key make-up courses during the summer, with which transfer students could save one year. This should make the transfer both more feasible and more popular.

The Technician program was briefly described previously. It is operating at full capacity, in general, with the shops which are the principal bottleneck, busy from 8 AM to 10 PM. The professors are unfortunately in the third category of government teachers, namely with a low starting pay of \$153 per month full time and a teaching load of 30 class hours per week. Thus most of these professors who already have a full-time load must have a second teaching job in a private school with about another 15 contact hours per week in order to earn enough to support their families. This heavy class load means that there is insufficient time to improve their courses or personally to assist their students.

Recommendation:

- a) A way should be found by the government or the university to lighten the professors' load and/or increase the pay, on the condition that the corresponding extra-class time be spent at the university on course, self, or student up-grading. Alternatively, they could be required to put the extra time on thesis projects, so far not extensively used.

A decrease in work load, at least to 27 class hours, equivalent to the fourth grade of government teachers, or preferably to 21 to 24 hours, would be very desirable.

- b) Student theses on subject such as new alloys, Heath-kit wiring and testing, electrical and magnetic measurements, and industrial consulting could be developed. (The electrical department particularly wishes to develop electrical and illumination standards and methods.).

The Technical School laboratory courses in Santiago are good in general and comparable with those of some U. S. engineering schools. However, the Engineering School laboratory courses in general do not appear, comparatively speaking, to be as far advanced as they should be. The Unit Operations laboratory on the other hand, is excellent, and is considered to be the best in Chile (cost: \$100,000). Other laboratories are planning improvements, and when they move into the new campus within the next few months, these improvements will be possible.

The following research instruments are now being constructed as theses: a nuclear magnetic resonance apparatus, transmitting antenna field strength meter, an analog computer, solar energy devices, effect of previous heating on calcareous gangues in copper and manganese concentration, design of a shock-absorbing base for a stamp mill, rusting of steel by gypsum using Fe-59 tracer, grinding of minerals with tracers, and mechanism of slimes handling in flotation with S, P and T in labeled reagents. The above list is not all inclusive.

The University authorities are definitely interested in foreign study opportunities for Faculty members. They are emphasizing original thesis research for their students. The new buildings will provide better facilities for this research. The authorities have also prepared a two-to three-year staff plan

for training abroad.

According to this plan, in Unit Operations and Processes they would like the following:

(1) the laboratory director, Abdon Zomosa, to visit several U. S. universities and research centers to find out how they use these laboratories. Zomosa obtained the M. S. in the United States in this field and installed the Unit Operations laboratory at Concepción before coming to Santiago. After this trip;

(2) the head of the Unit Operations laboratory would study and research for one year at the most appropriate laboratory visited by Zomosa.

(3) simultaneously with 2 above, if possible, a United States unit operations specialist would come to help in experiments and research.

(4) following the visit of the unit operations specialist, mentioned above, the head of the Unit Processes laboratory would go to the United States for a year in unit processes and reaction kinetics.

(5) A United States expert in analysis and other spectroscopy for at least one year.

In optical spectroscopy they have a Hilger quartz spectroscope with attachments. At their own expense two selected

graduates went to Spain to specialize in spectroscopy, and have just returned. Two others were sent to England for three years with the same goal, and will return in 1961. Eventually they would like to expand the laboratory to mass spectrography and solid state physics.

Recommendations:

Assuming funds are limited, the Mission suggests that priority be given to the above plans in the following order.

Chilean Specialist to the United States

- 1) The head of the Unit Operations laboratory would study and research for one year at the most appropriate laboratory.
- 2) Following the visit of the unit operations specialist, mentioned above, the head of the Unit Processes laboratory would go to the United States for a year in unit processes and reaction kinetics.
- 3) If extra funds are available later and the trip could be arranged to include technical meetings, provision should be made for the laboratory director's visit to the United States.

United States Specialists to Chile

Action could be deferred on the recommendations for the visits of a U. S. unit operations specialist and for an expert in analysis and spectroscopy, pending development of the above recommendations.

C. UNIVERSIDAD CATOLICA DE CHILE ( CATHOLIC UNIVERSITY OF CHILE)

1. Biology

The over-all organization of the Universidad Católica does not differ significantly from that of the University of Chile. Thus, it is not surprising to find that teaching and research in biology are primarily centered in the Faculty of Medicine and Biological Sciences (see however, references to the new trend, pages 9 and 50). The following schedule of course requirements for the Licenciado in Biology illustrates the common practice of slanting courses and course content in the direction of professional school requirements<sup>1</sup>:

<u>1st year</u>	<u>2nd year</u>
Mathematics I	Mathematics II
Physical chemistry and inorganic chemistry	Organic chemistry I
Morphology and embryology	Physics
<u>3rd year</u>	<u>4th year</u>
Organic chemistry II	Pharmacology
Biological chemistry	Physio-pathology and
Physiology	General pathology
Essay in the field of general biology	History of Science
Optional: Physics, chemistry, physiology, pathological anatomy, bacteriology, parasitology	
<u>5th year</u>	
A research problem	

The Department of Biology and Chemistry (Faculty of Philosophy and Science Education) presents a somewhat broader picture of biology; for example: the first-year student takes Animal Morphology, Animal Histology, Plant Morphology, Cytology and Physical Biology; in the second year: Embryology, Zoology, Botany, Microscopic Morphology; the third year: Introduction to Methodology, Genetics, Zoology, Botany, Practical Genetics; fourth year: Evolution, Biochemistry, Physiology and Physiopathology Methods of Biology; and in the fifth year: Biological Methods, Hygiene, Philosophy of Biology.

On paper this appears as satisfactory coverage, but in reality biology is less emphasized than teaching methods. Laboratory experience is scanty. The chief aim is to train secondary school teachers.

As in the Universidad de Chile, some excellent research is being done on basic problems of interest to medicine. As far as could be learned, there is little research in biology within the Faculty of Philosophy and Education. Especially to be noted are the investigations conducted by Dr. Hector Croxatto of the Department of Physiology (Medicine), Dr. Joaquin Laco V. in Neurophysiology and Dr. Juan Vial Correa in Cytology-Anatomy. No signifi-

cant research was apparent on basic problems completely independent of professional school interests.

Research apparatus and equipment for those interested is only fairly adequate. The above investigators indicated verbally that their research would be promoted if certain modern equipment were available. This will be covered in Sections V, VI, and VII.

The main problem connected with an acceleration of basic research appears to be related to the weakness inherent in the teaching program rather than in financial support. Students do not become excited over research adventure, - the emphasis is on training rather than on education and the product is more a technician than a research scholar.

There appears to be a lively interest in the development of an "Institute of Biology" comprising all laboratories concerned with basic teaching and research in biology. Although this proposal includes the creation of a new Department of Plant Biology and Genetics, the following list of existing departments to be included in the new institution indicates a heavy weighting in the direction of professional school interests: Anatomy, Neurophysiology, Physiology, Microbiology, Physiopathology, Pharmacology, Biochemistry. Despite this tendency, however, the creation of such an institute would be a distinct step toward unification of teaching and research in biology, particularly so in that a significant proportion of staff members

attached to professional school Faculties are engaged in research of high basic value. The assumption is that such an Institute would provide instruction to its own major students and also to students from the professional schools. The creation of such a center has fairly good chances in its favor, since the administration, which in a church-sponsored university has greater real power than that of a public university, appears to favor the plan. This is another example of a growing trend in the Chilean universities to centralize and strengthen basic science teaching and research (cf. also Sec. 2 below).

## 2. Chemistry and Physics

The development of basic sciences is one of the main interests of the University. The University has created a Comision Cientifica to coordinate the scientific development, which is just getting started. Within four years they hope to have basic science institutes together in a new building. This commission is aware of the importance of having the basic sciences centralized and taught by scientists rather than having them duplicated in several professional schools. They have succeeded in the case of organic chemistry and year by year they hope to centralize other basic sciences as professors leave, or retire.

Professor Bianchi has an active centralized program of organic chemistry and is doing good research, particularly in the

natural plant products. An infra-red absorption spectrograph is available for the work.

There is, however, duplication of other chemistry courses in chemistry, medicine, engineering, and other areas.

There is a course in physical chemistry given in the Institute of Physics and Astronomy. It does not yet have a physical laboratory as part of the course. The teacher is alert and able. It is not clear whether this course duplicates other courses in physical chemistry given in the Institute of Chemistry and also in the Facultad de Tecnología, and in Engineering.

No active research programs in the Institute of Physics were noted.

Insofar as the teaching of Physics is concerned, there are beginning courses in six different laboratories including the Physics Institute, the Engineering College, Civil Engineering Construction, Electrical Engineering, Chemical Technology and Teacher's College. Centralization of these separate activities would appear to promise worthwhile results.

### 3. Engineering

The Engineering School laboratories are organized into the Department of Technological Research. They are quite poorly equipped compared to those of the University of Chile. However, a moderate amount of engineering testing and of student theses is under way. As at the University of Chile, the idea of establishing

the Department of Technical Research was to give each component laboratory vitality in research as well as in teaching. The full-time technical staff now is only five, and will be eight next year. There are eighteen full-time assistants, and a number of thesis students.

Some research on soils in earthquakes and on dirt road stabilization with cement and niter, such as on ferrous alloy casting, is underway with industry and government support.

Their electronics laboratory is small and has adequate travel fellowships for its staff.

Members of the staff indicated that their main equipment needs are for a Heat Engines laboratory, and for pulsing jacks to put pulsing loads on test specimens. Although more fellowships may be desired later, the only new travel fellowship they wish now is for Professor Arturo Morales, to work for one year with Professor Martin Duke at the University of California on soil mechanics. Professor Duke was recently in Chile (as a member of the team sent by the Earthquake Engineering Research Institute in June<sup>\*</sup>). The field is clearly of vital importance to the country.

\*Editors Note: Another member of the EERI team was Professor Ray W. Clough, Jr. of the California Institute of Technology, (C. I. T.) who also served on the NAS team of engineers sent to give courses at the Graduate School of Engineers, University of Chile, for the period, July-August 1959. Mr. Victor Jenschke, one of Professor Clough's Chilean students at that time, is now pursuing special students under him at C. I. T.

## D. CATHOLIC UNIVERSITY OF VALPARAISO

### 1. Biology

The major biological emphasis at this university is given to an applied field, namely fisheries technology. Some of this touches on basic science, such as the study of fish migrations and feeding habits, but in the main, the technical side of biology is stressed.

There is no School of Medicine at the University. This absence of a Medical School and of the stimulus which such a school provides to biological instruction and research is readily apparent.

#### Recommendation:

There is a great need for serious attention to basic science instruction, not only in biology, but in other areas as well.

### 2. Engineering

Teaching and research equipment of all types is quite meager. However, there is a fairly active School of Electronics with a TV laboratory under Carlos Melendez Infante, Director. The School awards a four-year Technician degree in Electronics, and has a staff of four full-time, one half-time, and three part-time (single course) professors.

In the television laboratory a good demonstration of closed-circuit operation was put on with several cameras and receivers, some constructed or assembled there. A 500-watt transmitter has been built which can cover all Valparaiso, and design projects are underway for radiotelephone connections with a fishing boat and with

a university farm in the south.

Although the development of television is made difficult both by existing laws and the foreign exchange situation, it will certainly eventually become important educationally as well as commercially in Chile. In general there is no appreciable experience in high frequency electronics. Thus it seems very appropriate to encourage this activity.

The School proposes that three graduates, Jorge Petit, Carlos Holtzmann and Claudio Moraga, be awarded one-year fellowships for graduate study in the United States, starting September, 1961, with the understanding that they stay longer to earn the Ph. D., if they can receive research assistantships in the school selected.

Comments and Recommendation:

An earlier date does not seem feasible. In all probability September admission is best to prepare for an assistantship for the following school year. However, if a good university indicates willingness to consider the fellows for an assistantship within 12 months of a January, 1961, admission, this earlier date would be preferable for one or all. They should go to different universities to vary their learning.

The university also requests assistance in obtaining a TV or electronics research contract. For this, application should, of course, be made direct to the desired agency in Washington, giving full details of facilities, interests, and needs. The U. S. Air Force and the Office of Naval Research have sponsored foreign research in these fields.

However, the university facilities and staff do not seem adequate to justify a special arrangement of this nature at this time.

There is some other thesis work of a semi-research nature in the chemical engineering program, and some is carried out in other fields in the Institute of Scientific Investigation. However, no request for help was received.

### 3. General

A research program on the chemistry of fermentation is underway as well as some on petroleum oxidation products and other problems in physical chemistry. The university has a very good glass blowing shop and first-class equipment has been ordered for liquid air production for low temperature research.

A situation involving the heavy attrition of students, due primarily to failures in mathematics was noted. For example, in chemistry only 14 of the first-year class of 90 were admitted to the second year.

#### Comment:

This situation merits serious consideration.

E. UNIVERSIDAD TECNICA "FEDERICO SANTA MARIA", VALPARAISO  
(TECHNICAL UNIVERSITY "FEDERICO SANTA MARIA")

1. Biology

No basic instruction nor research in biology is included in the present curriculum.

2. Chemistry

The buildings are excellent and the laboratories in chemical engineering, in physics and in chemistry are very good.

The course in physical chemistry and electrochemistry is well-organized and the laboratories and equipment are quite satisfactory, but there are only four to six students taking the course and these occupy the laboratory for two half days or more per week. Later it will be occupied also by some thesis students.

The teacher of physical chemistry who does not have many students, teaches 16 hours of lectures and 8 hours of laboratory per week. This schedule leaves very little time for research. In fact, there did not seem to be much evidence of research activities other than that by the staff. However, a considerable part of the last year of instruction is devoted by the students to research theses or projects.

The vice rector, Professor Hirschmann, is carrying on a research project on solar energy. (See page 72)

In organic chemistry there is an active program on natural products and experiments on extraction were in progress.

### 3. General

This university has only engineering and technicians programs (250 students), arts and trades (300 students) and an evening trade school (150 students). The professors are full-time and the teaching laboratories, which are fairly satisfactory according to United States standards, are put to good use for teaching and student thesis research. Special research equipment includes an old Siemens electron microscope (working on clay sizing and silica gel); a very small X-ray diffraction machine (Professor Keller); and large glass solvent extraction equipment. A well-organized, reasonably large library exists.

No specific requests for fellowships or visitors were received by the mission. The latter is familiar with the existing program in the Chemical Engineering Ph. D. (and the ICA sponsored arrangements with the University of Pittsburgh). Similar post graduate programs leading to the Ph. D. are expected to be extended to other departments in the future.

It will be interesting to see how the doctorate students in Chemical Engineering turn out, and how industry receives and evaluates them. With the careful individual attention being given by Professor Stutzman and his colleagues of the University of Pittsburgh it would be expected that they will be well prepared

If equipment funds were available a good X-ray diffraction machine, at least, should be provided for Professor Keller.

## F. UNIVERSIDAD DE CONCEPCION (UNIVERSITY OF CONCEPCION)

### 1. Biology

The teaching of biology at this university is on a sound basis, more so than in any other Chilean university. This is due to the recent establishment of the Instituto Central de Biología with its four-year coordinated curriculum.

The Instituto was set up in 1959 and consists of three closely articulated departments: Biology, Botany and Zoology. The curriculum, which is designed to give the student a mastery of broad biological principles and basic knowledge, includes essential foundation courses in mathematics, physics, and chemistry. Provision is made for majors in botany, zoology and general biology. The basic course in biology, as well as other sequential courses, are taken by students from the professional schools, thus doing away with the many fragmentary courses previously given and relieving the professional school of responsibility for this preparation. The Institute's graduates in biology would be equipped to enter graduate schools in the United States for further work in a biological field, or to qualify for government positions requiring broad biological training. Eventually, it is hoped the graduates will provide a source of supply for university teaching staffs in Chile and in other Latin American universities.

The present emphasis of the Institute is on teaching. However, there is some faculty research underway and the over-all plan calls for the development of a teaching-research center.

The recent earthquake destroyed much of the teaching-research equipment which must be replaced. There is hope that funds for this purpose can be secured. The building housing the Institute was not seriously damaged by the recent earthquake and is being completely remodeled in keeping with its most efficient use for the purposes covered by the original plan. This remodeling is to include modern classrooms, teaching and research laboratories, a central storeroom, shops, aquarium and greenhouse facilities, first-class library facilities and rooms for foreign faculty visitors. In part, this program has been made possible by the grant of \$500,000 by the Ford Foundation for the development of the four basic science institutes since the funds made available relieve the university budget by providing for costs involved in contracting for key personnel.

The current problem in the Institute's development lies in the securing of a broadly trained staff, and one in sympathy with the aims of the Institute. Progress is being made.

Comment:

In addition to recruitment from the United States and Europe, there is need to send certain of the middle and younger age group abroad for further study and also to secure American scholars as temporary faculty members.

One additional point should be made. As an adjunct to the Institute the university has a Marine Biological Station in a nearby coastal area. This not only provides for the training of marine biologists, but will offer opportunities for cooperative basic and applied research on fishery and other marine life problems. At the present time an effort is being made to gain governmental support for a cooperative organization which will utilize the several Marine Biology stations along the coast. Although this will primarily focus on fishery problems, such as food supply, migration as affected by food supply, temperatures and ocean currents, it will also have an interest in promoting basic research on various forms of ocean life, both plant and animal.

Comment:

The Institute of Biology at the University could be studied with profit by the other universities in Chile, not so much as a rigid pattern to follow, but rather for the basic principle involved, that of establishing a center for biological teaching and research, not alone for its own students but also as a service for the professional schools.

2. Chemistry and Physics

The University of Concepción is pioneering in Chile, and as has been noted, established the teaching of the sciences in four central institutes independent of the professional schools. They are taught by scientists on a full-time basis and the teaching

loads are comparable with those in American universities, so that the professors and staff members have adequate time for research.

Physics teaches 800 students and has 28 full-time staff members.

Mathematics teaches 700 students with 17 full-time staff members.

Chemistry has 1100 students with a staff of 40 full-time staff members, distributed as follows: 16 in general chemistry, 7 in analytical chemistry, 12 in organic chemistry and 5 in physical chemistry. Thirty per cent of the staff have degrees taken outside of Chile. Three persons are now on leave, two in the United States and one in England.

There are 600 students taking the first year of chemistry and less in the later years. A career chemist has four years plus one year of research thesis. Medical and dental students take general chemistry and organic chemistry. There are 100 students in physical chemistry including engineers, pharmacists and education students.

The Chemistry staff has 3-6 hours of lectures per week and 9-11 hours of laboratory. This is much better than at most of the other Chilean universities. The student schedule is about 36 hours per week with half lectures and half laboratory.

Calculus is required of all first-year students.

In mathematics the teaching load is about 8 hours per week and half of the staff is engaged in writing a new textbook.

The physical chemistry laboratory equipment is rather limited for 100 students and the simpler experiments are emphasized.

The new chemistry building was severely swayed back and forth by the earthquake, probably from  $+15^{\circ}$  to  $-15^{\circ}$ . All the reagent bottles were thrown to the floor and mostly broken. Most of the apparatus was thrown on the floor and much of it damaged. The losses are over 50 per cent, but the building remained intact and only one or two windows were broken.

Research in chemistry includes work on isotopic tracers.

Research in physics includes work on ultra sonics, crystallography, speedrography, atmospheric physics, and nuclear physics. Ninety per cent of the physics staff has done research physics.

Very good basic research is being carried out in chemical engineering, in the Engineering Institute. The work includes:

Analytical research

Polaragraphy

Forest products, including paper pulp

Kinetics of the decomposition of sodium nitrate

The unit operation laboratory in chemical engineering is very well equipped and there is a very good library which has chemical

abstracts going back to the beginning in 1907. There is an excellent glass blowing shop.

The rector of the university, David Stitchkin Branover, is a splendid leader who is planning for the future. The morale of the staff is excellent in spite of the earthquake. Two alumni now at the University of Wisconsin expressed great pride in the university and its pioneering plans of centralized basic science taught by full-time scientists.

### 3. Engineering and Chemical Engineering

The University of Concepción had received the \$500,000 Basic Institutes grant from the Ford Foundation before our visit. We were informed that this grant, plus the fact the grant is for the development of basic institutes, would indicate the reason for no ICA assistance being requested for the engineering and technology programs as of now, excepting the urgent need for the United States specialist to advise on the organization of a School of Mechanical Engineering.

#### Recommendation:

The Mission recommends that the assistance requested be provided. \*

\*Editor's Note: The Academy has collaborated with the University of Concepción in accordance with the above request and arrangements have been completed for Professor Lewis N. Buck, Chairman of the Department of Mechanical Engineering, University of Pittsburgh. He is spending the period, November-December 1960, in Chile where he will be based at the University of Concepción and will visit other universities interested in his field of specialization.

The new chemical engineering program is considerably more basic than that of the University of Chile, and yields good graduates. There are fewer descriptive courses, and fewer courses and class hours per semester, allowing ample time for individual efforts.

The laboratories of the program are all organized as the Institute of Technologies. There the teaching laboratories and the student theses are carried out. The unit operations laboratory room is excellent and the equipment adequate, but mainly home-made. It is to be improved with part of a \$300,000 German loan for equipment. Several research laboratories are also located in the building. One of the most involved in research seems to be the metallurgy laboratory, established some eleven years ago by a French scientist since returned to France. Theses are on equilibrium and kinetics of the oxidation of iron, dissociation of pyrite in a vacuum, reduction of pyrite by hydrogen, zone refining of zinc dross and diffusion of oxygen through FeO.

Another was the inorganic chemistry laboratory under Professor Jaime Cases Casanova. Work underway includes pyrolysis of niter, ion exchange with niter to separate dilute nitric acid and caustic, analytical methods for niter pyrolysis products.

Both of these laboratories and any similar ones are doing perfectly good work, and do not really need personnel interchange.

However, if the need does develop, students who have spent some time in these laboratories would be perfectly well-grounded to go into graduate degree work in the United States.

#### G. UNIVERSIDAD AUSTRAL, VALDIVIA (SOUTHERN UNIVERSITY)

The Universidad Austral is in its sixth year of existence, and consists of the General Studies Faculty, School of Agricultural Sciences, Forestry, and Engineering. There are nine institutes under the faculty of basic studies. In its present stage of development, it is somewhat similar in organization to an American land-grant institution. However, with respect to physical plant, general facilities, equipment, library, breadth of offerings, and support funds, it would be put well down on the American land-grant college list. It possesses something more important than all these, however; that is, vision, dedication to high standards, a feeling for scholarly values, all linked to the best interest of the particular society it serves by a chain of good "horse sense".

Austral is the product of one man, Dr. Eduardo Morales Miranda,\* the present rector. Dr. Morales has a strong desire to free Chilean education from its rigid ties to the past and makes known his frank opposition to the hold which tradition still exerts on university organization. He seems to seek an adjustment of educational philosophy and organization to the changing times, without losing sight of the fundamental purpose of education, the

\*Editor's Note: Re-elected October 13, 1960, for 6 years.

development of the mind and the acquisition of personally and socially helpful skills. Austral and Concepción are among the few Latin American universities where the walls of educational tradition have been most widely breached. They both promise great returns. They are part of the new trend in science teaching in Chile to which reference has been made previously.

The basis of education and subsequent training at Austral is the "General Studies Faculty". This is somewhat similar to a lower division in an American liberal arts college. Students must complete two years of carefully selected "general studies", which cover humanities, social sciences, languages and the basic sciences (including mathematics) before they are permitted to begin specialization in the Schools of Agricultural Sciences and Forestry Engineering. This is in contrast to the general practice in Latin America of permitting entrance to professional schools on the basis of a high school "Bachillerato" plus an examination. This program in General Studies is not limited to a basic general preparation as a foundation for subsequent specialization; it has its own major programs associated with the several Institutes (Departments). At the present time, with a total university enrollment of approximately 400, there are 26 General Studies majors and thesis students.

The following Institutes relating to basic sciences withing the Faculty of Basic Studies are functioning effectively: (The number

within parenthesis following each Institute indicates number of professors and instructors.)

Biology	(4)	Geography and Geology	(1)
Botany	(3)	Chemistry	(4)
Zoology	(3)	Microbiology	(2)
Physiology	(2)	Physics	(4)
		Mathematics	(5)

Little pure research is being done, but there is considerable investigative activity on applied problems in both agriculture and forestry. Some work on forest products is underway under the guidance of several visiting professors from Europe.

The long-range plan of the university emphasizes three points:

- (1) Providing a strong basic foundation, - cultural and scientific, upon which not only to build specialists in basic and applied fields and to strengthen this program both intensively and extensively, but also to develop socially informed and responsible citizens.
- (2) In keeping with its location in an agricultural, forestry and fisheries area of Chile, to develop a strong program relating to the applications of science to the end of more effectively exploiting the rich natural resources of this region.
- (3) The encouragement of basic science research, particularly that which would have a bearing on the above applications (i. e. marine biology, animal physiology and pathology, plant biology)

Unfortunately, vision and purpose outrun funds. The university is dreadfully poor, salaries are low (monthly salaries: Professors, \$200; Dean, \$300; Rector, \$500). Although the buildings on the main campus outside Valdivia were not greatly damaged by the earthquakes, the downtown structures were completely destroyed. Much of the laboratory, glassware and sensitive apparatus was either destroyed or badly damaged. It is probable that the Chilean government will provide some aid toward restoration, but not for desired strengthening of the existing programs, nor for expansions. This government source now provides about \$65,000 per year for general purposes. At the present time the support need is not so much in the area of particular individual, laboratory or institute research as it is for the university as a whole.

## H. NORTHERN CHILE

### 1. General

Antofagasta is the center of most of the activities of northern Chile. It is a large active city which obtains its water from the mountains 200 miles away through a steel pipe line. Most of northern Chile is an extreme desert with 364 days of sunshine and 1 mm, of rain per year. It has two activities which account for a substantial part of Chile's export trade; a very large open pit copper mine at Chuquicamata, and a large sodium nitrate extraction plant which produces 3/4 of the world's iodine.

The seven universities of Chile represented on the Council of Rectors of Chile do not include a university in northern Chile, but there are good educational facilities serving this area. All are quite new. They are: 1) a branch of the University of Chile under Dean Luciano Cruz Coke; 2) the Universidad del Norte, under Rector R. P. Francisco Dussuel, S. J. which is associated with the Catholic University of Santiago; and 3) a branch of the Universidad Técnica del Estado.

The branch of the Universidad de Chile specializes in teaching sciences and the Universidad del Norte specializes in teaching the humanities and social sciences, but is also active in the physical sciences.

There are thus good educational facilities for the young men and women of northern Chile. Although these institutions are only

a few years old, they are doing good work and they have plans for large expansion. The University of Chile is about to build an entirely new campus on a fine site at the edge of the city, and the Technical University has new buildings and good land along the shore.

### SOLAR ENERGY

Although primarily teaching institutions, The University of Chile branch and the Universidad del Norte are engaged in research in certain fields including work in seismology and marine biology. They have good programs in solar energy research. This region probably has the best weather conditions in the world for such investigations.

a) The Universidad Técnica del Estado (UTE). The UTE branch in Antofagasta has a good program of practical teaching and research at the undergraduate and early graduate level. The School of Mines of the University's Institute of Scientific and Technological Research is studying the extraction of copper from ores and the flotation of copper ores on a pilot plant scale. It is also concerned with problems of the leaching of nitrates in the northern Chile region and related matters. Applied research programs are being carried out on phosphates and metal extraction. Studies on coal and petroleum are starting. There is a practical teaching program in mining, electrochemistry, mechanical engineering and chemical

technology. These on research projects are carried out by the students during their last year.

b) University of Chile. Professor German Frick is continuing his research on solar cookers and solar heaters, and he is now cooperating with French scientists and a French company in developing solar voltaic cells. This work is also being supplemented by research on solid state physics in Santiago at the University of Chile. Professor Frick has a station in the dry hills above Antofagasta where he is testing these photo cells.

c) Universidad del Norte. Here there is an excellent research program on solar energy, including solar water heaters, algae culture, cooling by night radiation to the sky and removal and collection of water from the higher humidity at night. Temperatures of  $-10^{\circ}$  C. are obtained in this rather remarkable desert area. Mr. Carlos Espinoza, a young man on the staff, is responsible for this program. Rev. German E. Saa is carrying on research in seismology, but he is also engaged in solar utilization research.

Mr. Espinoza has organized an active Solar Energy Society with 14 members, but it is limited to the staff and students of the Catholic University. This lack of cooperation between different groups seems to be quite common in South America, even among professional scientists.

Mr. Espinoza urged that an American professor, active in solar energy, be sent to the Universidad del Norte even for a short time. Such a visiting specialist should also be associated with the branch of the University of Chile in Antofogasta. Mr. Espinoza stated that they have the unexcelled sunshine, the manpower and sufficient apparatus, but that they need inspiration and guidance.

Recommendation:

It is recommended that an American specialist be made available to work with both universities in Antofogasta, as well as with the Universidad Técnica "Federico Santa María".\*

d) Future Plans. Vice Rector Hirschmann (UTFSM), Professor Frick and Mr. Espinoza would like to sponsor a solar energy symposium in 1963 or 1964. There are adequate hotel facilities in the area. The setting would be excellent and such a symposium could do much to increase the interest and the morale of the Chilean scientists. The factors of timing and financial support necessary for a successful international symposium are such that outside support would be needed to carry this plan to fruition.

2. Industrial Research in Northern Chile

The large copper mine at Chuquicamata is very productive and good research has been done in locating new deposits through aerial color photography. It is largely an operating project and research is

\*The Academy has completed arrangements to implement this recommendation. Professor John A. Duffie, Director of the Solar Energy Laboratory of the University of Wisconsin, will be the specialist. Mr. Victor Bocic (see p.75) has been given a special grant to work with Professor Daniels and with Professor Duffie at the University of Wisconsin.

primarily carried out in the United States. Some research is carried out in copper leaching from ore at the University of Chile, but much should be done. The Anaconda Company could well sponsor in the universities basic research on copper, its ores and extraction.

The large nitrate extraction plant at Mariá Elena has a variety of interesting problems in inorganic chemistry which should be studied. The industry is vital to Chile and to the more than 20,000 people at the plant, but it is hard pressed by competition with synthetic ammonia plants in the United States and Europe. It is having an economic revival at present because of large increases in the demand for iodine. There is every reason to stress basic research in this industry and to try out new methods of recovery. The operating company should be more alert to new research opportunities, such as the use of dyes in solar evaporation, possibilities in chromatographic adsorption and solvent extraction for concentrating iodine. The company is active in some types of research such as phase rule studies and electronic computers, but it would do well to put more into basic inorganic research or support it in the Chilean universities. The copper mining and the nitrate leaching employ many graduates of the Chilean universities.

### 3. Fellowship Recommendations (see page 74)

- a) Name: Victor Bocic Arzic, Casilla 784, Antofagasta, Chile  
Area of Interest: Mechanical Engineering  
Is interested in doing solar energy research in the United States. He has applied for a scholarship.

Recommendation:

The Mission recommends that support be found to enable him to work at a North American University which has a good program in solar energy research (perhaps the University of Wisconsin)\*

- b) Name: Carlos Espinoza, CIESA Universidad del Norte,  
Antofagasta, Chile  
Field of Interest: Solar Energy Research

Recommendation:

The Mission recommends that Espinoza be given encouragement and advanced training.

\*Editors Note: This fellowship has been obtained. See footnote, page74.

SECTION IIIREMARKS ON POLICIES GOVERNING GRANTS IN AID

## A. FACULTY AND STUDENT INTERCHANGE

1. Chile to the United States

The Mission believes that the contract policy emphasizing the "middle" (with reference to age and academic position) faculty group is wise. It should be pointed out, however, that selection from this group should include those wanting to acquaint themselves with the organization of teaching in both lecture room and laboratory, and with teaching practices designed to develop reasoning processes and to awaken a dormant curiosity. The weakness in university teaching in Chile lies in the lecture-textbook memory method with its lack of opportunity for discussion. This approach does not tend to develop research men and if Chile is to increase the output of basic scientists the universities must profoundly alter their teaching approach. Because of this situation, it is believed that faculty members who request grants for the purpose of teaching improvement should be given equal consideration to those intending to carry on research.

Chilean scholars planning to go to the United States must have time to prepare. They should be able to write in advance to the university department to which they are going. It would be highly desirable if they could remain long enough to obtain an advanced degree in the

United States; however, this may mean that eventually the man is lost to Chile. An advanced degree can normally be achieved by an ICA fellowship for one year with permission to extend at no extra cost, because in that period of time an alert and competent student can earn a continuing research assistantship in most universities nowadays. The student should, of course, first have studied as far as possible in his field in Chile, for reasons of economy.

Catholic University at Valparaiso reported that it was difficult to arrange with ICA to have Chilean scientists stay a second year in the United States even if they get an appointment as research assistants or fellows. This situation has been investigated by the Mission's staff returning to Washington, and it is understood that ICA does not now object to longer stays if properly justified. The Mission feels that encouragement should be given to plans to spend a second or third year in the United States, if their advisors in the U. S. institutions so recommend, and they can arrange their finances themselves, perhaps through the method of obtaining a research assistant appointment.

Another sentiment sometimes expressed is that to better assure the Fellow's return, he should have been employed in a Chilean university for two years or more before departure, and then have a leave of absence for only one year. The thought here is that his Chilean service would be a period of both perfecting his training as far

as possible before going, and of accustoming him to the working conditions in Chile.

One important improvement in the arrangements is necessary. After application for an ICA fellowship to the United States, the notification of award is prompt, but there is often a serious delay in notifying the scholar of his assignment to a specific university, i. e. his first, second, or third choice. For example, one man applied in November and was notified by the ICA in January to leave for the United States in August; he has not yet (July) been notified to which university he should go. Another staff member recently waited six months from time of notification of fellowship before receiving information regarding the assigned university, only two weeks before having to leave Chile.

## 2. United States to Chile

Most Chilean universities would prefer that United States faculty visitors remain one or two years. There are four main arguments behind this desired time period: 1) time is required for him to adjust to a new set of foreign conditions; 2) time is required for the development of a new teaching area, if such is the purpose of the visit; 3) the U. S. professor could serve as the replacement for a Chilean on leave; and 4) the concern both with ideas for the betterment of the teaching-research programs and for an opportunity to implement them.

The Mission recognizes the pertinence of these arguments, and would hope that long-term visiting professors could be found in sufficient numbers to satisfy Chilean wishes. Since such programs would be difficult to arrange, consideration should be given to shorter periods, for a series of lectures, general consultation, or research. Experience has shown that a stay of three to six months, preferably the latter, can be of great aid, especially if it coincides with a semester period. The shorter period would have great value if the individual were to come as a consultant on research problems. The main point is that the policy on appointments should be flexible, so that it may fit a variety of situations.

Whether or not the American professor going to Chile should have a working knowledge of Spanish will depend largely on the nature of his proposed activity; however, such knowledge will be an important asset, without question. Professors planning a Chilean assignment should communicate in advance with the staff in Chile with which they will be associated and send reprints and/or books relating to the proposed research programs. This will greatly reduce delays incident to the beginning of their work.

**B. GRANTS IN AID AS RELATED TO LARGE OR SMALL UNITS OF ACTIVITY OR TO INDIVIDUALS**

The Mission believes that here again the policy should be flexible. There will be situations such as the funding of a teaching-research unit (as in the case of the Ford Foundation grant for the

development of the four basic science institutes at the University of Concepción) or for the strengthening of a promising university program (such as the University Austral, Valdivia). But from the research point of view, the best quality output coming out of Chilean universities is from individuals, or from groups of two or three. We are convinced that, on the average, the greatest return on a research investment will come from such as these. Funds granted for the development of a research institute frequently involve the support of mediocre as well as good research, whereas new funds given to individuals can be based on demonstrated quality.

#### C. FLEXIBILITY OF RESEARCH GRANTS

It is believed that grants to individuals of demonstrated research quality should carry few restrictions as to detailed expenditures. The good investigator will want to make the grant go as far as possible toward the solution of his problem. A restricted grant is difficult to alter, but local conditions change as the research progresses. Where in the beginning the investigator may have considered his primary need was for certain equipment, now it may become one of technical aid. The grant agreement should be so worded as to permit its most effective use in the attempt to find a solution of the research problem.

#### D. RESEARCH SUPPORT OF NEW ACTIVITIES

It is important that the visiting professor from the United States be able to bring with him; or have shipped, special equipment and documents, including reference works and textbooks which would make his

visit more effective.

In the case of the team of engineers which the Academy sent to give lectures during the mid-term period, July-August 1959, at the new school of graduate study, arrangements were made in advance for the shipment of reference material and texts in sufficient quantity for the anticipated number of students for their respective classes. The modest investment involved proved very fruitful and the team of engineers has recommended that this policy be followed in the future.

The Mission concurs in this recommendation and considers it important that the scope of the recommendation be extended to include also special equipment. The figure of \$500 to \$2,500 is suggested in each case depending upon the nature of the work to be done by the visiting professor. It is further recommended that the materials shipped remain at the university when the visitor departs.

There is yet another aspect of this research support which the Mission considers of paramount importance and which is concerned with providing the Chilean scientist with equipment and reference material when he returns to his home institution. The private foundations in the United States have been following this policy for some time and have found it so successful that it has become an integral part of their programs. The Mission recommends that the U. S. governmental agencies adopt the same policy, particularly in the present case of Chile, and suggests that a minimum amount of \$1,000 be made available to each

returning foreign scientist for the purchase of apparatus, equipment, supplies, and reference material.

#### E. COMMENTS REGARDING THE EXPANSION INTO NEW FIELDS

Expansion of research and teaching activities into fields not hitherto included in the university curriculum is usually worthy and often desirable. However, the development of new fields should be undertaken with caution so as not to handicap the normal growth of already established faculties and laboratories in the sciences. A case in point is the Petterssen Report recommending the establishment of an institute of terrestrial sciences which would group the present geophysical work in the institute of seismology together with the proposed courses in meteorology and the recommended expansion in the marine sciences, including physical oceanography. The bottleneck in this case is the present lack of trained personnel in some of the new fields which would be included under the proposed new institute.

#### F. SCIENTIFIC FILMS

Scientific films should be used much more in teaching, and ways of reducing the cost to users should be found.

##### Recommendation:

The Mission recommends that the United States Information Service could arrange to circulate educational science films on the basis of one-week loans to many cities and countries.

## G. ESTABLISHMENT OF A NATIONAL RESEARCH COUNCIL

In many countries there is an organization of scientists which advises the Government and takes responsibility for national aspects of science. Frequently, it is concerned with contacts with foreign scientists. Such an organization does not exist in Chile.

If a national research council, or a similar body, were to be organized in Chile along lines peculiarly suited to the country's needs, it could provide effective leadership in the development of science and technology. This has been the experience of several countries in recent years.

SECTION IVRESUME OF REQUESTS FOR FELLOWSHIPS AND TRAVEL GRANTS: TO  
THE UNITED STATESA. UNIVERSIDAD DE CHILE (cf. Sec. II A for available details)1. Faculty Members:a) Faculty of Philosophy and Education (Biology)

- (1) Name: Dr. José Herrera, Professor of  
Zoology  
Area of Interest: Zoology  
Institution to be visited: Cornell and/or Smithsonian  
Institution  
Length of Stay: 6 Months  
Beginning Date: 1961 or 1962
- (2) Name: Maria Etcheverry, M. S.,  
Laboratory Specialist  
Area of Interest: Physiology and Ecology (to complete  
studies for doctorate)  
Institution to be visited: University of Wisconsin, for study  
and Smithsonian Institution for  
research  
Length of Stay: Not specified (to alternate with  
Dr. Herrera)  
Beginning Date: 1961 or 1962

b) Faculty of Physical and Mathematical Sciences -  
Hydraulics Laboratory

- (1) Name: Gabriel Rodriguez Jaque, Chemist  
Area of Interest: Electron Microscopy  
Institution to be visited: RCA laboratory or equivalent  
Length of Stay: 6 Months  
Beginning Date: 1961
- (2) Name: Juan Figueroa Vera, Metallurgist  
Area of Interest: Thermal and Magnetic Methods  
Institution to be visited: Not specified  
Length of Stay: 1 Year  
Beginning Date: 1962

(3) Name: Hernán Ibañez, staff member of  
the Hydraulics Laboratory  
Area of Interest: Not specified  
Institution to be visited: Colorado State University  
Length of Stay: 1 Year  
Beginning Date: Possibly 1961

c) Institute of Electricity

The Institute proposed that five members be sent to the United States for one year within a two-year period. Only one name was submitted and that is given below:

(1) Name: Bartolomé Dezerega Salgado  
Area of Interest: Research on microwave circuits  
Institution to be visited: Stanford University  
Length of Stay: 1 Year  
Beginning Date: Not specified.

d) Mining

(1) Name: Young Chilean (see pages 40 and 41)  
Area of interest: Mining  
Institution to be visited: Pennsylvania State, Colorado,  
or Missouri  
Length of Stay: 1 Year  
Beginning Date: Soon

e) School of Chemistry and Pharmacy

The following requests were received:

1961-62 - 2 in Inorganic Chemistry  
                  1 in Organic Chemistry  
1962-63 - 2 in Physical Chemistry  
                  1 in Inorganic Chemistry  
                  1 in Organic Chemistry  
1963-64 - 1 in Analytical Chemistry  
                  1 in Inorganic Chemistry

1 in Organic Chemistry

1 in Physical Chemistry

In addition to the above requests, the Mission suggests that provision be made for the following trip to the United States of an administrative official:

f) Administrative

(1) Name:	Alejandro Koppmann, Secretary and Purchasing Agent
Area of Interest:	Methods used to handle orders and shipment of equipment
Institution to be visited:	Rockefeller Institute
Length of Stay:	3 Months
Beginning Date:	Not specified

B. UNIVERSIDAD TECNICA DEL ESTADO, SANTIAGO  
(cf. Sec. II B for details)

- |                             |  |
|-----------------------------|--|
| (1) Name:                   | Abdon Zomosa, Director of the<br>Unit Operations and Processes<br>Laboratory |
| Area of Interest:           | Engineering  |
| Institutions to be visited: | Several U. S. universities and<br>research centers, to be selected           |
| Length of Stay:             | 3 Months   |
| Beginning Date:             | Not specified  |
- (2) Head of the Unit Operations Laboratory to study and do research for one year at an appropriate laboratory in the United States.
- (3) Following the visit of a U. S. unit operations specialist (recommended under requests for visits to Chile), the Head of the Unit Processes Laboratory should go to the United States for a year in unit processes and reaction kinetics.
- If funds are limited, it is suggested that priority be given to the latter two recommendations.

C. UNIVERSIDAD CATOLICA DE CHILE, SANTIAGO (cf. Sec. II C  
for details available)

1. Faculty

a) Institute of Physics

- |                            |  |
|----------------------------|--|
| (1) Name:                  | José Edwards, Physical<br>Chemist (speaks English) |
| Area of Interest:          | Chemical kinetics & Physical<br>Chemistry          |
| Institution to be visited: | To be selected                                     |
| Length of Stay:            | 1 Year   |
| Beginning Date:            | Not specified                                      |
|                            |  |
| (2) Name:                  | Professor Arturo Morales                           |
| Area of Interest:          | Engineering (soil mechanics)                       |
| Institution to be visited: | University of California                           |
| Length of Stay:            | 1 Year   |
| Beginning Date:            | 1961   |

2. Graduate Students (no data available other than that given below)

- a) Mr. Garcia - Astrophysics
- b) Saphoors - Physics
- c) Mr. Fridli - Electricity
- d) Mr. Fernando Díaz - Infra-red Spectroscopy

D. UNIVERSIDAD CATOLICA DE VALPARAISO (cf. Sec. II D for  
details available)

1. Faculty

- |                                |  |
|--------------------------------|--|
| (1) Name:                      | Professor Alejandro<br>Livingston                                      |
| Area of Interest:              | Thermodynamics and Unit<br>Operations                                  |
| (No further details available) |  |
|                                |  |
| (2) Name:                      | Mrs. Cecilia Barra, Pro-<br>fessor of General and<br>Organic Chemistry |
| (No further details available) |  |

**Note:** The appointment of the above two is contingent upon  
securing replacements from the United States.

(3) Name: Professor George  
Schleicher, Electronics  
Laboratory  
Area of Interest: Electronics  
Length of Stay: 3 Months  
(No further details available)

2. Graduate Students

Jorge Petit  
Carlos Holtzmann  
Claudio Moraga

E. UNIVERSIDAD TECNICA "FEDERICO SANTA MARIA", VALPARAISO

(1) Name: Victor Bocic A. , Mechanical  
Engineer  
Area of Interest: Solar Energy Research  
Institution to be visited: Solar Energy Laboratory,  
University of Wisconsin  
Length of Stay: 1 Year  
Beginning Date: January, 1961

F. UNIVERSIDAD DE CONCEPCION (cf. Sec. II F for details)

1. Institute of Chemical Engineering

(1) Name: Walter Dreifuss Spiegel,  
Chemical Engineer  
Area of Interest: Microbiology and Bio-Engineering  
Institution to be visited: University of California, Cornell  
University and other universities  
Length of Stay: 3 to 4 Months  
Beginning Date: December, 1961

2. Institute of Biology

(1) Name: Mario Silva, Assistant Pro-  
fessor of Botany  
Area of Interest: Plant Physiology  
Institution to be visited: University of California (Berkeley)  
Length of Stay: 1 Year  
Beginning Date: Not specified

G. UNIVERSIDAD AUSTRAL, VALDIVIA

No requests received.

H. NORTHERN CHILE, ANTOFAGASTA

No requests received.

SECTION VRESUME OF REQUESTS FOR U. S. SPECIALISTS TO WORK AT  
CHILEAN INSTITUTIONS

## A. UNIVERSIDAD DE CHILE, SANTIAGO

1. Faculty of Chemistry and Pharmacy

- |     |   |  |
|-----|---|--|
| (1) | Name:   | Professor C. D. Coryell                  |
|     | Institution:                                  | Massachusetts Institute of<br>Technology |
|     | Field:  | Inorganic Chemistry                      |
|     | Period Requested:                             | 1961-62                                  |
|     | Length of Stay:                               | Not specified                            |
| (2) | Professor of Physical and Inorganic Chemistry |  |
|     | Period Requested:                             | 1962-63                                  |
| (3) | Name:   | Professor I. M. Kolthoff                 |
|     | Institution:                                  | University of Minnesota                  |
|     | Field:  | Organic and Analytical Chemistry         |
|     | Period Requested:                             | 1963-64                                  |
|     | Length of Stay:                               | Not specified                            |

2. School of Geology

- |     |                    |            |
|-----|--------------------|------------|
| (1) | Geophysicist       |            |
|     | Period Requested:  | 1961-62-63 |
| (2) | Stratigrapher      |            |
|     | Period Requested:  | 1961-62-63 |
| (3) | Economic Geologist |            |
|     | Period Requested:  | 1961-62-63 |

3. School of Pharmacy and Chemistry

- |     |                   |                            |
|-----|-------------------|----------------------------|
| (1) | Name:             | Professor Victor K. La Mer |
|     | Institution:      | Columbia University        |
|     | Field:            | Surface Films              |
|     | Period Requested: | 1962 or 1963               |
|     | Length of Stay:   | Not specified              |

- (2) Name: Professor Carl Djerassi  
 Institution: Stanford University  
 Field: Organic Chemistry  
 Period Requested: Not specified  
 Length of Stay: Not specified
- (3) Name: Professor Tagaley  
 Institution: Tulane University  
 Field: Physical Chemistry  
 Period Requested: Not specified  
 Length of Stay: Not specified
- (4) Name: Professor Hans B. Jonassen  
 Institution: Tulane University  
 Field: Inorganic Chemistry  
 Period Requested: Not specified  
 Length of Stay: Not specified

#### 4. Hydraulics Laboratory

Colorado State professor  
 Length of Stay: 1 or 2 Years  
 Period Requested: Not specified

#### 5. Materials and Testing Institute (IDIEM)

Three U. S professors have been requested by the Rector.

#### 6. Institute of Electricity (IEE)

Professor of Electronics  
 Period Requested: Beginning August 1961  
 Length of Stay: 1 Year

#### 7. Institute of Metallurgy

Name: Professor Herbert H. Kellogg  
 Institution: Columbia University  
 Field: Metallurgy  
 Period Requested: Middle of 1961  
 Length of Stay: Adequate to include visits to the  
 Universidad de Concepción and  
 other institutions (3 to 4 months).

6. Joint Team Project in Science Education\*  
(University of Chile and the Catholic University of Valparaiso).

Names:	Dr. Watson Davis Director, Science Service Washington, D. C.
	Dr. Isaias Raw Director of the Brazilian Institute for Education, Science and Culture (IBECC) São Paulo, Brazil
	Dr. Romulo Pieroni Professor of General and Experimental Physics MacKenzie University São Paulo, Brazil
Field:	Science Education, University and Secondary Schools, Science Kits, Science Fairs, Talent Searches.
Period Requested:	Month of January, 1961.

B. UNIVERSIDAD TECNICA DEL ESTADO, SANTIAGO

No requests received.

C. UNIVERSIDAD CATOLICA DE CHILE, SANTIAGO

(1) Name:	Dr. Ernst Florey** Dr. Elizabeth Florey**
Institution:	University of Washington, Seattle
Field:	Comparative Neurophysiology
Period Requested:	First half of 1961
Length of Stay:	6 Months

\*Editor's Note: Arrangements have been completed for this team to arrive at Santiago on January 1, 1961, and to work with the summer school in Valparaiso. Teachers, professors and grantees from several Chilean universities and neighboring countries will attend this OAS sponsored project.

\*\* Arrangements have been completed by the Academy covering the travel of this research team to Chile in December, 1960. The Drs. Florey will be based at the Catholic University, but expect to carry out investigations at the University of Concepción and in the region of the University of Valdivia.

## D. UNIVERSIDAD CATOLICA DE VALPARAISO

United States professors are desired in the following fields:

- 1) Petrochemicals
- 2) Molecular Structure
- 3) Instrumental Analyses

Note: It is very desirable that these visitors have experience in research, laboratory organization and work programming.

E. UNIVERSIDAD TECNICA "FEDERICO SANTA MARIA",  
VALPARAISO

No requests received.

## F. UNIVERSIDAD DE CONCEPCION

(1) Name:	Professor N. Lewis Buck*
Institution:	University of Pittsburgh
Field:	Mechanical Engineering
Period Requested:	November 1960
Length of Stay:	Approximately 5 weeks

1. Institute of Chemistry

(2) Name:	Professor George Scatchard, Rtd.
Institution:	Massachusetts Institute of Technology
Field:	Physical Chemistry
Period Requested:	Not specified
Length of Stay:	Not specified

\*Editor's Note: Arrangements have been completed by the Academy, in collaboration with the University of Concepción, for Professor Buck's travel at the time desired. He will also consult with other universities while in Chile.

2. Department of Mathematics

(3) Name: Dr. Lewis C. Butler\*  
 Institution: Alfred University  
 Field: Mathematics  
 Period Requested: January 1961  
 Length of Stay: Approximately 2 years

## G. UNIVERSIDAD AUSTRAL, VALDIVIA

Professor in Statistics and Design. The Project Coordinator has suggested the following person:

Name: Dr. Paulo Vanzolini\*\*  
 Institution: University of São Paulo, Brazil  
 Period Requested: Not specified  
 Length of Stay: Not specified

## H. NORTHERN CHILE

Name: Professor John A. Duffie\*\*\*  
 Institution: University of Wisconsin  
 Field: Solar Energy  
 Period Requested: November 1960  
 Length of Stay: 2 Weeks

\*Editor's Note: Alfred University has granted Professor Butler leave of absence for 2 years. Travel and other arrangements are being completed. He will serve as Director of the Institute of mathematics.

\*\* Arrangements for Dr. Vanzolini's visit are being made.

\*\*\*Arrangements have been completed by the Academy for Professor Duffie to work with the several university branches in Antofagasta and to confer also with interested authorities in Santiago at the time desired.

SECTION VIRESUME OF REQUESTS FOR GRANTS TO COVER PURCHASE OF NEW EQUIPMENT, SUPPLIES, AND OTHER ITEMS, EXCLUSIVE OF BUILDINGS

(Note: It was made clear to all concerned that the International Cooperation Administration - National Academy of Sciences contract did not cover these items; therefore all the Mission could do would be to transmit the request, with the suggestion that if the Academy's Committee on Inter-American Scientific Cooperation became aware of possible fund sources it would do what it could to acquaint the prospective donor with the request. The National Academy of Sciences is not obligated in any way, however).

## A. UNIVERSITY OF CHILE (SANTIAGO)

1. Biology (Faculty of Philosophy and Education)

- a) Subscriptions to reviews and publications in entomology.
- b) Acquisition of books on entomology.
- c) Acquisition of "classical" entomological publications and back files of journals.
- d) Funds for the translation of modern English texts into Spanish.

## B. UNIVERSIDAD TECNICA DEL ESTADO, SANTIAGO

No requests were received.

C. UNIVERSIDAD CATOLICA DE CHILE, SANTIAGO

See Section II C for full details on plans for basic science development, including the following requests for funds:

1. Department of Microbiology and Immunology

Request for project of Dr. Manuel Rodriguez, supplies and apparatus, in the amount of U. S. \$8,000.

2. Department of Anatomy

Request for project of Dr. Patricio Sanchez, systematic investigations of Chilean aquatic fauna, in the amount of U. S. \$9,900, total for three years.

3. Department of Nuclear Medicine

Request for Project of Dr. Ismael Mena, radioactive isotopes, in the amount of U. S. \$15,000, total for three years.

4. Department of Anatomy, Laboratory of Electronic Microscopy

Request for project of Dr. Juan D. Vial, for investigation of cytological changes associated with the interruption of "tróficas" functions of the nervous system, in the amount of U. S. \$11,000 per year, for a three to four year program.

5. Department of Biochemistry

Request for a spectrophotometer, U. S. \$7,500.

6. Library

An inquiry was made for a grant of U. S. \$4,000 for back files and periodicals.

7. Laboratories of Physiology, Neurophysiology and Physiopathology

Request for equipment and material for research, in the amount of U. S. \$10,000. No further details were given.

D. UNIVERSIDAD CATOLICA DE VALPARAISO

No requests were received.

E. UNIVERSIDAD TECNICA "FEDERICO SANTA MARIA," VALPARAISO

A request was made for an X-ray diffraction machine. (See Sec. II E for further details).

F. UNIVERSIDAD DE CONCEPCION

1. Dental Library

The Dental library was largely destroyed by the May 22, 1960 earthquake and the following fire. The American Dental Association may have an interest in replacing some of the books and journals.

2. Institute Needs

A request has been made by Rector Stitckin for the replacement of equipment and other needed items.

**G. UNIVERSIDAD AUSTRAL, VALDIVIA**

Although there are no specific requests at the present, there is general need for support in the way of equipment, supplies, and the like, for this university. (See Sec. II G for details).

SECTION VIITHE LIBRARY AND INFORMATION CENTER SITUATION

## A. STATUS OF CHILEAN LIBRARIES

Most worth-while modern-day research requires access to a rather good technical journal library. None of the libraries visited seem to be really adequate, and most of them were grossly inadequate, the outstanding exception being that at the University of Chile's Marine Biology Laboratory at Montemar.

One of the difficulties is the high dollar exchange cost of U. S. journals. Generally foreign subscriptions are charged at a higher rate than in the United States, which is justified by the general practice of distributing overhead and initial printing costs equally. The result is that to keep within their meager book budgets, the universities cannot subscribe to very many journals.

Recommendation:

The Mission recommends that the Academy investigate with several representative U. S. technical societies whether it would be possible, economically, to establish a special rate for foreign subscriptions, particularly for developing countries.

## B. THE PROPOSED SCIENTIFIC INFORMATION CENTER

1. Smathers Loan

The Smathers Loan includes \$100 000 for setting up a Scientific Information Center; another \$50,000 is provided for the Technical

Advisory Committee of the Council of Rectors. It seems to be generally felt that the \$50,000 is not particularly needed by the Committee and can also be made available for the Information Center. This would be desirable since the sum of \$100,000 is hardly adequate. The sum of \$50,000 would be well invested in the Information Center. The more complete the services of the Center could be made, the more quickly and effectively it would assist the greatly expanding Chilean efforts in science and engineering advanced teaching and research.

2. The Stanford Research Institute Report

The Report on "A Plan for Establishing a Central Technical Library Service in Chile" outlines such an operation. It recommends providing the following services:

- a) Union List of Scientific Periodicals in Chile
- b) Guide to the Research Libraries in Chile
- c) Directory of Scientific Societies and Institutes in Chile
- d) Bibliographic Information Service (literature searches or subject bibliographies)
- e) Inter-library Loan assistance and liaison
- f) Information on Research Projects under investigation
- g) Reading and Reference Room
- h) Photocopy and Reproduction Service
- i) Translation Service
- j) A library of scientific and engineering journals, indexes and abstracts.

For these services a staff of 17 is estimated, after the initial year. It is recommended that the Council of Rectors provide assurance that adequate funds would continue to be made available for maintenance and growth of the service. "Space available at the National Library in Santiago" is stated to be most adequate, and advantageously located.

It was also pointed out in June, 1958 that there is lack of any regular contact between libraries and thus of joint efforts. This situation seems still to obtain.

### 3. Present Status of the Information Center Project\*

Although these funds have been available to the Council of Rectors for some two years, there has been no decision on their utilization as yet. This has been attributed to the preference of one or more of the universities (depending on supposed location of the Center) on more of a library type of activity (emphasis of 2(j) above) and of the other universities for a literature reproduction type of activity (2h). However, it seems from recent statements that there is now fairly general agreement on preference for an information service, including photocopying and reproduction, to the development of an additional library service. This is evidently desirable for a number of reasons:

\*It is understood that this matter was given active consideration by the Council of Rectors at a meeting held at Santiago early in October, 1960.

- a) After the photoreproduction, the reference is returned immediately to the stacks, to be available at once for subsequent utilization.
- b) Mailing of the photocopy to distant and even near points is much simpler, cheaper, safer and faster.
- c) Mailing of most original references, in fact, should not normally be allowed, due to deterioration and possible loss.
- d) In general, the investigator will find that he prefers to retain the technical information in his own institution's library (as a photocopy) than have to return the original after a reasonable time (which could probably not exceed two weeks). It would be considerably more expensive to locate photocopying machines at each university or separated faculty, not to mention the industries and other groups which might be interested.
- e) Due to the time required for acquiring the reference and photocopying, which is independent of the source of the request, plus the time of receipt (which by phone would be constant and by air mail would not vary too greatly) and delivery being in a relatively narrow range for all the universities, none would feel discriminated against due to location.

#### 4. Location of the Center

To retain its independence from any one institution, yet be in Santiago near the largest technical collections, the National Library is probably the most convenient and reasonable location for the Information Center. Alternatively, or later on, if the business builds up considerably, a separate location near the center of Santiago, or near the most appropriate university libraries in Santiago, could be considered.

On the occasion of a visit on July 11, 1960 to Mr. Ernesto Galliano, (Secretary-Counsel of the Dirección de Bibliotecas, Archivos y Museos) Acting Director of the National Library, he stated he would be very interested to consider having the Information Center located there, in spite of the relative shortage of space, and the probability that title to the equipment would remain with the Council of Rectors. He did not seem to be aware of the previous discussion of the SRI representative with the National Library officials.

#### 5. Operation of the Center

##### Recommendations

The Mission recommends that:

The operations of the Center not be supervised by the National Library in order to maintain an atmosphere of speed and efficiency. At the present time, a wait of an hour or so in a long line at the National Library is generally required for school

children to draw out a book. The Library does not yet have the initiative to reassign staff and arrange facilities so that many student hours could be saved. The number of staff service hours would be constant for a given number of readers.

b) It is further recommended that the operation be carried out, at least in the beginning, under the Technical Advisory Committee of the Council of Rectors. This agency, which represents most, if not all, of the universities and agencies which might use the Center, has already demonstrated that it can work together in the disposition of Point 4 fellowship funds in the past.

c) It is suggested that consideration be given to an initial staff of:

one information center specialist, possibly on loan from the United States, or from a qualified international organization, such as the Pan American Union or UNESCO

one Chilean photographic technician; and

one secretary.

The salaries could be paid presumably from the \$50,000 earmarked for the Technical Advisory Committee, Point 4 or Chilean university funds, or prorated from these.

Thereafter, the Center should be self-supporting and the rates for services should be determined with that purpose in mind. This does not seem unreasonable, as for example, the University Microfilms Service of the University of Michigan, at Ann Arbor, which has been charging on the order of 1.25¢ per microfilm exposure. In this

case the average article would probably be less accessible and shorter, but probably two pages per exposure should be available to decrease the cost if desired, so that a similar cost per page could result. Microcards would be more compact and readily filed, and might cost no more. Only one system should be used, to be selected by the specialist retained.

To keep the operation simple, at least at the start, it is recommended that only the following activities be carried out:

#### First Year

- 1) Select and order the photographic equipment for the Center (microfilm or microcard readers at the using centers should be provided by each user himself in the numbers each one desires).
- 2) Prepare the quarters to receive the equipment, and install equipment when received.
- 3) Prepare the procedures, including order form and initial price list (photocopies and journal library cards), and operating schedules, and distribute them widely.
- 4) In available intervening time, start a reproducible library card index of the technical journals available in Santiago libraries. The master card for each journal would list the issues available in each library.
- 5) Investigate and finalize the best procedures for obtaining photocopies from the United States of articles not available here, as masters.

Second Year

- 6) Complete (4) and distribute complete sets at cost, on order.
- 7) Start filling orders received for photocopies.
- 8) Continue (4) for Chilean libraries outside of Santiago on the existing cards, or new ones as required. These would be available probably for inter-library loan by the Center or other Chilean libraries, or key ones might be eventually microfilmed by the Center for its stacks.
- 9) Order directly for the Center's stacks new technical journals not available in Santiago, and, as funds permit, also new key journals that are in Santiago but for which the demand for photocopies is frequent enough that it would be a sufficient economy and time-saver to have them in the Center.

The journals in the SRI Report are an adequate preliminary basis for new journals. The list, however, should be checked against a typical U. S. university engineering and science library since it has been noted that some key journals are missing from the SRI Report; for instance the Journal and the Symposium Series of the American Institute of Chemical Engineers, several journals of the American Society of Mechanical Engineers, and others. These journals would be available for reference at the Center, but not for removal.

In general, back issues should not be purchased because of their elevated cost.

It will be noticed that many services listed in the SRI report have not been retained in the above recommendations for reasons of their

dubious value, or excessive costs. Some of these last might be added later if a real need for them is established and if the services themselves could be made self-supporting.

SECTION VIIIGENERAL SUMMARY

## A. ORGANIZATION

The universities of Chile, with two possible exceptions, are similar to most Latin American universities in that they are loose aggregations of quasi-independent professional schools. In the two official universities the number, organization, and authority of such schools is fixed by law and the central administration can exert little actual control over them. In the church and independent universities, more authority is vested in the central administration. However, in the main they follow the same general organizational pattern.

There is little effective relationship among the separate professional schools in teaching, research, or planning. Each faculty controls the programs of its own constituent schools and determines its own policies within legal limitations. This independent concern with its own rights and privileges results in slanting basic science instruction in the direction of professional ends, much duplication of basic courses, the lack of articulated course programs and schedules among schools, and the tendency to develop many independent libraries, which in turn results in duplication and lack of general accessibility. Associated with this situation is a tendency to develop political groups both within and among school faculties for the purpose of protecting

traditional privileges, or for developing a power block.

The lack of a cohesive central administration is accentuated in some instances by scattered school locations instead of concentration on a central campus. This again isolates faculties and students and handicaps the development of common services.

## B. THE TEACHING SITUATION

Five major factors exist which affect the present teaching programs:

- 1) The tendency toward in-breeding in faculty appointments.
- 2) The generally inadequate salary scale, which compels faculty members to take on extramural activities in order to increase their income. This results in a large proportion of part-time faculty members.
- 3) The role of students in exerting considerable influence on academic policies, teaching methods, and at times, even on course content.
- 4) The inadequate preparation of the entering student with respect to basic studies. The secondary schools develop a student who is taught to memorize rather than to reason and evaluate.
- 5) The reliance on the acquisition of factual information through university lectures and the general lack of

discussion periods; examinations which seek to test the memory of the student, rather than his understanding of the meaning and inter-relationships of facts.

## C. GENERAL NEEDS

### 1. Teaching

- a. The need for a change in approach from pure memory to an understanding of basic facts, plus the development of a capacity to reason from them logically, critically, and imaginatively.
- b. The "provincial" experience of the faculty member. All too frequently this has been acquired within the confines of a particular professional school. The solution is in a graduate or postgraduate extension of this limited experience in a recognized foreign university (as involved in the NAS-ICA U. S. - Chile exchange program).
- c. The centralization of instruction in the basic sciences, and the elimination of such instruction in the professional schools.
- d. The development of effective laboratory instruction in the basic sciences.

### 2. Research

- a. The development of a better interrelationship between teaching and research and between research groups.

- b. The development of common centers for expensive equipment, e. g. , digital or similar computers, electron microscopes, nuclear devices, etc.
- c. The provision for qualified research assistants, including, in certain cases, further training abroad.
- d. Subsidies for the purchase of scientific literature including books and journals.

SECTION IXGENERAL RECOMMENDATIONS

## A. STUDENT AND FACULTY INTERCHANGE

1. Teaching and research should be given equal emphasis in selections of students and faculty for study abroad. The development of research-minded students will depend primarily on the teachers' approach to learning.
2. Flexibility as to length of stay is important in exchange programs. Time is related to purpose. Normally, a year is preferable for research or teaching experience whereas for consulting on research or visiting science centers, three to six months is considered adequate. Flexibility is advocated and each case should be decided on its own merits.
3. Permission for extensions should be facilitated where justified, provided normally that the individual can arrange for his own expenses.
4. The exchange program should include certain classes of skilled technicians, such as maintenance personnel, computer or electronic technicians.
5. Research grants should include funds for the purchase by the returning scientist of books, apparatus, equipment, supplies and reference material related to his work. (cf. page 62)
6. Individuals to be selected for exchange 1960-61-62 (cf. Sec. IV A):

The individuals listed in Section IV should receive more detailed attention since the Mission members could not secure (in most cases) sufficient background material in the time available.

## B. POLICIES RELATED TO SUPPORT

### 1. New Teaching or Research Units

The support of certain new units such as Basic Science Teaching Centers or institutes deserves special consideration. Support for such new units should take into account the problem of continuing university support after outside aid ceases. This matter is of particular importance in Chile where local support funds are often limited and uncertain.

### 2. Individuals or Research Groups

The Mission recommends that an emphasis be given to grants to individuals and research groups. Grants in this area can be made on the basis of demonstrated accomplishment in most cases. The Mission further recommends that such grants be made as flexible as possible, since the nature of the needs often vary greatly during progress of the research program

### 3. Permanent Structures

The Mission recommends that grants for permanent structures be considered only under exceptional circumstances, in view of the existing legislation which provides funds for these purposes and the demonstrated ability of the universities to find support for such construction.

#### 4. Specific Equipment and Other Needs

The requests under this heading will be found under Section VI. It is the understanding of the Mission that funds under the present NAS-ICA contract cannot be used for this purpose, hence no specific recommendations are made. The Academy or its Committee on Inter-American Scientific Cooperation may wish to pass these requests on to the ICA or to other groups having a possible interest.

#### C. GENERAL LIBRARY SITUATION (For full details, see Section VII, B.)

In order to assist in providing a good technical journal library, the Mission recommends that the Academy investigate with several representative U. S. technical societies whether it would be possible, economically, to establish a special rate for foreign subscriptions, particularly for developing countries. This would help fill the gap in most libraries which are in need of quality technical journals necessary for research.

#### D. SCIENTIFIC INFORMATION CENTER

The Mission gave detailed consideration to the recommendations and plans for the establishment of a centralized scientific and technical library which could serve all the universities of Chile and the principal interested governmental agencies. It compared the arguments of this type of library service with a scientific documentation or information

service of a centralized nature for the same users and arrived at the conclusion that the scientific information center is more suited to Chile's needs at this time and that it could be established more quickly and could provide a speedier service. The Mission also made certain specific recommendations concerning the location and organization of the center.

## BACKGROUND INFORMATION

BACKGROUND INFORMATION

The foregoing report of the Mission sent by the National Academy of Sciences--National Research Council of the United States to the universities of Chile is a part of the Technological Development Project of the International Cooperation Administration (ICA), more familiarly known in Latin America as "Point Four". The project is a joint enterprise of the Council of Rectors of the seven universities of Chile and of the ICA, the latter being represented by the United States Operations Mission (USOM) in Santiago, to which the original Chilean requests for cooperation were directed. The project was approved by both parties some time before the Academy--Research Council was requested to assist in its implementation.

The Council of Rectors was created by the 1955 Law, No. 11.575,<sup>1</sup> and given the responsibility of administering the funds provided for the physical improvement of the universities by that same legislation. The sum provided by the law, one-half of one percent of the annual federal tax income of the nation from certain sources, has yielded approximately \$1,500,000 per year and is available for a 20-year period.

The Rectors of the seven universities mentioned by the Academy's Mission in the Preface to their report, constitute the Council of Rectors. The Council has also established a 14-man Technical Advisory Committee composed of their representatives together with seven authorities representing, respectively, other aspects of the national economy: The Government Develop-

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<sup>1</sup> See Page 131

ment Corporation; The Management Association; The Manufacturers Association; The Construction Society; The Mining Society; The Agricultural Society; and a Labor specialist.

The Technological Development Project has the broad objective of bringing about the strengthening of the scientific and technological capabilities of the universities so that they may be in a position to expand and accelerate their contribution to the economic development of the country. Its specific purposes are to aid the universities in a number of different ways, primarily in respect to teaching and research in science and engineering. These include the improvement of existing teaching and research facilities, and assistance in the establishment of such facilities in fields in which they presently do not exist; the development of a cadre of trained scientists and engineers well versed in modern concepts and methods; and, in the long run, the establishment of special research institutes, where such do not presently exist, to promote the development of the natural resources of the nation. The overall program which the Chilean authorities have in mind is thus, necessarily, of a long-range nature.

The objectives of the Academy--Research Council Mission were to assist the Council of Rectors in determining the personnel needs required by their plans, and to guide the Academy in the wise use of the limited funds placed at its disposition by ICA to provide the specialists desired, some ten to fifteen man-years total. The project contemplates movement of these specialists in both directions, i. e. , U. S. professors to Chile and Chilean scientists and engineers to the U. S. for experience and training. The Report addresses itself

to these objectives.

The antecedents of the present Mission go back several years and are incorporated in a series of five separate reports, prepared for the ICA and the Council of Rectors during the period 1955 to 1958, namely:

1. "The Development of a Program of Scientific and Technological Research in Chile", by Dr. William G. Steere - 1955;
2. "University Facility Requirements to Meet the Technical and Scientific Needs of Chile", by Ralph A. Krause, Stanford Research Institute - 1956;
3. "Distribution of Funds for Laboratory Equipment for the Universities of Chile", by Dan McLachlan, Jr. and Paul L. Magill, Stanford Research Institute - 1956;
4. "A Plan for Establishing a Central Technical Library Service in Chile", by Lorraine Pratt, Stanford Research Institute - 1958;
5. "Report on ICA-Chile Technological Development Project", by Paul L. Magill, Stanford Research Institute - 1958.

The project originally was designed to assist in the improvement of university facilities and competence in the fields of techno-economic planning, as well as scientific research. However, as a result of these reports, the concentration on techno-economic studies was re-directed toward the improvement of teaching organization and research potential in both science and engineering. Pursuant to this reorientation, the USOM and the Council of Rectors requested the assistance of the NAS-NRC as an organization of prestige in both areas.

The Academy assigned responsibility for the supervision of the project to its Committee on Inter-American Scientific Cooperation, under the Chair-

manship of Dr. J. George Harrar, Vice President of the Rockefeller Foundation. The Committee selected Dr. Harry M. Miller, Jr. for the full-time position of Project Coordinator. Dr. Miller was at that time the Associate Director for the Natural and Medical Sciences of the Rockefeller Foundation. In his numerous visits to Latin America over the past twenty years, he had come to know intimately the scientists and their institutions and had personally selected many able Chilean scientists to be recipients of the Foundation's fellowships, which he administered. The Foundation very graciously made his services available to the Academy during a period of several months until arrangements could be completed for him to become a member of the Academy's staff.

Dr. Miller has already made three visits this year to Chile where he has worked closely with the Council of Rectors, the Council's Technical Advisory Committee, the USOM and other university authorities in implementation of the project. He also aided the Committee in the selection of the team which the Academy sent to Chile in accordance with the mutual desires of the Council of Rectors and the USOM.

The composition of the Mission was determined by the science and technology interests of the universities. Since these fall naturally into three basic groups, life sciences, physical sciences and engineering, specialists in these fields were selected.

The Committee was particularly pleased that the Vice President of the Academy, Dr. Farrington Daniels, who had spent three months in visits to 10 countries of South East Asia earlier this year, offered his services as the

physical sciences specialist. Dr. Daniels is the author of university textbooks in chemistry which are widely used. He is also recognized as an international authority on solar energy, and Chile is the birthplace of modern experimentation in this field (Santa Elena, 1871).

For the life sciences the Academy invited Vice Chancellor Emeritus of the University of California, Alva R. Davis, former Dean of the Faculty of Letters and Science, who the previous year had spent several months in Chile as Director of the Basic Science Institutes Study of the University of Concepción, another Point Four collaborative activity. He also is the author of the work plan for the Institute of Biology at that University. Reference is made to the Concepción Plan in the report, and to the grant of \$500,000 which the Ford Foundation earlier this year made to the University for the implementation of that plan. Dr. Davis served as Chairman of the Mission.

Dr. Charles F. Bonilla, Professor of Engineering at Columbia University, accepted the Academy's invitation to serve as the engineering specialist on the team. Besides his long personal acquaintance with Latin America, and his experience as consultant for several industrial firms, he was the first Director of the Atomic Energy Commission's Inter-American School of Nuclear Studies in Puerto Rico.

The team members were invited to meet with the Council of Rectors in Santiago immediately upon their arrival in Chile. The Academy's Coordinator for the project and the Associate Director of the Academy's Office of International Relations accompanied the Mission on this first meeting (and subsequently on a number of visits to the universities). Dr. Muller conveyed the

greetings and expressions of sympathy of American Universities to their Chilean colleagues. He restated the purposes of the Mission (see text of address, page 128). Dr. Daniels brought a special message from the President and Governing Board of the Academy. The Rectors gave the team a cordial welcome and agreed to designate their personal representatives who, armed with statements concerning their plans and specific manpower needs, were to meet with them immediately. The Council also decided to hold another meeting with the Mission in Valparaiso in the middle of July, during the closing days of their stay in Chile.

In accordance with the arrangements made, the Mission met with the designated representatives of the Rectors who set forth in general terms the plans for the future development of the respective institutions in science and engineering. A program of visits covering the length of Chile from Antofagasta to Valdivia was also established.

On those visits the university officials collaborated effectively with the Mission. They arranged a discussion meeting with their faculty members as the first order of business on each visit to the separate institutions, so that the team members might have a broad picture of the existing situation and projected plans of the university as a whole and of the respective scientific departments. The Mission then followed the practice of splitting up so that each specialist could spend the maximum amount of time with those interested in his field of responsibility. Subsequent to these separate visits the members of the Mission met together to compare notes. In many cases, return visits were made to clarify the understanding of plans and needs. The latter were often projected

over five-year periods.

The Mission was particularly impressed by the plans of several universities to reorganize their basic science curricula in Biology, Chemistry, Physics, and Mathematics as the firm basis for the development of future Chilean scientists. They gave their wholehearted endorsement to these efforts in the respective institutions, mutatis mutandis, recognizing that this new orientation in both teaching and research is requisite for the granting of higher degrees in science and as the foundation for effective specialization in the applied fields. They encouraged the initial efforts tending towards the teaching of science by scientists, rather than, as heretofore has been the case in many instances, by professional people.

In the course of the many conferences held, the Mission members naturally became acquainted with aspects of university plans which involved areas beyond the scope of their commitment, such as building and equipment needs and requirements in the field of scientific documentation. Sections VI and VII of the Report make reference to these. It was important that the Mission become as familiar as time permitted with these aspects in order that they could be of maximum assistance in meeting the Academy's responsibility of finding the specialists which the whole project required.

It is equally obvious that the limited funds at the disposal of the Academy could not possibly meet all the manpower needs which would be brought to the attention of the Mission. Thus it is that the report contains references to requests for a specific number of specialists in a given faculty, school or institute, whereas the Mission recommended a lower number, singling out only those which it considered to be of first priority. This does not imply in any sense that the plans

enunciated to the Mission are considered excessive, unless the latter is expressly stated. The Mission and the Academy are both sympathetic to these larger needs and will do everything that lies within their power to bring these needs to the attention of other institutions which may be able to assist.

Sections IV and V of the Mission's Report deal with the requests for Chilean and American specialists, respectively. Progress on these recommendations is set forth in Editorial notes. In addition to this information, the picture of the Academy's cooperation will be more complete if one takes into consideration other related efforts, including:

1. the team of four engineering professors sent by the Academy to lecture for six weeks at the first session of the new School of Graduate Engineers of the University of Chile, July-August, 1959. The specialists were:

Dr. Ray W. Clough, Jr., University of California, anti-seismic construction;

Dr. Robert Hechtman, George Washington University, large steel structures;

Dr. Vito August Vanoni, California Institute of Technology, hydraulics;

Dr. Gordon R. Williams, Massachusetts Institute of Technology, hydraulic engineering.

2. the Mission of Dr. Sverre Petterssen, sent by the Academy at the request of the University of Chile, to advise on the organization of courses in meteorology and related matters; he spent the month of April 1960 in Chile. Dr. Petterssen is Chairman of the Department of Meteorology at the University of Chicago and past President of the American Meteorological Society.

3. the Mission of Professor Nathaniel Arbiter, who spent one and one-half months (July-August 1960) at the second session of the School of Graduate

Engineers, an arrangement made by the National Academy of Sciences at the request of the Director of the School of Engineering at the University of Chile. Dr. Arbiter is Head of the Department of Mineral Engineering at the School of Mines of Columbia University.

One source of fellowships, for visits by Chilean university personnel to the United States for special experience, lies directly within the capabilities of the USOM itself in Santiago, since their annual budget provides for a limited number of short-term (up to three months) and longer-term (up to one year) fellowships. The Technical Advisory Committee of the Council of Rectors has rendered notable service in working closely with the USOM in the selection of the recipients of these fellowships, in order to assure that opportunities will be utilized to maximum advantage in meeting the planned needs of the research and teaching institutes. The USOM has requested the Academy's Coordinator to work with them and the Advisory Committee in order to integrate this possibility into the overall implementation scheme. Other possible sources of fellowship aid are also being explored with national and international organizations, both official and private, such as the Leader grants of the Department of State, the Fulbright and Smith-Mundt Fellowships, those of the Organization of American States (OAS) and of private foundations.

The USOM informed the Academy's representatives of other ICA projects underway or planned in one or more of the universities and their dependencies. A case in point is the special project which the University of Pittsburgh has undertaken to assist the Universidad Técnica "Federico Santa Maríá", in the establishment of post-graduate courses and degrees in chemistry. Another is

the ICA contract with the University of Stanford providing certain key specialists on a long-term basis for the recently established School of Geology at the University of Chile. Reference is made to both in the Report.

The Council of Rectors also informed the Mission of the overall responsibilities which had been assigned to it in connection with the administration of the revenues produced by the 1955 law, to which reference has been made above. These funds may not be used for salaries or other personnel expenses. This is one of the basic reasons why the Council requested the assistance of "Point Four" in providing funds which could be used in the two-way travel of specialists.

Another fund, \$650,000, has been made available to the Council of Rectors through the Smathers Loan, pursuant to the approval of both Congresses. Of this amount, \$700,000 was earmarked for the purchase of scientific equipment for the seven universities for both laboratory and teaching uses. Most of this equipment had already been purchased and delivered at the time the Mission arrived. The availability of these teaching and laboratory aids has made a significant difference in the student-professor relationship and the esprit de corps of the recipient institutions in general. The remaining \$150,000, it is understood, is earmarked for the Technical Advisory Committee and for scientific documentation, as stated in the Report. These funds were distributed among the respective universities for their use in accordance with the same ratio that obtains in the distribution of the Chilean funds made available through the Law 11.575.

Many national and international efforts were already being mounted to remedy the disaster situation which prevailed at the time that the Academy's Mission was in Chile. One noteworthy example is the Government's (Chile) action

pursuant to the request of the University of Concepción, in awarding 10 percent of the first and second prizes of the bi-weekly national lottery, for a period of 10 years, to that University for its reconstruction program. It is estimated that this will amount to a total of approximately five to six million dollars between 1960 and 1970. Listings of the destroyed or damaged scientific instruments and materials have been furnished by the two rectors of the University of Concepción and the University at Valdivia to many organizations, and efforts are being made to replace these critical items. \_\_\_\_\_ ACS

Text of Address to the Council of Rectors

Señor Presidente del Consejo de Rectores, Señores Rectores:

El grupo representante de la Academia Nacional de Ciencias de Washington ha llegado a Chile hace pocos días en momentos que son muy tristes para el pueblo chileno a causa de los desastres que han castigado una región importante del territorio nacional y a sus ciudadanos.

El Dr. Simonpietri y yo traemos en nombre de la Academia saludos a los Señores Rectores de las siete Universidades, y junto con el resto de nuestro grupo, el Dr. Davis y el Profesor Bonilla, traemos también mensajes de simpatía y condolencia de nuestras universidades y de todo el pueblo norteamericano para las regiones y personas aflijidas por los tristes acontecimientos de los últimos meses.

Como Uds. saben, nosotros venimos a ponernos a su disposición en relación con los entendimientos entre el consejo de Rectores y las agencias norteamericanas que tienen interés en cooperar al desarrollo del programa tecnológico en el cual las Universidades trabajan desde 1956. Como Uds. pueden imaginar, se presentaron algunas dificultades para conseguir los servicios de destacados científicos norteamericanos, pero lo logramos por lo que el Dr. Simonpietri y yo nos sentimos profundamente satisfechos. Nos complace poder contar con la cooperación técnica del Dr. Alva Davis, antiguo Decano de la Facultad de Ciencias y Letras y Vice Canciller de la Universidad de California en Berkeley, y con la valiosa colaboración del Profesor Charles F. Bonilla, Profesor de Ingeniería Química de la Universidad de Columbia en Nueva York; somos además especialmente afortunados al poder contar con la

colaboración del Vice-Presidente de la Academia Nacional de Ciencias, el Profesor Farrington Daniels, gran químico y experto reconocido internacionalmente en investigaciones sobre energía solar, quien llega próximamente.

No venimos al país a sugerir normas o ideas norteamericanas pre-determinadas sobre lo que puedan o deben hacer las universidades chilenas para acelerar el ritmo de desarrollo que ya existe bajo la digna dirección de los Señores Rectores, sino para colaborar con Uds. Estamos en el país para informarnos sobre los planes que tienen las Universidades para fortalecer la enseñanza y la investigación en ciencias básicas y ramas tecnológicas para que podamos a nuestra vez recomendar a la Academia y al Punto IV como colaborar más efectivamente en la ejecución de dichos planes. Esperamos entonces ser informados sobre los programas concretos de cada Universidad antes de dejar su progresista país, para que la Academia pueda estudiar en qué forma le será posible prestar cooperación, con la ayuda financiera del Punto IV.

Yo creo que Uds. están informados que la Academia no tiene fondos propios, sino que recibe subvenciones de varias entidades gubernamentales y particulares para fines determinados. Por este motivo los representantes de la Academia tienen que luchar para obtener recursos y tienen también el deber de supervigilar el apropiado uso de estos fondos. Para informarse bien los miembros de este grupo desean visitar, dentro de lo posible, todos los diversos centros de enseñanza e investigación y conocer personalmente los profesores y técnicos que allí trabajan.

En vista de la triste situación actual en el extremo Sur, vamos a dejar la posibilidad de visitar Valdivia por el momento, con la esperanza de que la

situación mejore y podamos realizar ésto más adelante. También parece indicado postergar por el momento una visita a la Universidad de Concepción, que desgraciadamente continúa siendo aflijida, esta última vez por un incendio. De acuerdo entonces con el Señor Presidente del Consejo, planeamos hacer una rápida visita preliminar a Valparaíso mañana Viernes y el Sábado para establecer contacto con las diferentes reparticiones científicas y tecnológicas de los tres centros de la Universidad Católica, la Universidad Técnica Federico Santa María y el Departamento de Ciencias de la Universidad de Chile.

En las semanas que siguen hasta aproximadamente el 19 de Julio el grupo va continuar haciendo visitas. El Profesor Daniels contempla visita al Norte en los días siguientes.

Esperamos entonces recibir por escrito, tan pronto como sea factible, los programas de desarrollo de cada Universidad con indicaciones de prioridad e importancia para que se pueda discutir más efectivamente con los científicos de cada programa. El Dr. Simonpietri que tiene gran experiencia en asuntos científicos internacionales, y que conoce ya su país y muchos de sus líderes, vá ahora a agregar ciertos detalles sobre los planes y esperanzas nuestras.

Termino una vez más con mis expresiones de alegría de estar otra vez entre los amigos y colegas chilenos, aún en un momento tan grave en el cual todos los patriotas tienen que reunirse y trabajar juntos para el bienestar total del pueblo chileno.

Harry M. Miller, Jr.  
Coordinator, Chile Project  
National Academy of Sciences--  
National Research Council

June 23, 1960

**LEY No. 11.575****(Excerpto)**

**Art. 36** Desde el 1<sup>o</sup> de Enero de 1956 el medio por ciento de todos los impuestos directos e indirectos de carácter fiscal y de los derechos de aduana y de exportación, ingresan durante 20 años a una cuenta especial de depósito que la Contraloría General de la República ordenará llevar y se destinará a formar el Fondo de Construcción e Investigación Universitaria.

- a) Los recursos que se acumulan en la expresada cuenta se repartirán en la siguiente forma: 10/100 para la Universidad de Chile, de los cuales 2/100, a lo menos deberán invertirse en la dependencias de la Universidad de Chile en Valparaíso, 2/100 para la Universidad de Concepción; 2/100 para la Universidad Católica de Santiago; 1/100 para la Universidad Católica de Valparaíso, 1/100 para la Universidad Técnica "Federico Santa María", 1/100 para la Universidad Técnica del Estado y 1/100 para la Universidad Austral la que sólo podrá disponer de estos recursos una vez que se le haya otorgado personalidad jurídica. Para estos efectos dicha cuenta especial de depósito se subdividirá en letras o como lo determine la Contraloría General de la República abonándose a cada una de las Universidades las sumas que les corresponden y sobre ellas podrán girar los Rectores de las respectivas Universidades sólo para construir amueblar, habilitar, y dotar estaciones experimentales, plantas laboratorios e institutos de investigación científica y tecnológica, destinadas a aumentar y mejorar la productividad de la agricultura, industria y minería, a promover el inventario y aprovechamiento racional de los recursos del país y a procurar una mejor organización de las diferentes actividades económicas.
- b) Las Universidades orientarán las actividades que desarrollan estos planteles hacia la colaboración con la Corporación de Fomento de la Producción, los organismos técnicos del Estado y las entidades y empresas privadas
- c) Un Consejo compuesto por los Rectores de las Universidades mencionadas en la letra a) del presente artículo y presidido por el Rector de la Universidad de Chile, confeccionará anualmente planes de coordinación de las investigaciones tecnológicas, dentro de los presupuestos que para ellas hayan aprobado las respectivas Universi-

dades. Estos planes se aprobarán y se llevarán a cabo en la forma y condiciones que establecerá un Reglamento especial que dictará el Presidente de la República, previo informe de este Consejo y dentro del plazo de 60 días, desde la fecha de la publicación de la presente ley en el "Diario Oficial."

- d) Los recursos que se conceden por este artículo no podrán gastarse en sueldos, viáticos, ni viajes y se destinarán exclusivamente, a financiar costos de construcción, instalaciones experiencias, adquisiciones de terrenos, maquinarias, implementos, enseres útiles, vehículos, motorizados de usos industriales y animales.
- e) Las Universidades indicadas, sobre la base de los ingresos que se les conceden por esta ley, podrán contratar préstamos hasta por las siguientes cantidades: setecientos millones la Universidad de Chile; trescientos millones la Universidad de Concepción; trescientos millones la Universidad Católica de Santiago; ciento-cincuenta millones la Universidad Católica de Valparaíso; cientocincuenta millones la Universidad Técnica "Federico Santa María;" trescientos millones la Universidad Técnica del Estado y cien millones la Universidad Austral.

Estos préstamos se podrán reajustar según las variaciones que experimente el sueldo vital.

(Es copia fiel del texto recibido)