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Discussed are the goals of the Advisory Council on College Chemistry and the effect on College Chemistry of termination of National Science Foundation funding. Reported are conferences on (1) the relevance of thermodynamics to chemists and engineers and its place in a chemistry curriculum, (2) new approaches to teaching thermodynamics in an elementary chemistry course, (3) the development of chemistry programs in two-year colleges, (4) the teaching of solid-state chemistry, and (5) the use of on-line computing systems for instructional purposes in undergraduate chemistry. Details regarding the Council's continuing and cancelled programs, publications, and films available from the Film Clearinghouse, are given. (GR)

Advisory Council on College Chemistry

NEWSLETTER

Number 16, June 1969 *(Serial Publication Number 40)*

THE STATE OF THE COUNCIL

A brief announcement was sent out last fall informing you of the NSF rejection of the Council's proposal for continuing support, and of the immediate and sudden problem caused by the ceiling placed on the expenditure of NSF funds. A Newsletter with additional information was promised in two or three months. It has taken twice as long to get this to you but only now, since the Minneapolis ACS meeting, can we give you more definite information on the state and future of the Advisory Council and its programs.

The Executive Committee of the AC_3 engaged during the ACS Minneapolis meeting in long discussion, seeking to find the best course to plot in view of the NSF instructions received in a letter of October 1968 rejecting the proposal for continued support:

". . . I must inform you that the National Science Foundation will be unable to provide continuing support to the Advisory Council on College Chemistry.

". . . We suggest that you prepare a revised budget covering the anticipated expenses of the Executive Office and essential project work. Projects which can be supported under this arrangement are those that are already well under way and which can be brought to a meaningful termination point during the next year. Those which are in the early stages of development and those which can be 'spun-off' to become separate activities should be deleted from the revision . . ."

The actions that are being taken in view of this termination of funding are described in this Newsletter along with information on various AC_3 activities that have occurred during this academic year.

EDITORIAL

The review letters on which the rejection of the proposal for continued NSF funding of the AC_3 was, in part, based had a refrain very much like Gilbert and Sullivan's "They never would be miss'd, they never would be miss'd." But for many of us who have been involved. in large or small measure, such a comment raises the prior question, "What is it that never would be missed?" Many different answers would be given, and it might be of value to have set down one such answer – one that is based on a personal but an inside view of the AC_3.

From any position that provides a familiarity with the AC_3 activities, the AC_3 is seen to be a collection of somewhat like-minded chemists who are concerned about chemistry and chemical education. This ill-defined group includes many of the present and past elected Council members, many of the present and past staff members, and many of the 10,000 chemists reached by the AC_3 Newsletter who have participated in any extent in activities related to the AC_3 symbol. Included in this effective, if unofficial, membership are chemists from one extreme in which the title, "research chemist," would be welcomed to the other in which "teacher" would be considered an equal compliment.

This nearly amorphous group, heterogeneous with regard to talent and interests, is, in terms of its mission, an organization of amateurs. It stemmed from

a group of chemists who, some years ago, were encouraged to apply for an NSF grant to be used to stimulate improvements in undergraduate chemical education. What structure there now is to the AC_3 emerged so that the granted funds could be used in a relatively organized way to carry out the various projects that seemed of value. Such projects resulted from the ideas, and the dedication, of many individuals in the chemical community concerned with chemical education.

The AC_3 is thus not an official body representing, or dictating to, the chemical community. Nor has it set itself any relatively easy goals such as the recommending of curricula or the writing of textbook materials. Without such tangible goals, the true goal — other than "to do something for chemical education" — of the activities and the people that we loosely label the AC_3 is hard to state concisely and perhaps has been only recently recognized, even by those connected with its operation.

Thus, "What is it that never would be missed?" is not an idle question. Only ignorance of the nature of the AC_3 and its role in chemical education or lack of interest in chemistry and chemical education can make it seem so.

The role of the Council that can be seen as emerging is that of providing a meeting ground for chemists who have an interest in their subject and in the basic element for all progress in chemistry — a continual flow of talented students through all, or part, of our chemistry offerings. The attitude which best finds a home within the Council's activities is that which seeks not merely well-organized student contact with chemistry, nor student commitments to chemistry as a profession, but rather student encounters with chemistry that are a proper part of the educational, even cultural, programs in institutions of higher learning. And this implies an attention both to the subject of chemistry and to the students who study it.

The coming together of such concerned chemists with a variety of interests and talents is much needed — and it does not constitute merely the setting up of yet another professional society. Academic chemistry now so obviously suffers from the polarity that often separates teachers from researchers, humanitarians from technicians, and the dedicated from the talented. It is the establishment of the middle ground on which a scholarly concern can be stimulated, and respect for this concern can be fostered, that has become the recognized role and goal of the Council.

Assisting the development of an identity for scholarly chemists throughout the country is, one finds, no simple, straightforward matter. A variety of components are necessary. The insight that experts bring to a topic such as chemical dynamics or solid state chemistry is one aspect. Regional conferences, and even the Newsletter, that develop some feeling of community is another. A consultants' service with no objective other than unbiased assistance is another. All such activities, one finds when one tries to work towards the accepted goal, must be included.

Individual AC_3 projects tend, in contrast to this broad and consequential goal, to seem of little significance. But they have served, when taken together, to create for many chemists the feeling of being part of an untrammeled effort towards an acceptable academic goal, one not biased by a commitment to unworthy or improper ends. It is the beginning of this esprit de corps and the respectability for a broad, scholarly concern for chemistry that can be fostered by a variety of efforts that has led to the many Council activities.

For many of us, a most troublesome feature, even with the setting up of a variety of projects, has been the inability to locate and to draw the many like-minded chemists more quickly into AC_3 activities. Mechanisms for doing this and at the same time maintaining the thrust of a manageable group are not quickly and easily found. With time, and with clear intent of those with administrative roles within the AC_3, the AC_3 could well have become the needed, open meeting ground.

It is not difficult to see that with this diffuse character and with the goal of contributing to the development of respect and regard for a broad scholarly concern for chemistry, the AC_3, or at least its funding, should soon be in jeopardy.

Many of the most prestigious, and honored, academic leaders of the chemical profession have little interest in, sympathy for, or knowledge of, much other than hard-core research. Many teachers, even if dedicated to their duties, have little appreciation of their subject beyond the routine performance of their teaching duties. The National Science Foundation must find it difficult, particularly in the face of opposition from the leaders of the profession, to support an endeavor that does not even seek to produce the normal currency of the academic world — papers in professional journals, or standard textbooks.

But ever increasing concern is voiced for the lack of vitality of academic chemistry, for its separation from the real world, for the near-fixed domain in which it deals, for the closed loop in which faculty members teach students so that they too can become faculty members. The area of concern of the participants in AC_3 activities is, in various quarters, becoming recognized as crucial for the profession of chemistry and for the scholarly and humanitarian component that so needs renewal in academic pursuits. Clearly the students enrolling as chemistry majors are no longer the most talented, excited, and numerous of the students in science and engineering. Clearly other students ask, or demand, something more than the pre-technician view of chemistry that is often given them to fulfill the requirement that is imposed on them.

Chemistry will not be exempt from the forces of renewal that are affecting the entire area of education today. Progress will be made and it will require the scholarly spirit, fostering of which became the chief goal of the Council. There will be a move away, even among chemists, from the fill'r-up-with-chemistry three-hours-lecture-three-hours-laboratory scheme. There will be increasing rewards for insight into the conceptual basis of chemistry, and for reappraisal of the subject and of the approaches into it most suitable for future scientists and laymen. There will be renewed vigor and vitality at all the frontiers that chemistry reaches in place of an ever increasing technician-like attention to a relatively static area of physical science.

But control of academic chemistry seems to be mainly in the hands of those with detailed concern for sections of the frontier of the traditional areas of chemistry, and all normal developments – the review of our NSF proposal by the leaders of the profession being an appropriate example – lead to further strengthening of the existing leadership and further lessening of the vitality of academic chemistry. The Advisory Council can be seen as an aberration in this pattern that might have provided the start of a healthy modification of the direction of academic chemistry. The thrust within the chemical community depends primarily on individual actions and, with the demise of a well-funded Council, these efforts will be isolated and will lack general acceptance by the relatively hostile professional environment.

The soliciting, and accepting of, the prejudices now well established in the chemical community to terminate now the funding of the AC_3 – and to fail to work with some of those who have been involved with the AC_3 effort to consider alternate funding for some activity with a similar mission – will surely turn out to be unwise and will be seen to have led to a short-sighted use of federal funds for chemistry. Much damage has been done to the basic strength of chemistry, that stems from a vital educational scene, by the project-by-project and the research-oriented funding. Having drawn so much of the talent of academic chemistry into a narrow concern for research, our system tends to do so more and more and, as a result, the academic environment as seen by students of chemistry is increasingly drained of talent and scholarship. That eminent chemists advise a continuation of our present course is not sufficient justification to continue with an expenditure procedure that continually polarizes chemistry in the academic community and can lead to a further withering of the scholastic heart of the subject.

It is not that the specific activities of the AC_3 provided much of a remedy for this, but the very existence, and support, of the AC_3 seemed to indicate a recognition of the need for attention to more than the outermost frontier of the subject.

Despite the withdrawal of NSF support there is now ample evidence that many chemists are sufficiently interested to keep the spirit of the Advisory Council alive in one form or another. Thus, no plans have been made formally to dissolve the organization nor to give up attempts to bring together scholarly and imaginative chemists who have a commitment to chemistry and to education. Routes, other than those assisted by NSF funds channelled through the AC_3, must be found to build basic strength and vitality in the chemistry that can stand in our colleges and universities as a proper component of higher education.

From the office of the AC_3, no clear way in which this can be done can now be seen. A variety of spontaneous suggestions and indications of interest have been received. More would be welcomed. From such responses, ways might be found to continue to encourage and facilitate the coming together and the cooperative efforts of academic chemists.

– G. M. Barrow
AC_3 Executive Director

TRUSTEES FOR THE ADVISORY COUNCIL

Most difficult is the task, not recognized in the termination-of-funding letter, of understanding the essential character of the AC_3 and working towards a procedure that will keep what is of value in existence. In Executive Committee sessions and in a Council meeting no clear future course could be laid out. A mechanism for action, in the face of insufficient funds to hold regular Council and Executive Committee meetings, was adopted. In spite of the ominous sounding word "trustee" the intent was to provide a mechanism that would at least safeguard the name of the AC_3 and would also allow a renewal of the AC_3 as support, monetary or moral, came forward. The resolution that was adopted is:

Whereas continued funding for the Advisory Council on College Chemistry has not been granted by the National Science Foundation,

1. This Council does hereby create a body known as the Trustees of the AC_3, comprising
   a. The present and past chairmen of the Council and
   b. The present and past Executive Directors of this Council.
2. The Council does hereby authorize said trustees to select and empower their successors until a successor Council shall be established.
3. The Council does hereby confer on said trustees all powers of the Council and its Executive Committee.
4. Any previous actions of the Council or the Executive Committee which conflict with the intent of these actions are hereby rescinded.

The many individuals who really constitute the AC_3 will, through the AC_3 Trustees, have a clear and, we hope, effective group to coordinate all future efforts.

In the discussions at the time this mechanism was developed by the Executive Committee, it was recognized that the intention of those present was to provide a means of winding up the present NSF-supported AC_3 activity as rapidly as possible – but with due consideration to the commitments to the staff and to proper transfer or termination of the various projects already underway.

Discussions were started, and will continue, with the Division of Chemical Education to see what projects initiated in the AC_3 are appropriate for continuation by the Division. A variety of successful transfers seem likely and, as these are accomplished, information will be provided by an autumn Newsletter or by information in the Journal of Chemical Education.

At the present time the Council, through its Trustees, plans to complete, or spin off, most of its current projects by the end of the autumn of 1969 and to have wound up or transferred all remaining projects throughout that academic year. The status of some of these projects is described below.

PUBLICATIONS

Publication and distribution of all reports that have been delayed is now planned for the coming summer. Some of these are now ready for the printer, while others are in various stages of preparation. When actual publication occurs, information on the availability of the reports will be published in a Newsletter or in the Journal of Chemical Education.

In addition to these publications there will be at least one more Newsletter to keep you up-to-date on events as well as on decisions about the disposition of the Council and its various programs.

CONTINUATION OF COUNCIL PROGRAMS

All of the activities and programs of the Council do not find their completion in the publication of a report or booklet, nor are they of the type that can ever be said to be completed. The Consultants Service, for instance, seems to be a valuable, non-publishing, program that should somehow continue to be made available to schools who want it. The Regional Conference program likewise does not, except somewhat incidentally, generate publications for general circulation but it is one of the best received of the programs that have been developed.

Other projects, such as the Library List or the Film Catalog, might be considered complete after publication of the list or catalog. But such lists have a habit of getting out of date very quickly. Publications like these need to be continuing programs which lead to regular updating and revisions. It is such programs that will receive major attention in discussions between the AC_3 Trustees and representatives of the Division of Chemical Education.

CANCELLED PROGRAMS

Some AC_3 programs that went under when funds were blocked last fall will not come up for air.

The Experiment Clearinghouse program has been discontinued. Experiments which had been checked by their authors and duplicated before the limitation on expenditures were mailed to those who requested them. Others that had not yet been edited by their authors or which had been sent in after the ceiling was imposed were not distributed. We appreciate the interest shown in the Experiment Clearinghouse by those who submitted experiments and by those who requested them, and regret that circumstances forced cancellation of the program.

The Film Kit program has been discontinued, and kits with new films are not being circulated. Films from earlier kits are still out on extended loan but are subject to recall.

A *Concept Development Unit* project was described as a future AC_3 project in the preceding Newsletter. A prototype unit, that would have dealt with Atomic States, had been started last summer under the direction of Dr. Jeff C. Davis, Jr. of the University of South Florida. The expenditure ceiling has however prevented further work from being carried out, and the pending termination of AC_3 funding makes it unwise to begin again this rather major project. Some very preliminary material produced last summer on the topic, *Waves, Photons, and Spectra*, is now available. This textual material is however not backed up by the supplementary teaching aids, sources of demonstration equipment, and literature references and excerpts that were intended to play a major role in the units.

PSNS

In 1963 and 1964, AC_3, together with the Commission on College Physics, organized a conference that led to a clarification of the need for better materials for college physical science courses for non-science majors. In April 1965, as a result of this conference, a project entitled Physical Science for Nonscience Students (PSNS) was organized at Rensselaer Polytechnic Institute. The PSNS staff, which grew to include 34 chemists and physicists, with the support of the National Science Foundation, produced a new course, "An Approach to Physical Science," which, after several years testing and several preliminary editions, is now available in final form – a text, a teacher's resource book, and laboratory equipment and supplies – from John Wiley & Sons, Inc., 605 Third Avenue, New York, N.Y. 10016.

The course features the experimental aspect of physical science and emphasizes the nature of the solid state, rather than a survey of all physical science. Many specially designed experiments have been combined with the text material. Experiment equipment and supplies can also be obtained from the publisher.

CHEMICAL THERMODYNAMICS

We are happy to report that Rubin Battino, of Wright State University, Dayton, Ohio, has picked up the chemical thermodynamics ball. Although neither he nor the AC_3 was able to find funds for a workshop-type session to explore the modern teaching of thermodynamics, he has arranged a most promising session for the Fall, 1969 ACS meeting.

The symposium on the teaching of thermodynamics will be held under the sponsorship of the Division of Chemical Education of the American Chemical Society in New York City in September. The day allotted for the symposium is Wednesday, September 10. The program is divided into three quarter-day sessions with three invited speakers in each session. Since the subject of chemical thermodynamics is so central to chemical engineering curricula, a chemical engineer has been invited to participate in each session.

The first session is on the relevance of thermodynamics to chemists and chemical engineers. It will be chaired by Prof. Mark W. Zemansky and the speakers will be Dr. L. K. Nash, Dr. E. E. Wood, and Dr. H. C. Van Ness. The second session is on the place of thermodynamics in the curriculum. The speakers in this session are Dr. H. A. Bent, Dr. N. Craig, and Dr. J. J. Martin. The third session is on methods of teaching thermodynamics and the speakers are Dr. C. E. Wales, Dr. W. H. Eberhardt, and Dr. R. C. Plumb.

MOLECULES, ENERGY LEVELS AND THERMODYNAMICS

Many chemistry teachers, particularly in elementary courses, like to stray from a strictly classical, phenomenological presentation of chemical thermodynamics. Included in the participants at a U.S.-Japan conference held last year (see Newsletter No. 15, Summer 1968) were some chemists who felt there were merits in approaching thermodynamics in an elementary course after developing some ideas on atomic and molecular energies and some appreciation of the way atoms and molecules are distributed throughout the patterns of allowed energies.

A report based on some of the proceedings of this conference is now available as AC_3 Serial Publication 41, *An Informal Guide to the Use of Molecular and Thermodynamic Concepts as a Theme in an Elementary Chemistry Course*. This report should be of interest principally to teachers of elementary chemistry courses that include, as almost all do, some material on both atomic-molecular phenomena and on thermodynamics.

A copy of this report will be sent to each Chemistry Department chairman, with instructions that it be passed along to the appropriate teacher. Copies can also be obtained by writing to the Advisory Council on College Chemistry, Department of Chemistry, Stanford University, Stanford, California 94305.

1968 REGIONAL CONFERENCES

Six regional conferences were held in the Fall of 1968. Other Fall conferences had been scheduled and were in various stages of preparation but the sudden limitation on expenditures forced their cancellation. The six conferences held are listed here. Copies of the full conference reports may be obtained on request to the AC_3 offices.

"Chemistry Programs in the Pennsylvania State Colleges"
Shippensburg State College
September 13-14, 1968
Robert I. Walter, Chairman
Speakers:
William H. Eberhardt, Georgia Tech
Alfred B. Garrett, Ohio State University
Russell H. Johnsen, Florida State University
R. I. Walter, Univ. of Illinois at Chicago Circle

"Non-Traditional Chemistry Curricula"
Drew University
October 11-12, 1968
James M. Miller, Chairman
Speakers:
Dwaine O. Cowan, Johns Hopkins University
Wilmer J. Stratton, Earlham College
Charles F. Wilcox, Cornell University

"High School-College Chemistry Interface"
California State College at Fullerton
October 18-19, 1968
Fred Kakis, Chairman

"Chemistry: The First Year"
Bethel College
October 25-26, 1968
William J. Johnson, Chairman
Speakers:
Lester C. Howick, University of Arkansas
Wilbert Hutton, Jr., Iowa State University
George Splittgerber, Colorado State University

"Teaching Modern Physical Chemistry"
University of Arkansas
November 15-16, 1968
George Blyholder, Chairman
Speakers:
Robert A. Alberty, MIT
William C. Oelke, Grinnell College
Richard N. Porter, University of Arkansas

"High School-College Chemistry Interface"
State University of New York, Binghamton
October 25-26, 1968
Clifford Meyers, Chairman
Speakers:
John V. Favitta, New York State Education Department
William T. Lippincott, Ohio State University
William T. Mooney, Jr., El Camino College
Ben R. Willeford, Bucknell University

REGIONAL CONFERENCES AND A FEDERATION OF REGIONAL ORGANIZATIONS

Many on the AC_3 mailing list recognize that there really are many chemists and teachers in the country who are interested in improving chemical education and who are doing things about it. The fellowship that is generated by suitable publications or conferences helps to broadcast the developments that occur and to dispel the feelings of isolation that can so easily develop on many campuses.

Although Newsletter articles, and articles in other journals, mention many of the new approaches and ideas that are being developed and used throughout the country, the Regional Conference program seemed to be especially effective in bringing chemists with a common interest in education together and in fostering cooperation among neighboring institutions. Regional or statewide associations of college chemistry teachers, the organization of which was one of the underlying purposes of the Regional Conference program, help to give a greater sense of professionalism to the concerned chemical educator. There is an indication, though, that the strictly regional associations leave something to be desired.

During the next few months, AC_3 hopes to study the possibility of encouraging a national association, or federation, of regional and statewide associations of chemistry teachers to see if some of the special features of the AC_3 regional conferences can be brought to the meetings of existing, or new, regional groups. The actual method of operation of such a federation remains to be thrashed out, but there does seem to be promise of increasing the effectiveness of each regional group. Funds will be allocated to help representatives of existing associations come together with AC_3 personnel to discuss the possibility of federation.

One of the problems immediately encountered in setting up this effort is that regional associations are hard to locate. We know of some, but we are sure there are many that we don't know about. And some of the ones we do know about are not easily located because their officers and "head office" change each year.

The ones we do know about are listed here:

California Association of Chemistry Teachers
Michigan College Chemistry Teachers' Association
Middle Atlantic Association of Liberal Arts Chemistry Teachers
Midwest Association of Chemistry Teachers in Liberal Arts Colleges
New England Association of Chemistry Teachers
Association of Pennsylvania State College Chemistry Teachers
Orange County Chemistry Teachers Association
South Central Independent College Association of Chemists.

The AC_3 Executive Office would like to know the names and current addresses of all regional or statewide associations. *You can help by sending us the names and addresses of any that you know about.*

FILM COMPETITION AND DISPLAY

A Chemistry Film Competition and Display was held at Stanford University on August 29 and 30, 1968. Teacher-produced 8 mm and super 8 mm chemistry films were eligible for entry in the contest. A total of 30 films were submitted for judging, many of the films being ones produced at the AC_3 Film Content and Technique Workshop held at Stanford on June 18-22, 1968.

Films were screened for scientific accuracy and were judged according to

1. value as a supplement to lecture or laboratory instruction in chemistry,
2. suitability of the topic for motion picture presentation, and
3. novelty of content and effectiveness of photographic display.

The judges were Dr. Wendell H. Slabaugh, Department of Chemistry, Oregon State University; Dr. Richard E. Powell, Department of Chemistry, University of California; David W. Ridgway, CHEM Study, University of California; Dr. Therald Moeller, Department of Chemistry, University of Illinois; Dr. Stanley J. Cristol, Department of Chemistry, University of Colorado; Dr. Charles N. Caughlan, Department of Chemistry, Montana State University; and Herman W. Kitchen, Unit I Productions, New York City.

Prints of most of the twelve award films are now available at cost through the AC_3 Film Clearinghouse. The starred films in the following list were winners in the Film Competition. In addition, the film, "Stereochemical Conventions," by J. W. Horton, Wisconsin State University, Superior, Wisconsin, received an AC_3 award.

AC_3 FILM CLEARINGHOUSE

The Film Clearinghouse announced in the last Newsletter is now in operation. The Clearinghouse will distribute non-commercial, educational 8 mm or super 8 mm films produced by chemistry teachers. The Clearinghouse is being operated by Rod O'Connor at the University of Arizona. The list of films now available appears below. Most of the films are silent super 8 and range in cost from $5 to $16.

Inquiries about these films should be addressed to:

Rod O'Connor
AC_3 Film Clearinghouse
Department of Chemistry
University of Arizona
Tucson, Arizona 85721

Teachers willing to make their films available for distribution on a non-profit basis should write to Rod O'Connor at the above address.

* *Absorbance Measurements Using The Spectronic 20* — Elmer Rice, California State Polytechnic College
* *Conductometric Titrations* — Frank Guthrie, Rose Polytechnic Institute
  Critical Temperature — Karl Marhenke, Cabrillo College; James Hill, Wesley College
* *Determination of K_d for A Weak Acid* — N. V. Duffy, Kent State; Ed Eagan, Quinsigamond Community College
* *Fluid-Flow Simulation of Molecular Orbitals* -- Roger Gymer, AC_3
  Half Time and Rate Law — Gilbert Haight, University of Illinois
* *How To Do "The Molecule"* — Donald Hicks, Georgia State College
* *Ionic Equilibria* — Naola Watson, Sacramento City College
  Light Absorption & Complementary Colors — K. N. Carter, Presbyterian College
* *Optical Isomers: R and S System* — Richard Campbell, University of Iowa
* *Qualitative Analysis Group I* — N. V. Duffy, R. Franklin, Kent State University
* *Sampling Techniques For IR-Mull Technique* — Harold Goldwhite, California State at Los Angeles; Jack Powers, Ripon College
  Symmetry of Molecules — Robert F. Zahrobsky, University of Illinois at Chicago Circle
  Techniques for X-Ray Diffraction I — Preparing and Mounting a Sample for Powder Camera — J. L. Mackey, Austin College
* *Thin-Layer Chromatography* — Lewis Smith, Chico State College; Jerry Janssen, Antioch College

AC_3 CONSULTANTS SERVICE

After an interruption caused by the expenditure ceiling, the Consultants Service is now back in operation. Seven consulting visitations have already been authorized through July 1, 1969, and tentative commitments have been made for four more visits. The Service will provide consultants to work closely with schools wishing assistance in the improvement of their undergraduate offerings in chemistry and in planning future department development.

Inquiries about the Consultants Service should be directed to Dr. Malcolm M. Renfrew, Director, AC_3 Consultants Service, Department of Chemistry, University of Idaho, Moscow, Idaho 83843.

DEVELOPMENT OF TEACHERS FOR CHEMISTRY PROGRAMS IN THE TWO-YEAR COLLEGES

An AC_3-supported survey, conducted by William T. Mooney, Jr., and an AC_3 conference held in Dallas last year (see AC_3 Newsletter 13, March 1968) dealt with topics such as the origin, the academic background, the continuing education, and the supply of teachers for two-year colleges. Information and recommendations presented during the conference led to the following conclusions:

1) the master's degree in chemistry should be considered the minimum academic requirement for such teaching assignments;
2) a degree, broadly based in the various areas of chemistry, with some chemical research and with an opportunity for supervised experience in the teaching of college chemistry is preferred over a more specialized degree of a "course work only" type or a degree which provides no opportunity for becoming involved in the teaching of chemistry;
3) teachers for chemical-technology occupational programs should have the equivalent of an ACS recommended bachelor's degree in chemistry plus industrial experience and specialized training in occupational education;
4) chemistry teachers should devote themselves to the mastery of topics considerably more advanced than those they must teach.

The Conference opened with a progress report and the preliminary findings from an AC_3 Study of the 1966-1967 Two-Year College Chemistry Programs and Faculty, which included information from 453 colleges (with a combined fall-term chemistry enrollment of 74,350) and from 651 faculty members. The chemistry-course enrollment distribution of the students in the reporting colleges is shown in the accompanying chart.

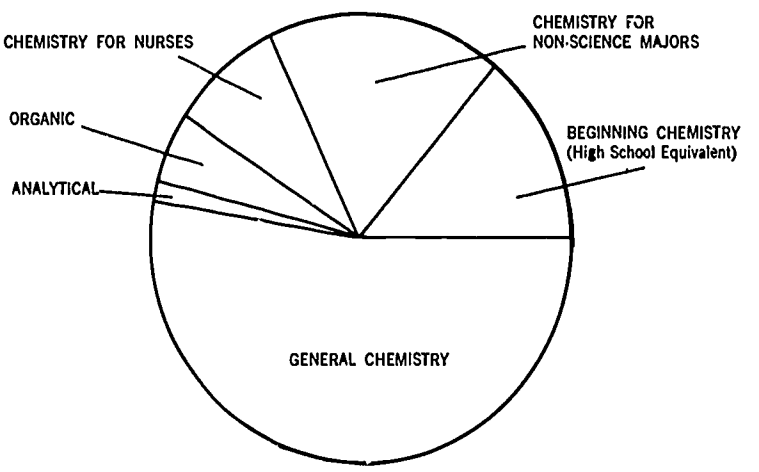

Figure 1

Distribution of student enrollment in chemistry courses in the reporting two-year colleges. (Not shown is the approximately 3% enrollment in chem. tech. and other courses.) Notice that about 90 percent of the student enrollment is in courses that are no more advanced than general chemistry.

The 453 colleges employed 1377 chemistry teachers, of whom 235 were on a part-time basis. Just over half of these chemistry teachers were engaged exclusively in chemistry teaching and most faculty members taught a general chemistry course or chemistry for the non-science majors. Only 251 taught analytical chemistry, 328 taught organic chemistry, and 77 taught separate courses for chemical or other technicians.

For the 1966-1967 academic year, the 453 colleges

sought to fill 309 faculty positions (109 to replace persons leaving chemistry and 200 to fill newly created positions) and over 10 percent of the positions were unfilled. During 1967-68 the same schools sought to fill 283 positions (128 for replacements and 155 for new positions) and, as of June 1, 1967, 30 percent were not filled. The study did not include the nearly 50 new colleges which opened in the fall of 1967, most of which were seeking one or more chemistry faculty.

Of the colleges polled, only 2% require a doctor's and 55% a master's degree. However, an additional 40% of the colleges indicated that they "desire" that the candidate have one of these advanced degrees. Sixty percent of the colleges indicate no requirement or desire for a state credential and 70% are equally unconcerned about completion of specified education courses. The degrees held by the responding two-year college faculty members is shown in the accompanying graph.

Figure 2
Distribution of HIGHEST degree held by 694 chemistry faculty in two-year colleges in 1966 - 67.

About half of the faculty respondents have had experience as a teaching assistant in chemistry during either their undergraduate or graduate work. But more than 85% of the faculty have never participated in a college course or seminar concerned chiefly with the teaching of college chemistry, and many of those who have participated have done so during recent summer NSF programs.

Several conference participants urged that teaching assistantships in chemistry be more effectively utilized to develop instructional competence. It was suggested that the assistants be introduced to a variety of modern audio-visual techniques and chemical education methods in chemistry and that they be given added responsibility in the conduct of course work.

Experimentation with new instructional techniques in chemistry was proposed as an adjunct to the present basic chemical research program within graduate chemistry departments. Teaching internship programs in two-year colleges, jointly supervised by a four-year college chemist and a two-year college chemist, were discussed in the light of the fact that although half of the faculty had practice teaching, only 4% had this experience in a two-year college.

Since 21% of the faculty respondents had attended a two-year college as students, it was recognized that a potential source of future chemistry faculty for two-year colleges is the contemporary student body of these colleges. To realize a future faculty from this source, the two-year colleges will have to employ outstanding teachers of chemistry for their general and second year chemistry programs, make these courses stimulating and interesting, and make a career as a chemistry teacher in a two-year college obviously attractive to their students.

The response to several questions concerning educational opportunities offered by nearby four-year or graduate institutions indicated that many two-year college chemistry teachers were unaware of or expected little of value to themselves in the educational opportunities in chemistry offered by these institutions. Many of these faculty asked for an expansion of programs such as the National Science Foundation Summer and Academic Year programs wherein content would be stressed, master professors would be heard and observed, and a concentrated period of time for study would be available.

Approximately 10% of the faculty reported semester teaching loads in excess of 22 contact hours per week, with over 60% reporting loads between 17 and 22 contact hours per week. Considering the time reported as spent on preparation and grading of papers and for other college assignments, the number of courses taught, and the general lack of sufficient technical assistance, the data from this faculty study tends to support the faculty members' written pleas for lighter teaching loads. In this connection, alternate methods of defining full loads were discussed.

Two proposals were made during the Conference to facilitate the entrance of people into chemistry teaching:

1) The development of "imitative institutes." The "imitative institute" would provide the teacher with a complete, tested, effective package of topical coverage and related learning work through his participation in a specific course like the one he will be called upon to teach. It will afford him an opportunity to ask, and have answered, questions he has himself and the kinds of questions he anticipates his students will ask. The understanding he would achieve would be particularly germane to his own instructional requirements.

2) The design of a pilot program to orient new faculty to the teaching of chemistry in the two-year colleges.

A study of new graduate programs for higher-education teaching was reported to the Conference. Reform in such programs seems to be following two trends:

1) the introduction of an intermediate degree upon admission to candidacy for the doctorate. This intermediate or candidacy degree represents a course competency greater than the master's.

2) a revision of the Ph.D. to include a more specific stream of study for teaching. The faculty study indicated that the two-year college teachers have not found the Ed.D. degree requirements realistic or desirable for their situations. Two on-going programs based on the completion of a doctoral research program in chemistry and including other requirements designed to stimulate and prepare or improve the student as a teacher of chemistry were described in detail during the Conference.

The Conference group concluded that:

1) any programs for the training of two-year college chemistry faculty must contain the minimum course content of the ACS certified bachelor's degree, and
2) teachers of transfer-type courses should have, in addition, the content of a conventional master's degree (including research and thesis) in chemistry.

This program might well be strengthened by adding some work in other fields of science since a larger proportion of the two-year college students appear to be less well prepared, less capable of handling more sophisticated scientific and mathematical material, and less motivated than their four-year college counterparts. This would allow the two-year college teacher to back up his competence in subject matter with formal training in the psychology of learning and chemical education teaching methods.

The Conference did not recommend any new specific degree programs for preparing chemistry teachers for two-year colleges but appeared to call for continual revision or options in the present graduate programs in chemistry which would more effectively prepare students for careers in the teaching of chemistry.

A publication by Wm. Mooney and Robert C. Brasted, the co-chairmen of the conference, is now available that reports the findings of the survey and certain recommendations on the topic of the conference. This report, including the statistical results of the survey, will be distributed to all two-year college teachers on the AC_3 mailing list. Copies can also be received by writing for *A Report on Education and Training of Chemistry Teachers for the Two-Year Colleges*. Address requests to the Advisory Council on College Chemistry, Department of Chemistry, Stanford University, Stanford, California 94305.

SOLID STATE CHEMISTRY

Chemistry has, it seems, a remarkable way of maintaining its identity. It tends to be conceived of as those areas that tradition says constitute chemistry. New fangled areas are given compound names to indicate that they are not part of this real core. Thus we have geochemistry, biochemistry, chemical physics, and so forth. To some chemists this inability of chemistry, or chemists, naturally to encompass such foreign areas is unfortunate. Some such feeling was in the minds of most of the participants at a conference on Solid State Chemistry held in New York on October 18 and 19, 1968.

The usual combination of words that one hears in connection with solid state is "solid state physics." It was to investigate ways of bringing to the attention of the academic chemists the very chemical nature of the solid state that the conferees addressed themselves.

The solid state presents some of the most exciting opportunities for illustration and application of chemical principles and for the introduction of chemical systems of great research and technological potential. Knowledge of this was common within the participants drawn from both academic and industrial scenes — it clearly is not common in the academic community at large.

There was, therefore, obviously no need to convince the participants of either the need for, or interesting potentials of, this area. The problem is to find a place for these applications and an argument which will convince faculty members to put them into their chemistry programs.

At present, there are perhaps 5,000 - 10,000 chemists in this country actually engaged in solid state chemistry, but there is little background anywhere in the formal education of chemists for this work. Neither in secondary school nor in college programs is there any real effort in this area. Not only is typically "inorganic" solid state chemistry ignored, but even the industrially significant area of polymers is virtually absent. Although in the past there has been little interest in even acquiring a faculty in these areas, there seems to be a counter trend now and many institutions are indeed searching for able people. There is, however, no school in the United States with a concentration of effort in solid state chemistry, a circumstance which is not at all true in Europe where institutions of great strength exist.

This situation exists in spite of the evident opportunities offered by solid state chemistry. The general topic offers a kind of "real-world" problem which is not only technologically significant, but intellectually exciting to the science-oriented individual. It presents challenges of synthesis and characterization which can be appreciated and integrated into all levels of the curriculum. It can appeal to the student in a general science course as well as to a specialist in a chemistry course.

The recognition that something might well be done in this solid state area stemmed from conversations, particularly between Harry Gray and William Eberhardt, at an earlier AC_3 Council meeting. The Chemical Dynamics conference, which led to the collection of papers that now have been published in *J Chem Ed* and distributed by the AC_3, provided a pattern in which subject-matter specialists and more general teachers were brought together to explore and produce an appropriate product. The Solid State Chemistry conference, organized by William Eberhardt, was held just before the expenditure ceiling curtailed current AC_3 activities. It did provide an exciting start to the project. The outcome, in view of the present and future problems of the Council's funding and life, is not clear but even the start that has been made should be of interest.

The goals of the project, as became clear, could be twofold.

Materials — reprints, books, films, experiments, etc.

– could be accumulated or prepared so that the teacher of a regular chemistry course could have access to illustrations and applications drawn from the solid state. This seems particularly desirable at the freshman level so that the student does not start off his study of chemistry with a narrow view of the subject. (It is interesting, as Bruce Hannay pointed out, that an early and major issue in chemistry courses is the law of definite composition and the law of multiple proportions. These laws apply however only to discrete molecules and the relatively uninteresting, for the solid state chemist, stoichiometric solids! The whole area of non-stoichiometric solids and the ideas of defects are thus placed aside the principal thrust of chemistry.)

The second goal could be the development of materials – again a variety of materials would be required – that would assist the teacher with some interest in and knowledge of the solid state to set up a solid state chemistry course, perhaps at the junior-senior or early graduate level. Such a course might be one part of a physical or inorganic chemistry sequence, or might be a quarter- or semester-long course like those now given on kinetics, thermodynamics, spectroscopy, and so forth.

The two goals, "chemistry with solid state ramifications" and "solid state chemistry," are not mutually exclusive and both goals were accepted as worthwhile and challenging.

Some examples of the topics that were mentioned in the free-flowing discussion at the conference should be given to indicate the subject matter that was considered. The categories that encompose most of the specific experiments and systems that were developed are:

1. Synthesis
2. Characterization (analysis)
3. Structure and Symmetry
4. Equilibria-Defects; the analogy with pH
5. Electromagnetics including Electronic Structure
6. Rates and Transport Properties
7. Catalysis
8. Electrochemistry
9. Phase transitions-Nucleation

Much of the discussion centered on possible experiments that could be incorporated into an advanced undergraduate or graduate course. Although much work would have to be done to make the suggested experiments feasible in laboratories without considerable solid state expertise, some exciting possibilities are apparent.

A variety of synthetic routes to interesting nonstoichiometric compounds were suggested. The tungsten bronzes, with compositions that can be varied from Na_2WO_4 (or $Na_2O{\cdot}WO_3$) by the incorporation of additional amounts of WO_3 can be prepared both chemically and electrochemically. Various proportions of CaF_2 and YF_3 can be incorporated in crystals with fixed structure but variable lattice parameters by relatively simple fusion. Other materials, as $BaTiO_3$, can be prepared either by a suitable fusion or by precipitation from aqueous solution. The materials in these examples are particularly suitable for the illustration of a variety of structural features.

Other experiments deal with the conductivity in solids and perhaps the easiest of these experiments for a chemist to appreciate is that developed by Howard Reiss which illustrates the analogy between positive and negative conductors in some solid semiconductors and hydrogen ion and hydroxyl ion conductors in aqueous systems. Equilibrium relations between the p and n type conductors can be written and the validity of the approach can be demonstrated by the measurement of the conductivity of suitably doped crystals. A suggested experiment consists of the doping of tin crystals that contain boron, which provides the p centers, with various amounts of lithium, which provide the electrons or n centers.

Many more experiments were suggested in the various areas listed above. Such suggestions were enough to stimulate the interest, and the excitement, of the generalists who were present.

But the route to the incorporation of such material in a regular or newly conceived chemistry course is not obvious and is obviously not easy. The solid state chemists tended to be quite casual about high temperatures, sealed tubes, ultrahigh vacuum, high pressures, electrode attachment, and so forth. It is lack of experience with such techniques that is perhaps the greatest obstacle to the entry of more academic chemists into the world of the solid state. For without the opportunity to do some of these manipulations, the subject remains foreign and apparently irrelevant. One can recognize, for example, that two quite recent excellent paperbacks on solid state chemistry have been published. They are:

Solid State Chemistry, by N. B. Hannay, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1967,

Seven Solid States, by W. J. Moore, W. A. Benjamin, New York, 1967.

But even such excellent and readable expositions cannot in themselves make very many chemists feel at all at home in the solid state. What seems to be needed is some access to the experiments that lead one to be interested in the models and the theories that are introduced, used, or emphasized in the solid state.

Even more difficult to reach is the goal of introducing some of the more modern aspects of studies of the solid state into the elementary chemistry courses. There the experimental problems, for many aspects of solid state chemistry, loom insurmountably high. But other aspects may yield to talented efforts. Microscopy, for example, is a long-ignored tool in chemical studies but, if revived, might allow a variety of phase transformations and surface phenomena to be studied even in an elementary course.

The mood at the conference was clearly one of

enthusiasm over the potential, and the challenge, of introducing students, in various ways, to the world of solid state chemistry. The expenditure limitations placed on the Council has so far prevented the planned next steps to be taken. But the subject is still there, and the interests of the participants can, perhaps, be again organized so that an exciting new dimension to chemistry can be made more accessible.

DIVISION OF CHEMICAL EDUCATION — DuPont Small Grants Program

The Division of Chemical Education has established a small grants program to provide modest financial support to individuals interested in chemical education projects. The Committee on the Teaching of Chemistry of the Division will administer the program. A grant to the Division of Chemical Education from E. I. DuPont deNemours provides the funds for supporting this program.

The purpose of the Small Grants Program is to encourage individuals to pursue short-range chemical education projects which could themselves provide teaching materials, information that would be useful to others in presenting chemistry to students, which might provide the beginning of a major project or which would be useful in attracting students to chemistry. Possible projects might involve the preparation of programmed instructional material, film loops, or other teaching aids, writing experiments or the computer analysis of student data to be used in writing an experiment. The size of the grants may range from $200 to $300. Exceptionally meritorious proposals requesting larger sums may be funded. The funds may be used for such items as the purchase of expendable materials, secretarial or draftsman's assistance, student stipends or computer time. Requests for the purchase of major items of equipment and for travel will not be approved.

A description of the program and suggestions for preparing a proposal can be obtained by writing to:

Professor H. A. Neidig
Chairman, Committee on the Teaching of Chemistry
Department of Chemistry
Lebanon Valley College
Annville, Pennsylvania 17003

AN UNDERGRADUATE-CHEMISTRY COMPUTER CONFERENCE

The Culler-Fried System at U.C. Santa Barbara

Computing systems that require a minimum of specialized language, that present a graphical display of functions, and allow almost immediate response to student inputs, hold a particular interest for teachers in undergraduate chemistry courses. The Culler-Fried system developed at the University of California at Santa Barbara meets these criteria, and the use of such a system in a physical chemistry course was the subject of a conference held there last January under the direction of Dr. David O. Harris, Department of Chemistry, University of California at Santa Barbara.

As a result of the conference, extension of the system to nine localities throughout the country all tied to the Santa Barbara computing center has been proposed, and support is now being sought from the NSF. If funding is obtained for this one-year experimental program, this attractive on-line computing system will be available for a variety of chemistry instructional purposes.

In describing his experiences with a physical chemistry course which made very extensive use of the Culler-Fried on-line system, Dr. Harris commented,

"The on-line user communicates with the central computer via a teleputer console having an operator-operand keyboard for input.

"The highly interactive nature of the system along with its ability to conveniently handle the various mathematical operations which occur in many areas of the physical sciences led us to initiate a program to explore the use of the system in conjunction with the junior level physical chemistry course given at UCSB . . .

"Since the OLS is particularly useful as the basis for a mathematical laboratory, this was the approach that was taken; the students were given problems to solve which required them to devise the mode of solution and in so doing they discovered for themselves properties of model chemical systems which they otherwise would not have seen. To assist them, however, we did provide them with a set of basic mathematical subroutines along with a set of problems which were worked out in detail to illustrate the use of the system."

Dr. Gen J. Culler, one of the developers of the system used at UCSB, describes some of the features of the system in this way:

"The user of the system is able, using only the concepts of classical mathematics, to create his own user's 'language'. The result is a language whose elements can be manipulated in much the same fashion as one composes mathematical techniques. Furthermore, these elements can easily be modified and adapted to new problem-solving environments so that the user's computing capability grows with his understanding of the problems."

An example of the displays that are obtained in the problems dealt with in Dr. Harris's course is provided by the first and second eigenfunction plots for the Morse potential function. Extensions, such as this, beyond the most easily handled examples, the harmonic oscillator potential function in this example, can be readily incorporated in a regular course.

Systems such as that developed at Santa Barbara seem to provide many of the features that are needed for computer use in fairly elementary chemistry courses to develop beyond the present stage where use depends on a very favorable local situation.

Advisory Council on College Chemistry

Department of Chemistry, Stanford University, Stanford, California 94305

The Advisory Council on College Chemistry, an independent group of chemists, has as its goal the improvement of undergraduate chemistry curricula and instruction. The Council collects and disseminates information through the activities of standing committees on Freshman Chemistry, Curriculum and Advanced Courses, Teaching Aids, Teacher Development, Science for Non-Science Majors, Two-Year College, and Resource Papers. Additional *ad hoc* groups act as necessary to further assist the Council in providing leadership and stimulus for imaginative projects on the part of individual chemists.

The Council is one of a group of collegiate commissions supported by grants from the National Science Foundation.

The AC_3 Newsletter is issued as one of several types of publications distributed by the Council. All correspondence and requests for publications should be addressed to:

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