1953 Meeting of

THE MIDWESTERN ASSOCIATION OF CHEMISTRY TEACHERS IN LIBERAL ARTS COLLEGES

held at

The Institute of Paper Chemistry and Lawrence College

Appleton, Wisconsin

October 16, 17, 1953

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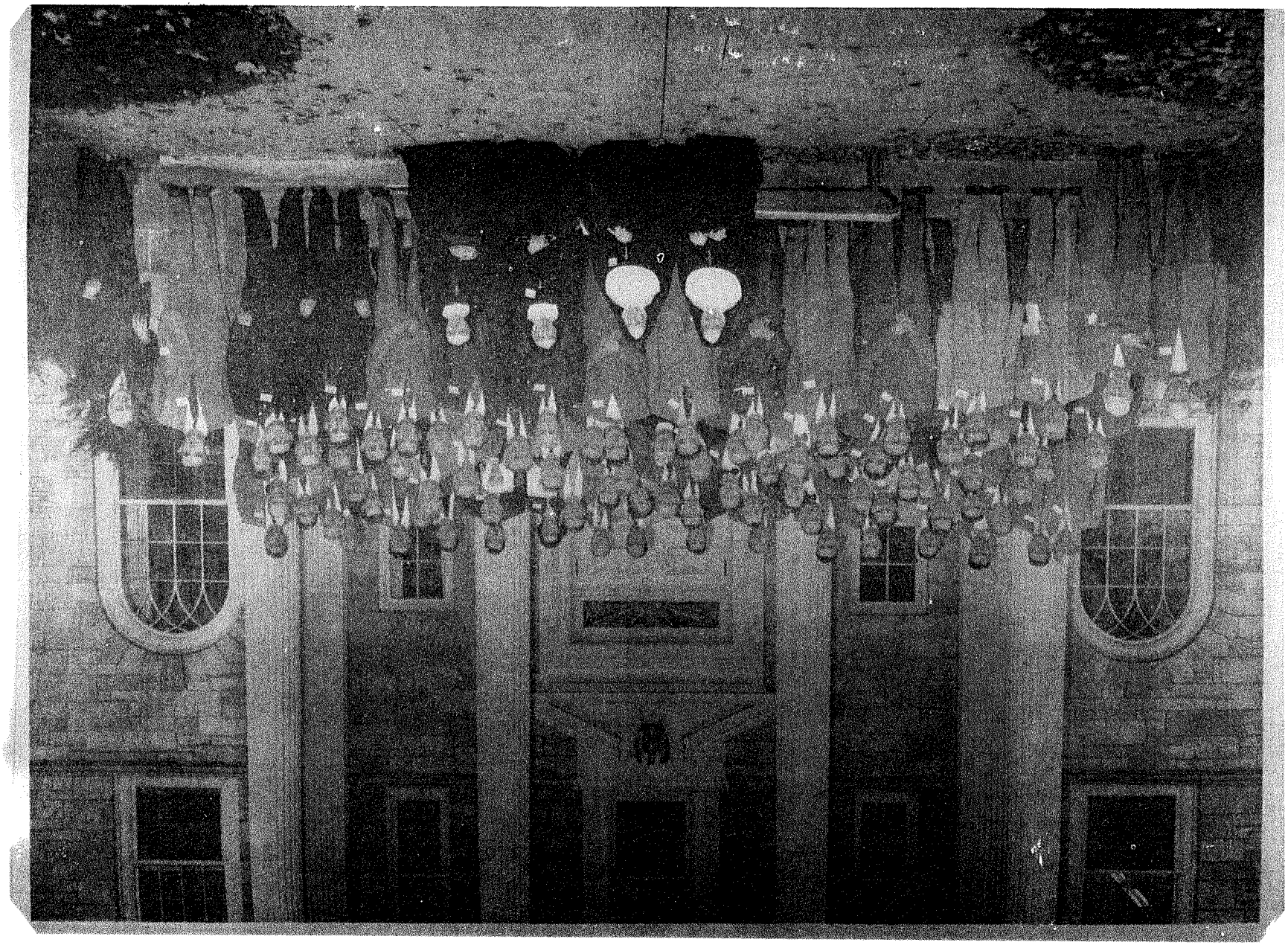

Row 1: Sister Marie James, Mother Antonine, Sister Loyola, Sister Agnes Clare

Row 2: Ben Shawver, L. B. Howell, C. E. Ronneberg, J. A. Ricketts, L. L. Motiff, E. L. Pool, W. C. Oelke, M. C. Paulson, J. J. Sjoblom, W. R. Kirner, C. H. Schauer, W. E. Thwaite, Jr., Brother I. Jerome, Brother I. Ambrose, J. A. Campbell, L. E. Wise

Row 3: J. E. Todd, S. M. Parmerter, R. V. Sinnett, S. F. Darling, B. H. Peterson, G. W. Thiessen, Rev. R. J. Dolter, R. F. Marschner, E. L. Haenisch, H. F. Lewis, J. L. Dalton, B. Nelson

Row 4: A. B. Stowe, R. G. Larson, F. Mathews, Rev. P. Pritzl, F. Fromm, E. W. Phelan, L. E. Steiner, C. L. Agre, E. O. Ellingson, E. L. Hill, G. Van Zyl, E. Underhill

Row 5: H. B. Van Valkenburgh, R. I. Grady, H. A. Chase, L. Oyster, J. H. Shroyer, Mrs. D. W. Gier, W. A. McMullen, P. A. Moore, C. D. Starr, Sister M. Marina, Sister M. Martinette, E. O. North, G. H. Reed, W. F. Bailey

Row 6: B. Bornong, P. M. Wright, D. W. Gier, H. A. Fiess, K. L. Hamm, Mrs. I. A. Koten, I. A. Koten, B. R. Bluestein, M. Armstrong, W. L. Silvernail, N. A. Anderson

Row 7: P. A. Merkle, E. C. Fuller, J. C. Hayes, E. Weaver, D. Mowery, H. R. Weimer, F. G. Edson, E. H. Lyons, Jr., E. O. Wiig, M. Cherry, L. O. Smith, J. Danforth, A. A. Sunier, W. P. Cortelyou, J. B. Culbertson, Homer Coppock
(front) (back)

THE MIDWESTERN ASSOCIATION OF CHEMISTRY TEACHERS IN LIBERAL ARTS COLLEGES
Appleton, Wisconsin, Oct. 16-17, 1953

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THE MIDWESTERN ASSOCIATION OF CHEMISTRY TEACHERS IN LIBERAL ARTS COLLEGES

Historical Statement

E. L. Haenisch,
Wabash College

As a part of the centennial celebration of Monmouth College in 1952, the chemistry department, under the leadership of Professor W. S. Haldeman, invited to the campus as guests of the College for a conference on teaching the chemistry faculties of a large number of neighboring institutions. In issuing the call for this conference, Professor Haldeman stated, "It is ironical that many of us have labored so long in the same geographical area and during this time have gotten to know so little of one another. If this conference serves to widen and deepen our acquaintance and to give us insights with respect to our work, it will have been a worthy feature during Monmouth's anniversary year."

The Monmouth group patterned their program in miniature along the lines of the workshops so successfully sponsored each June by the Division of Chemical Education of the American Chemical Society, the main feature of which is intensive discussion in small groups. Edward L. Haenisch of Wabash College was asked to serve as director of the conference which selected as its theme, "An Evaluation of the Teaching of College Chemistry in Liberal Arts Colleges."

Ninety representatives from 53 colleges (principally midwestern liberal arts colleges, but including a few state institutions which were neighbors of Monmouth) attended the meeting. They heard challenging addresses delivered by Dean Harry F. Lewis of The Institute of Paper Chemistry, Professor Alfred Garrett of Ohio State University and Dr. E. H. Volwiler, President and General Manager of the Abbott Laboratories. They formed six discussion groups organized around common teaching and administrative problems.

The response to this type of meeting was so great that at the concluding session on Saturday afternoon, November 15, 1952, those in attendance spontaneously decided to form some sort of a permanent organization which would hold a similar meeting at least annually. There was an immediate invitation from Dean Lewis to hold the 1953 meeting at Appleton, Wisconsin. This was accepted and the following organizing committee was elected with one representative from each of the states to be included in the organization.

Illinois--Ben T. Shawver, Monmouth College (Secretary)
Indiana--Edward L. Haenisch, Wabash College (Chairman)
Iowa--James B. Culbertson, Cornell College
Michigan--Gerrit Van Zyl, Hope College
Minnesota--Perry A. Moore, Hamline University
Missouri--Delta W. Gier, Park College
Wisconsin--Frederick J. Mathews, Beloit College

During the ensuing year this organizing committee, by correspondence, struggled with such problems as qualifications for membership, possible participation in a co-operative scheme with the JOURNAL OF CHEMICAL EDUCATION, and what sort of dues to levy. It seen became apparent that these problems would eventually have to be

settled by the membership itself. At a meeting in conjunction with the Chicago A.C.S. meeting the Committee did decide to limit the invitations to the 1953 meetings to liberal arts colleges in the seven state area except for such guests as Dean Lewis elected to invite.

An enthusiastic group of chemistry teachers gathered at The Institute of Paper Chemistry, Appleton, Wisconsin on October 16 and 17, 1953. They were most cordially entertained by the Institute and Lawrence College. The details of this meeting are a part of the report which contains this historical statement. Summaries of the Monmouth discussions were sent out in October 1953 to all who attended that conference. These proceedings were also distributed to those at Appleton.

At a business meeting which concluded the 1953 program the following action was taken.

(1) The qualifications for membership were unanimously adopted as: "Active membership in the Association shall include those persons who are teachers in direct charge of courses in chemistry as regular faculty members in the non-tax-supported, primarily liberal arts colleges in the seven state area set by the Monmouth meeting. Persons not directly engaged in the teaching of chemistry in such colleges but definitely interested in the Association's program may be elected by a majority vote of the council to associate membership."

(2) The present organizing committee was reelected to formulate a constitution and to present it at the next meeting.

(3) An invitation to hold the 1954 meeting at some convenient time in the fall on the campus of Grinnell College was accepted.

(4) The Secretary was unanimously authorized to circularize department heads in the colleges concerned and ask them to collect and send in $1.00 dues from each staff member who wanted to join the Association.

PROGRAM

FRIDAY, OCTOBER 16

9:30 - 12:00 a.m.	Visit to the Lakeview Mill of The Kimberly Clark Corporation
1:30 - 3:00 p.m.	Registration--General Activities Building, The Institute of Paper Chemistry. Guides will be available to take Conference members around the Institute buildings.
3:00 p.m.	Open Conference session--The Institute auditorium.
3:45 - 5:30 p.m.	Discussion Groups
6:00 p.m.	Dinner for Conference members and wives. Riverview Country Club. Your host--The Institute of Paper Chemistry
7:30 p.m.	Panel meeting--The Institute auditorium. Subject: The Institute of Paper Chemistry, Its Purpose and Program. Panel members from the staff of the Institute.
8:45 - 10:15 p.m.	Discussion Groups

SATURDAY, OCTOBER 17

8:30 - 9:45 a.m.	Discussion Groups--General Activities Building
9:45 - 10:15 a.m.	"Coffee and."
10:15 - 11:25 a.m.	Discussion Groups
11:30 - 12:20 p.m.	Inspection of the Lawrence campus with its new buildings.
12:20 p.m.	Lunch for Conference members and wives at Brokaw Hall. Your host--Lawrence College
1:45 - 3:00 p.m.	Panel meeting--The Institute auditorium. Subject: Research in the Liberal Arts College Panel Members: Walter R. Kirner, National Science Foundation Robert F. Marschner, Standard Oil Company of Indiana Earl W. Phelan, Argonne National Laboratory, A. E. C. Charles H. Schauer, Research Corporation R. I. Grady, College of Wooster E. L. Hill, Augustana College I. A. Koten, North Central College G. W. Thiessen, Monmouth College G. Van Zyl, Hope College Moderator: Harry F. Lewis, The Institute of Paper Chemistry
3:15 p.m.	Business meeting--The Institute auditorium.
4:30 p.m.	Adjournment

DISCUSSION GROUPS

Following the arrangements of the Monmouth meeting, the Conference first met in General Session, in which its members selected the subjects for six different discussion groups. Three of these elected to deal with general curriculum matters, a fourth--the design of the chemistry building and its facilities, a fifth--the accrediting of college chemistry departments, and a sixth--manpower, recruitment, and selective service.

The various discussions were actively pursued. The written summaries which follow at best do little more than touch on the coverage.

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GROUP 1 -- Undergraduate Research, the Seminar, and Most Effective Use of Time Available for the Undergraduate Chemistry Program

E. C. Fuller, Beloit, Chairman; Brother I. Jerome, St. Mary's, Recorder.

Participants:

M. C. Paulson, Bradley University; Charles D. Starr, Cornell College, Perry A. Moore, Hamline University; George H. Reed, Knox College; S. F. Darling, Lawrence College; W. F. Bailey, MacMurray College; G. W. Theissen, Monmouth College; Sister Mary Marina, B.V.M., Mundelein College; L. E. Steiner, Oberlin College; Roy G. Bossert, Ohio Wesleyan University; Bernard Bornong, St. Ambrose College; Brother I. Jerome, F.S.C., Saint Mary's College; C. L. Agre, St. Olaf College; Harold A. Fiess, Wheaton College; Edward C. Fuller, Beloit College.

The first piece of business conducted by this group, following the nomination of a chairman and secretary, was the formulation of the following agenda:

1. The Impact of General Education on the Chemistry Curriculum
2. The Seminar
   A. The voluntary seminar
   B. Seminar for credit
3. How to most effectively use the time available for the undergraduate chemistry program
   A. Advanced work for the gifted student
   B. Most desirable order for courses offered during the college chemistry program
4. Comprehensive examinations for chemistry majors

At the invitation of the chairman the group approved for their first topic of discussion, "The Impact of General Education on The Chemistry Curriculum." Attitudes toward general education science courses ranged from definite and active concern to a desire to be completely separated from any such courses.

Several members of the group described types of general education science courses that they had either taught or were taught in their schools. These ranged from the course taught by one individual of varied background including several sciences to the type of course handled by several individuals each specific science being taught by the individual in that field. The common opinion seemed to be that such courses were difficult to integrate, and that the standards were somewhat difficult to maintain.

At this point one of the members proposed that a properly taught introductory course should realize all these objectives of a general education type of science course. Exception to this was taken on the grounds that rather specific objectives are expected of general education type courses and the specific science course would not be accepted in fulfilling what would be expected of such courses.

Further experiences with general education science courses emphasized the difficulty of achieving a satisfactory result as well as the fact that the whole field of general education is far from settled or completely stabilized.

In summing up the attitude of the group toward general education science courses the chairman offered these alternatives:

1. An integrated course dealing with all or a number of the physical sciences should be developed by the science department staff.

2. Teach an elementary science course in such a way as to realize the suggested objectives to be achieved in general education science courses.

3. That students should be separated according to majors and non-majors and the non-majors be taught a course so as to realize general objectives.

4. Ignore the issue, if possible, of general education science courses.

At this point the group adjourned for dinner.

When the evening session convened it was decided to continue the discussion on general education. The idea of presenting the elementary chemistry course in such a way as to realize the objectives of a general education course was developed at some length.

The use of problems to challenge the student with care not to allow the course to become too much of a repetition of the high school course, and with as much allowance as possible for individual differences are points that were indicated as important in realizing a really effective elementary science course.

Lecture demonstrations were offered as effective teaching tools in realizing better results in teaching the elementary chemistry course.

The meeting adjourned at 10:20 p.m.

At the Saturday morning session the remaining points on the agenda were discussed, the first to be taken up was the seminar. Various systems as used in the different colleges were reviewed by representatives from these schools. The methods of handling the seminar were varied and the material covered in the seminar presentations ranged from literature reports to reports of student research. One example of a typical seminar procedure consisted in providing the one responsible for the seminar report with a set of guide questions that were to be looked up in the literature and made the matter for discussion. In another instance the seminar report consisted of analysis of research reports found in the literature. Student research, another approach to the seminar, after being edited by the faculty director was presented by the student before his fellow students as well as faculty people. It was thought that opportunities of this kind for the student to present a report before his fellow students were most valuable learning experiences.

At this point the idea of courses in the use of chemical literature was brought up and the general feeling was that such instruction, however accomplishe was very important in the undergraduate chemical education program.

The inclusion of undergraduate research in the chemistry major's progra brought forth a wide range in opinions. Generally all thought that if time permitted it would be desirable to include some research so as to introduce the stud to the idea of just what comprised research. The time element, in that there is most cases insufficient time to get all the courses into the program, caused some to suggest that research might be incorporated in the work of some of the advance chemistry courses.

The final point of discussion was the comprehensive examination. Many schools had employed it with some success and then had discontinued these examina tions because of the difficulty of implementing their administration or for some other reason. Some had found the comprehensive examination unsatisfactory in tha they disrupted the student's last few months due to the preparation for such examinations. Of the fifteen schools represented six administered comprehensive examinations currently and the attitude toward them was certainly not any common one to a majority of the schools.

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GROUP 2 -- The Chemistry Curriculum in the Liberal Arts College

Frank O. Green, Wheaton, Chairman; J. A. Ricketts, DePauw, Recorder

Participants:

Edward Hill, Augustana College; B. R. Bluestein, Coe College; John A. Ricketts, DePauw University; Edwin L. Pool, DePauw University; Warren A. McMullen Greenville College; W. C. Oelke, Grinnell College; Editha Underhill, Rockford College; R. G. Larson, Valparaiso College; Frank O. Green, Wheaton College; Roy I Grady, Wooster College; Walter R. Kirner, The National Science Foundation.

The topics that were discussed and the conclusions that were reached may be summarized as follows:

1. Research in the liberal arts college.

A research program should be carried on by the chemistry department. Doing research will produce better teaching of chemistry. Industrial and governmental research in the liberal arts college is desirable. With this support equipment can be purchased; the teaching faculty might be financed during the summer months in doing the research; and by incorporating the students in the research program, their interest in chemistry would definitely be stimulated.

However, it was emphasized that the primary purpose of the chemistry teacher is the teaching of chemistry. A too ambitious research program by the chemistry department would lead to a lower caliber of instruction.

2. How much mathematics does the chemistry major need?

In general the chemistry major from the freshman through the senior level needs a firmer foundation in the mathematics and its chemical applications. The student's lack of mathematical "know how" was traced to the attitude of the mathematics departments. That is, those mathematics departments who teach mathematics for mathematics sake, stressing mechanics of solution instead of principle. A strong foundation, therefore, is the responsibility of the chemistry department. This strengthening can be accomplished through actual course work (more problems of the thought type) and if possible, a special course (senior level) in the mathematics for the chemist which should include a review of algebra through differential equations might be taught.

3. The present chemistry curriculum.

Chemistry departments should critically survey their present curriculum and in many instances streamline their offerings so as to give the student a stronger foundation in the basic fields of chemistry. This goal can be realized by a 40 to 45 hour requirement.

Although the chemistry major receives a professional training, the teacher of chemistry must not be blind to the values of the "liberal arts" training.

4. The chemistry department and the pre-medical student.

In many institutions upper level chemistry courses for pre-medical students are divorced from those courses for professional chemistry majors. This adds to the individual instructor's teaching load. A survey of the chemistry requirements of the pre-medical student by the chemistry department might reveal a method whereby the duplication might be avoided. This approach might be particularly fruitful if the organic chemistry and the analytical chemistry courses are considered.

The policy of independent recommendations for each medical student was severely criticized. It was pointed out that in many instances the teacher wrote his recommendation after having observed the student in only one course.

Consequently, he could not completely evaluate the pre-medical student's capabilitie To alleviate this situation the "group reference plan" was suggested. The individua instructor will still write the recommendation; however, he would have access to the opinions of all the teachers in the physical and biological sciences as to the stude capabilities. These data might be catalogued on personal file card. The card would be compiled by each instructor after having contacted the student in one of his scie courses.

5. Advanced work for the chemistry major.

Advanced work will be defined as those courses over and above the basic work included in general chemistry, analytical chemistry, organic chemistry, and physical chemistry courses. Some plan of advanced work in chemistry should be inco: porated into the chemistry curriculum. This work should preferably begin in the junior year. The various suggestions that were offered can be summarized as follow

A. Senior research is desirable as it introduces the student to the original thinking which must be used in any scientific endeavor. In addition the importance of the chemistry laboratory to the chemist is emphasized.

B. The advanced work may take the form of additional courses such as Advanced Inorganic or Advanced Organic chemistry. The purpose of these courses sho be to cover additional material and to give the student an insight into what lies ahead if he enters graduate school.

C. Seminar courses can be offered. These should be open to both the junior and senior majors. The subject matter should concern those phases of chemis not normally stressed in the formal course work. In preparing for a seminar the student will become conscious of the chemical literature and the disciplines involv in using the chemical library.

D. The careful design of some laboratory experiments is encouraged, especially in the upper class laboratories. The types of experiments which appeal to the student are instrumental determinations in quantitative analysis, a 3 or mor step synthesis in organic chemistry, and experiments in physical chemistry which can yield precise results.

In the freshman and sophomore year the laboratory must be handled in a manner so as to compel the student to plan his time in the laboratory. The tendenc for "time wasting" might be eliminated by closing the laboratory promptly at a definite time.

6. The use of audio-visual aids in chemistry.

This panel recommends that this Midwestern Association of Chemistry Teachers appoint a committee to investigate and evaluate the usefulness of audio-visual aid techniques to the teaching of chemistry especially in course work above the freshman. This committee should survey what films are available and suggest what films should be available.

* * * * * * *

In three of the colleges which offer separate courses in Qualitative Analysis, it is preceded by Quantitative. This permits more drill on theory, and is considered quite successful by the schools using this sequence.

2. Organic Chemistry.

In a discussion of course sequence, it was found that six of the college represented offer Organic Chemistry normally in the Sophomore year instead of later The main advantage suggested for this sequence is that it presents a broader view of the field of chemistry in the first two years than when analytical chemistry follows the general course. Three members of this group expressed the opinion that the number of chemistry majors has been increased somewhat under this plan.

A survey of textbooks showed that those books using electronic interpret tions are favored strongly.

In a discussion of laboratory, it was found that fourteen colleges give two laboratory periods a week, and five offer only one period, but generally find that make-up sessions are necessary. In the teaching of laboratory, many members of the group advocated the use of relatively few experimental projects done quite fully, with the use of library facilities whenever possible. It was felt that this approach is considerably more feasible in small classes than in large ones. One member of the group recommended including an evaluation of the chemical products of student experiments in grading the work of small laboratory classes.

3. Physical Chemistry for Premedical Students.

Two of the colleges represented have solved the problem of fitting Physical Chemistry for premedical students into the curriculum by offering a one-semester course without calculus as a prerequisite. One other college sections the Analytical course so as to give premedical students two hours of Physical and two of Analytical instead of the four hours of Analytical offered in that semester to Chemistry majors.

4. Courses in addition to those in the basic program.

A total of eleven different advanced courses are offered by the colleges represented, with "Research," Qualitative Organic, Biochemistry, Instrumental Methods and Advanced Organic most widely given, in that order. Further work in the last two fields is also frequently offered as part of the work in other courses mainly in Quantitative Analysis. In addition to this, nine colleges offer or requi a seminar course for majors, frequently starting in the Junior year. The emphasis of seminars varies widely; in some cases it is mainly on research reports, in other on journal reports, and in others on the consideration of topics which have been dealt with only briefly in previous course work.

"Research" was discussed at great length, as it is offered almost universally, is conducted in a wide variety of methods, and may or may not bear credi The choice of projects may stem from student interest, or be a part of the researcl or field of interest as a member of the department. The group as a whole felt str that the choice of subject is much less important than the introduction to the met of research: reference to literature, planning the approach to a problem, laborato procedure and the preparation of a written report.

The question was raised as to the advisability of offering so much advanced work in the major field. It was generally felt that under no circumstances should the basic courses be slighted in order to allow a heavy program of extra courses. Also, it was emphasized that the broad background of the liberal arts student should not be decreased, and that chemistry majors in liberal arts colleges then have to take more than the 120 hours generally required for graduation.

5. Comprehensive Examinations.

Eight of the colleges represented now give and recommend comprehensive examinations as motivation for review and correlation of material. Five colleges give examinations in the major subject only, and two use the Graduate Record Examination with additional questions in Chemistry. Considerable interest was expressed in the examination given at Park College, which stresses Chemistry and its relation to other fields, with members of other divisions on the examining board. Dr. Gier was asked to bring samples of questions used to the next meeting of the Conference.

It was felt that the examination should be given early enough in the second semester of the Senior year that it does not interfere with final examinations, and in a few cases colleges give a second examination during the same year for a student who has failed once. Outside examiners are not now used to any extent, partly because they are not easily available, but a method of exchanging questions with other schools was mentioned. Preparation for the examination itself does not apparently take too much extra work on the part of the student, as he is working toward it from the Freshman year. Also, seminars are frequently used to guide students in integrating material in preparation for the comprehensive.

6. Purposes of the Laboratory in the Introductory Course.

All of the colleges represented require one or two laboratory periods each week in the introductory course, with the exception of three of the courses for nonmajors, in which lecture demonstrations are substituted. The group felt strongly that laboratory work should be given; and after considerable discussion the following were selected as the main purposes of the laboratory and reasons for its inclusion in the basic course: (1) developing powers of critical observation, (2) meeting problems on an experimental basis, (3) teaching basic techniques, (4) improving communication through the writing of clear reports, (5) arousing interest in the student. Again, it was generally felt that fewer experiments, well-planned, written and understood, are preferable to a large number of "test-tube" experiments.

7. The Place of Lecture Demonstrations in the Introductory Course.

It was felt by most of the group that lecture demonstrations are valuable in presenting chemistry as an experimental subject, as long as they are planned so as to avoid confusion. One member of the group uses only such demonstrations as present drill on quantitative relationships. It was emphasized that laboratory work should not be duplicated. The problem of time and the availability of the lecture room was stressed, and one solution was proposed; namely, that a series of materials for the lecture demonstrations for an entire

year may be prepared in about a week in the summer and kept in special drawers until needed.

The group recommended that the following topics, which could not be discussed at this time, be considered for a future meeting of the Conference:

(1). The historical approach to the basic course.

(2). The aims of the course in Quantitative Analysis, and its relation to other courses in the curriculum.

(3). The nature and extent of extra-curricular departmental activities.

(4). Methods of promoting increased use of library facilities.

(5). Specialized courses for nonmajors.

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GROUP 4-- New and Rebuilt Chemistry Buildings

Paul M. Wright, Wheaton, Chairman; C. E. Ronneberg, Denison, Recorder; H. F. Lewis, Institute of Paper Chemistry, Resource Person

Participants:

N. Arthur Anderson, Illinois College; Mother Antonine, College of St. Catherine; Maurice Armstrong, Millikin University; Harold A. Chase, Wheaton College; Sister Agnes Clare, College of St. Teresa; Sister Loyola, College of St. Teresa, Bernard A. Nelson, Wheaton College, Edward O. North, Lake Forest College; Conrad E. Ronneberg, Denison University, R. V. Sinnett, Ohio Wesleyan University; L. O. Smith, Valparaiso University; Harry R. Weimer, Manchester College; Paul M. Wright, Wheaton College.

This discussion group gave consideration to numerous questions pertaining to present trends in the construction of chemistry or science buildings in small Liberal Arts Colleges. It was soon recognized that it was not possible to give categorical answers to many of the questions that were raised. Nevertheless, the discussions were very fruitful in showing current trends in science buildings. The visit to the recently remodeled Stephenson Hall of Science at Lawrence was very informative. Visits to the new Worcester Art Institute and the new Student Union at Lawrence brought out the many building economies in one floor construction.

It is worthy of note that this discussion group included representatives from ten institutions which have either recently finished new building facilities for Chemistry, have new buildings in the planning stages, or contemplate building within four years.

In the following summary reference will be made to some of the topics discussed at considerable length with pertinent remarks or conclusions.

1. "In general, is it wise to attempt to modernize and enlarge an old chemistry building?" The group agreed that the answer is no! The process is always very expensive. Frequently the end result is inadequate and inefficient--it still remains an old building.

2. "What are simple and reasonably reliable bases for estimating the cost of a modern science building?" It depends somewhat on local conditions, but the following are suggestive:

The newest building at The Institute of Paper Chemistry, finished in 1953, had the following actual cost figures: $1.07 per cubic foot or $14.71 per square foot. This is a modern building with two floors and basement. It should be noted that this building contains no laboratories.

The authorities at Wheaton College, in planning their new science building, have been using cost figures supplied by a reliable firm of architects: $1.30 per cubic foot or $22.00 per square foot.

3. "On the basis of recent building experience, what is the cost of laboratory furniture and equipment?" In general, this will range from 20 to 30 percent of the actual building costs; it may even go higher depending on the equipment.

4. "For what period of time should a modern science building be built?" Because of the rapid rate of absolescence of science buildings, it might be desirable to plan for a building life of not much more than twenty years; this is seldom if ever done. A definite decision as to the planned life of a science building is important because it directly influences the type of construction and thus the building costs.

5. "What about one floor versus multifloor science buildings?" There are many definite advantages in one floor chemistry buildings. The initial cost is less because it permits cheaper wall construction; there is less fire hazard; there is better light, greater convenience in building lay-out, and there is no wasted space in stairways, etc. Many recently built industrial chemistry buildings are of this type. The new chemistry building at Reed College is an example of one built at a cost of only $130,000. The Reed College science buildings will eventually take care of the departments of chemistry, physics and biology and with all facilities on one floor.

Refer to Chemical and Engineering News, Vol. 24 (1946), page 2187, for a discussion of the advantages of a one floor plan.

6. "Should there be a 'working library' in the Chemistry building?" It was the consensus of those present that every chemistry department should provide a "working library" in a well-appointed room in the chemistry or science building.

7. "What about the location of offices of staff members?" In general, these should be in the front of the building.

8. "What principle should be followed in the location of the storeroom?" In terms of long time economy of operation, the storeroom should be centrally located in order to serve all the science laboratories. There are definite advantages in having labcratories visible from the storeroom.

9. "What is the best material for laboratory table tops?" There is no "best" material. Each kind of table top has certain disadvantages. Old fashioned soap stone (Alberene) is still available but it is hard to obtain. Delivery is very slow.Plastic impregnated sandstone (Kemrock) is excellent. Care must be taken with stone tops to prevent uneven strains resulting from temperature differentials. Stainless steel is easily attacked by certain chemicals such as hydrochloric or hydrofluoric acids. Modern laminated wood tops are excellent but require frequent maintenance. The selection of a material for table tops calls for a series of compromises involving availability, cost, ease of maintenance, etc.

10. "What about 'inside' versus 'outside' lecture rooms?" The group favored inside lecture rooms. They are quieter and the control of lighting is usually a simpler matter than in the case of an outside lecture room. Ease of control of lighting is important in connection with the use of visual aids.

11. "What about the respective merits of steel versus wood laboratory furniture?" This apparently is a matter of individual preference. Modern steel furniture has very little maintenance cost, never "sticks" and is very serviceable.

Most of the recently constructed industrial research laboratories have used steel furniture. The trend seems to favor steel furniture.

12. "What are some reliable, recent publications dealing with construction of chemistry buildings for small liberal arts colleges?" Consult:

"Laboratory Design," H. S. Coleman -- Reinhold Publishing Company, 1951, New York, New York

"General Problems of Laboratory Design," Harry F. Lewis, J. of Chem. Ed., 24: 330, 1947.

"Housing for the Small College Chemistry Department," Chem. and Eng. News, 24, 2187 (1946).

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GROUP 5 -- The Accrediting of College Chemistry Departments by the American Chemical Society

E. O. Wiig, University of Rochester and member A.C.S. Committee on Professional Training, Resource Person; Brother I. Ambrose, St. Mary's Recorder.

Participants:

Resource person, E. O. Wiig, University of Rochester and member A.C.S. Committee on Professional Training; Perry A. Moore, Hamline; Walter L. Silvernail, Illinois College; Rev. Robert Dolter, Loras; B. T. Shawver, Monmouth; W. P. Cortelyou, Roosevelt; Rev. Peter Pritzl, St. Norbert; Brother I. Ambrose, St. Mary's, Recorder.

The discussion of this group consisted of a brief introductory statement of the philosophy of the Accrediting Committee followed by a question session. In both of these activities Dr. Wiig served as the source of information as the topic did not lend itself to a discussion of the usual type.

PRELIMINARY REMARKS:

The primary purpose of the "Approved List" is to determine which graduates in chemistry shall be eligible for full membership in the A.C.S. Therefore, the Committee seeks to evaluate the complete education of the student. In doing this the Committee examines the over-all department rather than specific courses or requirements. However, a statement of minimum requirements is available from Mr. John Howard, Secretary of the A.C.S. Committee on Professional Training, 345 State St., Rochester, New York.

CURRICULUM:

In addition to the regular four department sequence the A.C.S. requires some advanced work. This will consist of 3-4 hours per week of laboratory for one semester and 2 hours per week of lecture for one year. However, as in all of its requirements, the A.C.S. permits considerable local variation in the application. Student research or a student thesis might be equivalent to a laboratory course. Or the thesis may require consultation with the advisor which will be equivalent to an hour per week of lecture. All local situation which makes actual practice somewhat different from catalogue statements should be brought to the attention of the Committee. Along this line it should be noted that a course with a certain number of listed lab hours may regularly actually involve several more. This will commonly apply to courses in Qualitative Analysis.

The Physical Chemistry course should use Calculus.

German should be used, usually in Organic. It follows from this that there be foreign language or German journals in the library. Beilstein can be considered as a minimum.

STAFF:

It is not true that a two or three man department cannot be accredited. However, it is difficult to offer the required courses with such a small faculty and maintain a reasonable load. This can be done with a very efficient organization utilizing senior students as assistants at the freshman level and a scheduling of coincident laboratory periods. The latter idea means, for example, to provide one instructor for an elementary organic and an advanced organic laboratory period occurring simultaneously.

A reasonable maximum teaching load is considered as fifteen contact hours.

Half of the staff should have the Ph.D. degree.

Part-time teachers should be included in the size of the staff by summing up the fractions representing the share of their time devoted to Chemistry.

MISCELLANEOUS:

Lecture sections may run to rather large sizes but recitation sections should not exceed thirty members.

The Accrediting Committee is interested in the achievement records of graduates in Graduate Schools.

Not all of the graduates must carry the full forty four-hour curriculum. An institution may submit a list of names of those students who have graduated under the A.C.S. requirements. It is true that the recognition

involves the entire department but the main reason for it is always the admission of graduates to full A.C.S. membership.

The full program should be in operation for at least one year before a college should expect to be added to the list of approved departments.

Some advanced courses may be offered in alternate years if it is still possible for a student to include everything.

There is no minimum listed by the Committee regarding a library requirement. But there should be a "number" of journals.

The usual obstacles met by a department seeking approval are the size and teaching load of staff.

* * * * * *

GROUP 6 -- Manpower, Recruitment, and Selective Service

J. L. Dalton, St. Ambrose, Chairman; Leone Oyster, Ripon, Recorder; J. E. Todd, Institute of Paper Chemistry, Resource Person

Participants:

J. L. Dalton, Chairman, St. Ambrose College; Loren K. Freeman, Shurtleff College; Robert F. Marschner, Standard Oil Company; Leone Oyster, Ripon College; Earl W. Phelan, Argonne National Laboratory; J. H. Shroyer, Bradley University; Arthur A. Sunier, Carroll College; J. Edward Todd, The Institute of Paper Chemistry; Gerritt Van Zyl, Hope College; Eugene Weaver, Wabash College.

Topic I. Recruitment.

The problem of getting more students in Chemistry from the High Schools into the Liberal Arts Colleges.

The following methods of interesting High School students and teachers in Chemistry and promoting better relations between High Schools and Colleges were suggested and discussed.

(1). Open House for High School science students and teachers. Invitations were sent out to local high school students and to those in near by towns. College students arranged and performed experiments in General, Analytical and Organic Chemistry, gave explanations and answered questions. Another type of Open House called "Scientific Foundations of Local Industries" was also used.

(2). Discussion Groups. High School science teachers were invited to participate. Speakers were obtained from local industries, regional laboratories, etc.

(3). Chemistry Clubs. Field trips to industrial plants and laboratories were sponsored as well as speakers from industries.

(4). Undergraduate Symposia.

(5). Local A.C.S. Groups. Some groups seemed to be especially active in interesting students and the Peoria and Chicago groups were highly commended for work along this line, while other groups seemed to fear competition from young chemists and were disinterested or actively oppositional. The Peoria group sponsors essay contests for high school science students with prizes and scholarships for talented students. The Chicago group sponsors Chemistry Fairs, a special day for high school science teachers and college students at the National Chemical Exhibition. Talks on Vocational Guidance, the Northern Regional Laboratory representing Chemistry on Vocational Day in the High School were tried.

(6). Industrial Scholarships. Some paper mills offer scholarships to local High School students interested in Chemistry or Engineering. Some of these scholarships are ear-marked for certain schools, for certain subjects, for the children of employees, but some are open to anyone.

(7). Travelling Exhibits. This device sponsored by the Great Lakes Academic and Athletic Conference seems successful.

(8). Letter of Appreciation. One professor of Chemistry writes a letter of appreciation to the high school science teacher for any studerts sent. This letter is written soon after college opens.

Underlying Causes for Lack of Interest in Chemistry. A survey was quoted which showed that almost all high school students take General Science, 25% take biology, 12% take Chemistry and 6% take Physics.

(1). Are students afraid of mathematics?

(2). Are students taking the easy path?

(3). Poor Training of High School Science Teachers. In many high schools the teaching of Chemistry is just a side-line for the foot-ball coach, or the science teacher has too many courses or too many outside duties to perform. In some states as little as 16 hours of Chemistry is all that is required to teach High School Chemistry.

(4). Perhaps the above mentioned lack of training accounts for the disinterest of High School Chemistry teachers in the programs of colleges and A.C.S. groups to attract prospective Chemistry students. It was reported that these teachers objected to attending any more meetings, such as open houses, fairs, exhibits, etc., and that very few were interested in joining local A.C.S. groups.

(5). The efforts of industry to stimulate more interest. The refresher courses offered to Science teachers by the General Electric Company and the annual Science Talent Search sponsored by the Westinghouse Company are examples.

Topic II. Scientific Manpower.

When demand is great the supply of prepared students is low. Better students should be encouraged to continue their study in the graduate schools rather than accept an industrial position at the end of the senior year.

(1). Industry is interested in more <u>good</u> chemists, not more chemists.

(2). The Standard Oil Company does not hire chemists with a Bachelor's degree but wants those with advanced degrees. This should be the general practice and students should be made aware of it.

(3). Aid for Students. Only about one third of the students who should attend college actually do so.

(a) Industrial scholarships. Many companies offer scholarships to seniors to encourage graduate study. It was suggested that it would be better to offer scholarships on the undergraduate level as more graduate assistantships are available than there are candidates.

(b) Scholarships for sophomores should be offered as an inducement for freshmen.

(c) Scholarships for freshmen from industry. A neutral board would select the candidate who would be recommended by his high school chemistry teacher. The industrial representative present pointed out that the mechanics of making the proper selection are very great. High School grades are not a valid index and a science talent search is expensive.

Topic III. Selective Service and Scientific Manpower.

The policy to provide for deferment of college students is being threatened by tightening up of the selective service. Since the Universal Military Service failed to pass, the local selective service boards are now operating on that principle.

(1). Colleges should press for deferment of students in natural science

(2). The tendency for local boards is to classify students in 1A. Coll should press for deferment and should cooperate with the graduate school to notify board and press for deferment, and should appeal to the state board and, if that fails, should take the matter to the national board.

(3). Schools where R.O.T.C. is compulsory have no interference from the local board for two years.

(4). When a student can serve best by continuing his study, he should be so advised, in spite of criticism from the draft board.

(5). Selectors should run the first classification on science rather than on military qualification, as is done now by the navy.

Topic IV. Competition Between State Supported Schools and Liberal Arts Colleges.

When enrollment declines, lack of income causes a financial and administrative problem. Small classes are dropped. New equipment and library acquisitions cannot be purchased; therefore, students in upper class courses go to state-supported schools.

(1). Classes should not be dropped or the institution will sink to a junior college level. Student fees in freshmen and sophomore courses should be used to maintain courses where the number of students is low.

(2). Liberal Arts program should be sold to the students.

(3). Undergraduate scholarships should be available for the better students.

(4). Grants from industry should be for the purchase of equipment as well as scholarships. This seems to be the accepted practice.

(5). Tuition scholarships cost more money and are perhaps more inefficient but are better for Liberal Arts Colleges as the student gets more for his money.

(6). The present system of educational aid for veterans is hard on the Liberal Arts colleges as it is cheaper for the veteran to go to tax-supported institutions.

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Panel -- The Institute of Paper Chemistry -- Its Purpose and Program.

Participants: John G. Strange, Vice President-Treasurer, J. Edward Todd, Dean of Admissions, Willis M. Van Horn, Research Associate in Biology, Roy P. Whitney, Research Associate in Chemical Engineering, Louis E. Wise, Research Associate in Wood Chemistry. Moderator: Edwin Schoenberger, Dean of Students.

(The following brief report is a summary of ideas and information presented by the panel.)

The Institute of Paper Chemistry was established in 1929 to provide graduate education in the sciences and technologies of the pulp and paper industry. Its founders had no desire to contribute to a growing vocationalism in American education at that time; rather they sought to build a center for teaching, research, and a library devoted to the basic sciences underlying a centuries-old art--papermaking.

The Institute, originally sponsored by nineteen paper companies in Wisconsin, is now supported by one hundred thirty-one pulp and paper companies with mills in thirty-six states. Its membership, restricted to manufacturers of pulp and/or paper in the United States accounts for more than 75% of the pulp, paper, and paperboard produced in this country. From their number they elect the board of trustees of the institution.

From its beginning the Institute has been affiliated with Lawrence College for the granting of degrees, and the president of the College is automatically a member of the Board of the Institute. However, financially and administratively the two instutions are separate.

The curriculum embracing four years of post graduate study and leading to the Doctor of Philosophy degree, is designed to train scientific generalists who may assume technical positions applying science to the paper industry, do research work on the development of new principles and prepare for higher executive or coordinating positions. The program is designed to integrate fields without regimenting students, to give breadth of training without superficiality, to lead to specialization without narrowness.

The first year emphasizes the fundamentals of chemistry and physics, optional classes in organic chemistry and chemical engineering are adapted to differences in undergraduate training among the students. The topics covered in organic and physical chemistry include carbohydrates, cellulose, lignin, extractives, hemicelluloses, high polymers, colloids, kinetics and thermodynamics. Those in physics include mechanics, hydraulics, heat, and thermodynamics. Courses are also given in wood technology, statistics, and German. The second year gives special attention to the application of scientific principles to technology and processes. During this year the student bridges the fundamental courses of the first year and a study of the operations of the industry. Readings, mill visits,

lectures, and seminars are approached as demonstrations and elucidations of principles, rather than as a means to learn routine techniques. Normally, the Master of Science degree is awarded after successful completion of the work of the first two years.

The third year has two objectives: the training of students in the ways and means of research and the measuring of the students' ability to do research. In the latter function, the program replaces the older qualifying examinations. Each student during the course of the year is assigned three problems and required to propose a fourth. These problems are broad and difficult; theoretically, any one of them or aspect of one could become a thesis topic. No students have the same problem. No problems have been repeated. The student is not expected to find a solution; he is directed to propose a program of research for one or more approaches to the problem. He presents his program in a written report to a special faculty committee assigned to that problem, and within a few days he meets with the committee to explain and defend his attack. The committee's evaluation of his performance is discussed with the student after each problem. After successful completion of the problems assigned to him, the student is accepted as a candidate for the degree of Doctor of Philosophy. He then begins active research on his thesis subject--usually proposed by himself.

An applicant for admission to the Institute must hold a bachelor's degree from an accredited college or university usually in chemistry or chemical engineering. Scholarships enable those who are admitted to pursue their academic program on a full time basis.

Graduates of the Institute are not necessarily research men. The differences in their interests, talents, and personalities determine eventually their function in the industry. They serve in research, development, production, sales, or administration.

A complete library of more than 15,000 volumes and a vigorous program of institutional and co-operative research carried on by the staff contribute to the strength of the academic program.

Panel -- Research in the Small College

Lewis: It is a pleasure to present to this conference by request made during the Monmouth meeting a panel on "Research in the Liberal Arts College." Since this is a scientific gathering, I have converted the panel subject into the form of an equation, namely, $P = kC$ and will attempt to justify the equation following a preliminary reference to two assumptions.

First, I think it is probably safe to assume that we all believe that the country needs more high quality, well trained scientists in line with our expanding economy and in the face of unsettled world conditions. This is equivalent to saying that we need increased productivity of scientists, if I may use the term productivity in relation to the training of scientists (for this conference, of course, chemists); that's the value P in the equation. You probably also appreciate the desirability of doing some research, the value C in the equation. In line with all of this, I assume that your presence here implies that you have an interest in increasing the productivity of your own school and the creativity of your own personal work in the department.

The second assumption is that you remember something of what I said at the Monmouth meeting on "Research in Teaching, Research and Teaching, Research or Teaching," and also that some of you may have been at Los Angeles at the meeting of the Division of Chemical Education where I addressed the luncheon meeting of the Division on the general subject "Activation of the College Research Potential"; this appeared in the September issue of the Journal of Chemical Education with the subtitle "Help for the Little Researcher."

What I should like to develop today before we hear from our panel members has to do with the nature of the relationship between productivity and creativity; is there a direct relationship between the two such as might be expressed even loosely by some constant k. Productivity I have evaluated from the Ph.D. output of the chemistry department; creativity from the research interest of the chemistry department. Can we show that a department is always productive because it is creative, or can a department be productive and not creative? Is a department ever creative and not productive?

Let me first clear up the details of the methods used for the measurement of productivity and creativity or someone will make it embarrassing for me later on. Some analytical chemist in the audience is going to want to know a little bit more about my standard methods.

Productiveness or productivity is most easily measured in terms of the Trytten report. What we might call the "productive index" of a college represents the number of chemical graduates who have earned their Ph.D.'s in the period covered by that report 1936-45. The information is a little out of date but still fairly significant. The "creative index" or creativity is not quite so easy to calculate. There are a number of procedures we might follow. For example, I could write you all personal letters and say that "I wouldn't quote you," and now "How much research are you honestly doing and how good is it?" Then we could assemble the replies and establish the equation which most nearly represents the results. This method could not possibly be objective, for there will be different interpretations by each individual who fills out such a questionnaire and writes

such a letter. Another thing I could do, and I have tried to do this in the past, is to add up the number of pages in the American chemical journals published by each person in the area covered by the conference; that isn't very good either for, as Hartman said [C. S. Hartman, Science 103, no. 2678:493-96(April 26, 1946)], the little researcher is more likely to publish in the journal of the State Academy of Science [and I might add this--in J. T. Baker's famous little publication The Chemist Analyst] than he is in the Journal of the American Chemical Society. Thus this method would be faulty, for one would not be able to catch all such articles in Chemical Abstracts.

What I actually did was to send out postcards to all the colleges listed in the area covered by the conference--123 in all--including a few colleges represented here from the fringe counties in Ohio. On those cards I asked "Whether you had received any financial support for research, who gave it to you, how much, and how are you permitted to use it?" for the period since 1948. The returns have been tabulated and are to be looked upon as literally up to the minute. These data have been used in estimating the "creative index." The actual value represents the total income received specifically for research in the period for 1948 to date in terms of thousands of dollars. Here we have one of the variables in my equation not covered by the value k; namely, I have had to use 1936-45 figures for the productive index and 1948-53 figures for the creative index, and situations change within college generations. Some departments such as were productive in the late thirties and early forties may no longer be productive; some departments such as are not presently creative may have been creative back in those earlier days, although the opposite is more likely to be true. What I should have done, I suppose, was to go down to Washington and look into Dr. Trytten's files for the productive figures for 1946-1950, inclusive. [The summaries for this five-year period are currently at the press, and I have been advised by Dr. Lapp that they will be issued shortly before January, 1954. At the time of final drafting of this report, I had productivity data for 29 colleges.]

I think there is good reason for believing that practically all of the colleges in the area doing research have turned in answers to the questionnaires. My reasoning for believing this is somewhat devious and is predicated on my feeling that productivity and creativity are related, which I hope I can prove to your satisfaction a little later on.

After the returns were in I started playing with my slide rule and found out that the colleges represented by men who returned the questionnaire and are also here at this meeting have a productive index of 9.8. Quite a number of men who were not able to attend the meeting also returned the questionnaires. Their college departments show a productive index of 3.71. Many departments neither returned the questionnaires nor sent representatives to this meeting; their colleges have a productive index of 1.06. If my further reasoning is valid, that colleges having a low productive index also have a low creative index, then their failure to return their questionnaires will affect the total research income to be reported little if any. The majority of these last 60 colleges are probably neither creative nor productive in the sense described in this meeting, although they may be in some entirely different sense.

If the productive schools are generally the creative schools, then I expect we may conclude that not only do you represent the productive schools but also the creative ones. An interesting preliminary statistic from the research reports is that two-thirds of the departments represented here [P.I. 9.8] have research contracts in comparison to only about half for the second group [P.I. 3.71].

The responses to the questionnaire provided an accurate idea of how much money has actually been assigned to the liberal arts colleges of the Middle West for research since 1948. A summary of the returns will be found in Table I.

TABLE I

SOURCE OF RESEARCH INCOME: NUMBER OF COLLEGES REPORTING, 71; NUMBER RECEIVING SUPPORT, 36

Sources	Number of Colleges	Amounts of Money
Income from all sources	36	$286,774
College sources	22	29,050
Research Corporation	24	67,979
National Science Foundation	0	0
Industry	22	58,800
Government	3	100,200
Other	9	30,747

Thus the chemists represented in the Middle Western Conference of Liberal Arts College Chemistry Teachers have received better than a quarter of a million dollars since 1948, with 36 schools in all receiving one or more grants. The average received per school has been $8,000. Twenty-two colleges of the 36 have budgeted money to the chemistry departments for research; that is one way to get research support and a very convincing argument to have when approaching either industry or the Research Corporation for support.

The Research Corporation has allocated $67,979 to 24 colleges in the group in the period since 1948. In a number of cases the individual colleges received more than one grant. Two out of three colleges on the list receiving support had help from the Research Corporation. Out in Los Angeles I must have exaggerated, for there I said that probably every liberal arts college in the country carrying on a good research program owed it to the Research Corporation, but there must be a few here in the Midwest going to other sources for help. Maybe the California climate made me stretch the point to the elastic limit.

Following the Research Corporation in the table is the National Science Foundation. This agency is not currently a source of research support for the Middle Western liberal arts colleges--at least within the scope of our program. Walt Kirner will probably tell us more about this in the panel discussion.

Industry contributed $58,800 to the research programs of 22 colleges. I do not know how many individual grants that might represent, but 61% of the 36 colleges report help from industry. The government is listed as allocating

something better than $100,000, but since only three colleges were in on that program I suspect the government grants, in part at least, came from defense spending and the lasting quality of this source is open to some question. Remaining grants of about $30,000 came in part at least from alumni. This is a hint to some of you who would like financing for research. What about your alumni? The ex-athletes support athletics; the ex-chemistry majors probably would support chemical research if they only knew what you wanted, but here you have to be specific--funds for a particular piece of equipment, support for an undergraduate research assistant, particular books or periodicals, short-term grants, smaller grants asked for regularly when the particular last project is completed; these are the best ways for approaching the alumni.

I would not want you to think that I think the only colleges that do research in the Middle Western group are the 36 receiving grants-in-aid. I know darn well there are a number of others carrying on research of the "research in teaching" variety such as we talked about in Monmouth. Two members of our panel will talk about their "research in teaching" programs.

In Table II the creative and productive indices are summarized; the data have been graphed in Figure 1, using average values for the creative indices as ordinates for schools grouped together by their similar productive indices as abscissas. The formula would appear to be justified, for there is in general a straight line relationship. What I did was to average the research incomes and productive indices of the colleges falling in the 0 to 5 productive index range. The 37 colleges found in this group had an average P.I. of 1.64 and a C.I. of 1.09 (in thousands of dollars). The second classification included the schools having P.I.'s between 6 and 15; their average was 9.0; their average C.I.--3.81. Seven were in the third group of those having P.I.'s between 16 and 30; their average P.I. was 20.4; their average C.I.--9.50. I have also included the average value for all the colleges in the graph as well as the averages for the colleges reporting and here (Class I) and for the colleges reporting but not represented here (Class II). And for the seventh point I have used the 1946-50 productivity figures sent me by the Office of Scientific Personnel of the National Research Council, with the appropriate creativity figures developed from the questionnaire. Point 7 is not too far off the straight line.

TABLE II

RELATION BETWEEN PRODUCTIVITY AND CREATIVITY FOR DIFFERENT CATEGORIES

Category	P.I. Average	C.I. Average	Reference Number Figure 3
Average of 60 colleges	7.7	3.04	1
Average of 39 colleges, Class 1*	9.8	3.6	2
Average of 21 colleges, Class 2**	3.71	1.99	3
37 colleges, 0-5 P.I.	1.64	1.09	4
14 colleges, 6-15 P.I.	10.1	3.81	5
7 colleges, 16-30 P.I.	20.4	9.5	6
28 colleges (1946-50 productivity)	13.9	6.04	7

* Colleges returning questionnaire and with representation at this meeting.
** Colleges returning questionnaire but without representation at this meeting.

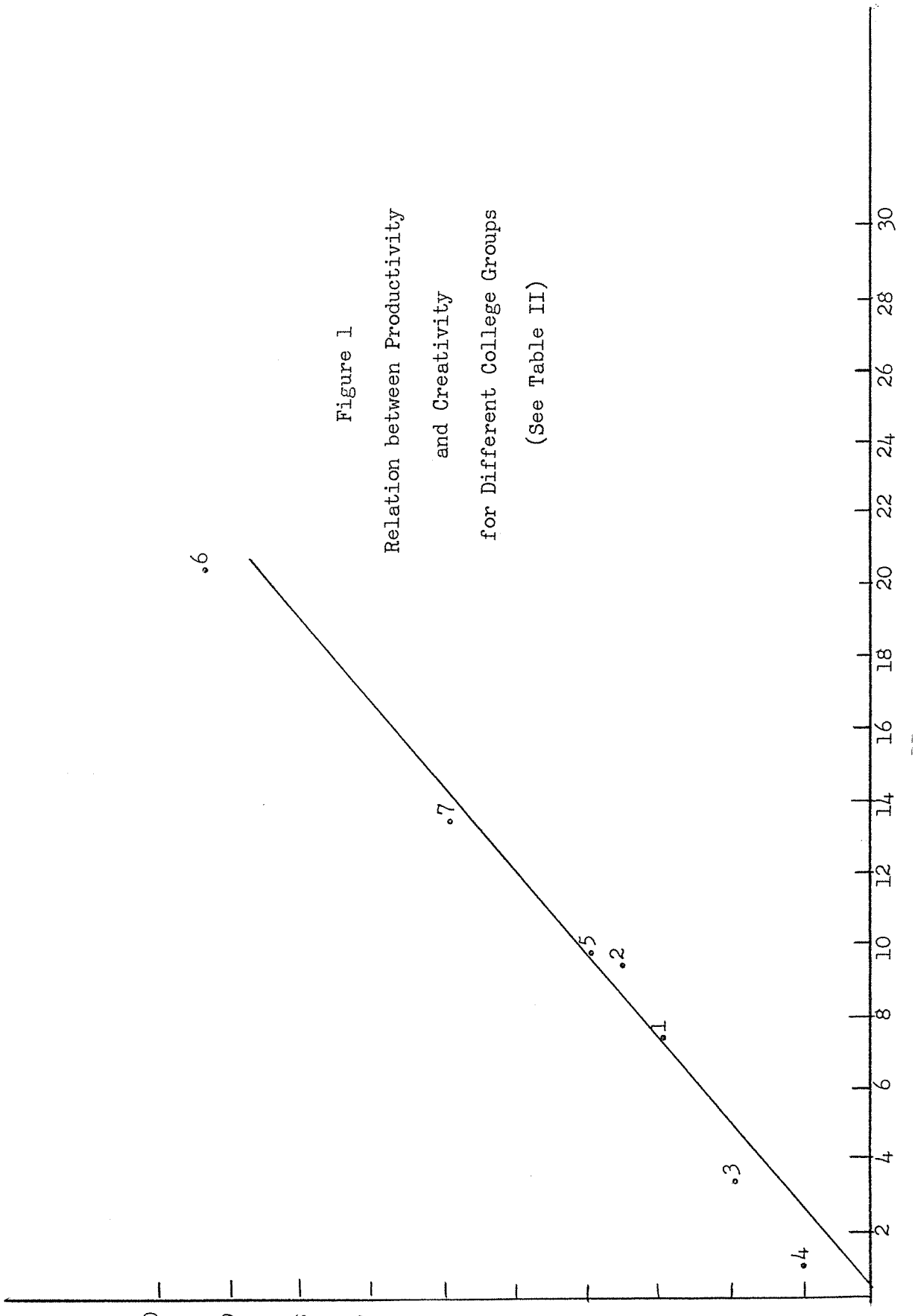


Figure 1

Relation between Productivity and Creativity for Different College Groups (See Table II)

A scatter curve was also prepared, Figure 2; this shows that averaging the data favors a good looking relationship; nevertheless the probability that a productive college is also a creative college is given definite support.

These data have been used to develop the mathematical value for the constant k in the equation. Let's take first the schools represented in the audience, Class I, and for purposes of calculation I will take the returns from 39 schools in this classification. These schools received in all the sum total of $140,415. The value for the average C.I. is 3.6; in other words, the average school in this group has received $3600 since 1948. These 39 schools produced 383 Ph.D.'s, so the average productive index is 9.8. Solving for the value of k in the equation $P = kC$, we find that $k = 2.72$. (I have left out of the calculations Augustana College where an unusual situation exists since there is an Augustana Research Foundation operating in part outside of the chemistry department). Twenty-one schools in Class 2 have been used for calculating the value for k in that group of schools. (Here I have left out purposely Siena Heights College and St. Scholastica, for these schools apparently operate a research program independent of their chemistry departments, and it is part of a broader research program from without). For this group the average C.I. is 1.99, the P.I. 3.71, and the k 1.86. If we take all 60 schools, the average C.I. is 3.04, average P.I. 7.7, and the k 2.53. Considering the fact that the P.I. values are for one ten-year period and the C.I. values for a later five-year period, these constants are not so bad and certainly support the premise that productive schools are very likely to be creative schools within the limits of the definitions.*

There is one small point remaining--namely, the relation between the productive index and the extent of support by percentage of the schools within each P.I. range. The statistics have been compiled for 69 colleges. They are summarized in Table III and graphically represented in Figure 3.

PI

TABLE III

PERCENTAGE OF SCHOOLS IN VARIOUS P.I. CATEGORIES RECEIVING FINANCIAL SUPPORT FOR RESEARCH

Categories	0-1	2-5	6-10	11-15	16-20	21-25	26-30	Over 30
No. of colleges	13	23	8	6	5	0	2	2
Total Ph.D.'s	4	87	65	77	90	-	53	98
Av. P.I./college	.31	3.8	8.1	12.8	18.0	-	26.5	49
No. of colleges supported	4	13	5	5	5	-	2	2
% Receiving support	30.8	56.5	62.5	83.5	100	-	100	100

* The value of k for 28 colleges (Table II) using productivity values for 1946-1950 and the creativity values 1948-1953 is 2.3. This checks in general the 3 k values using the 1936-45 productivity figures.

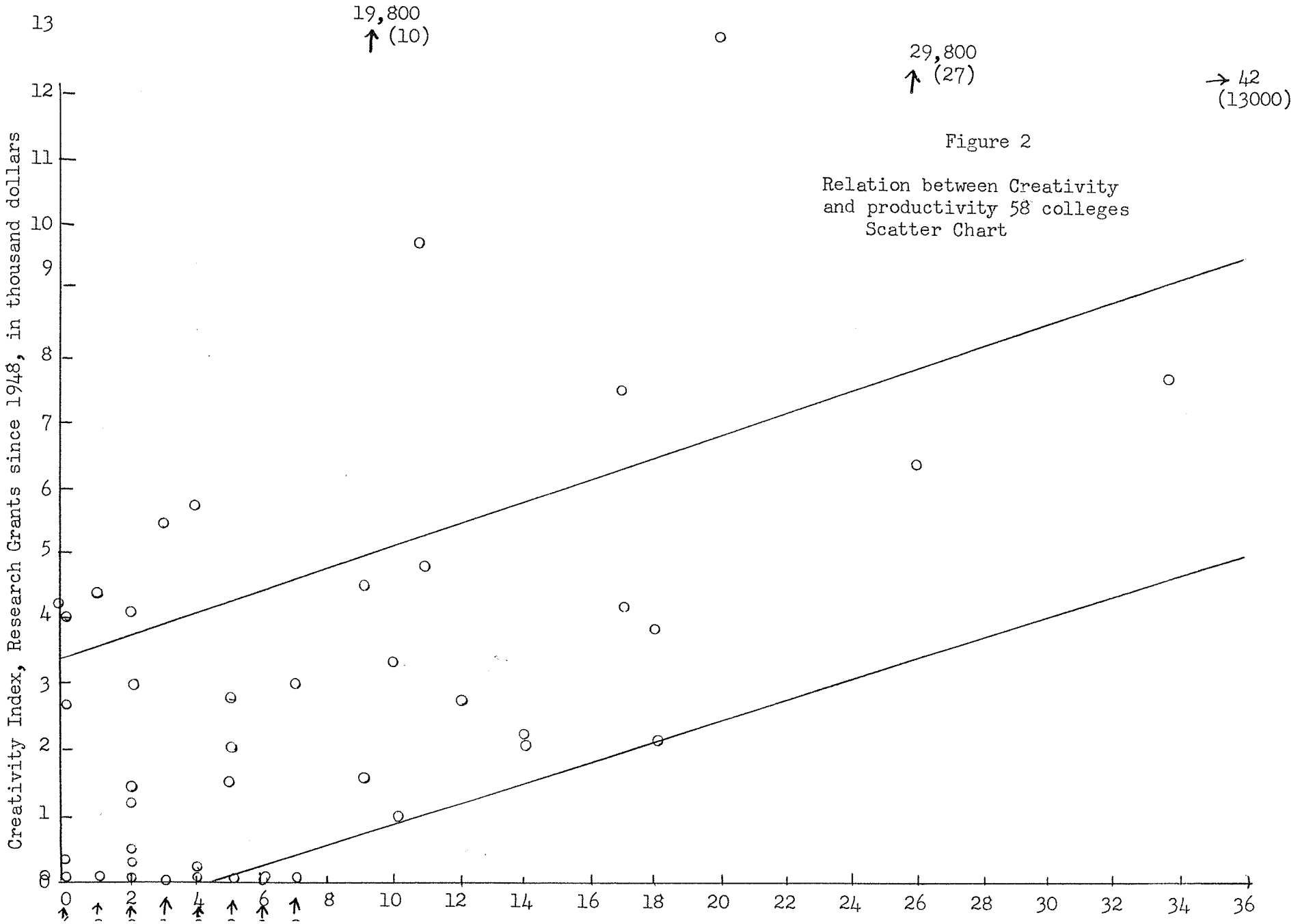


Figure 2

Relation between Creativity and productivity 58 colleges
Scatter Chart

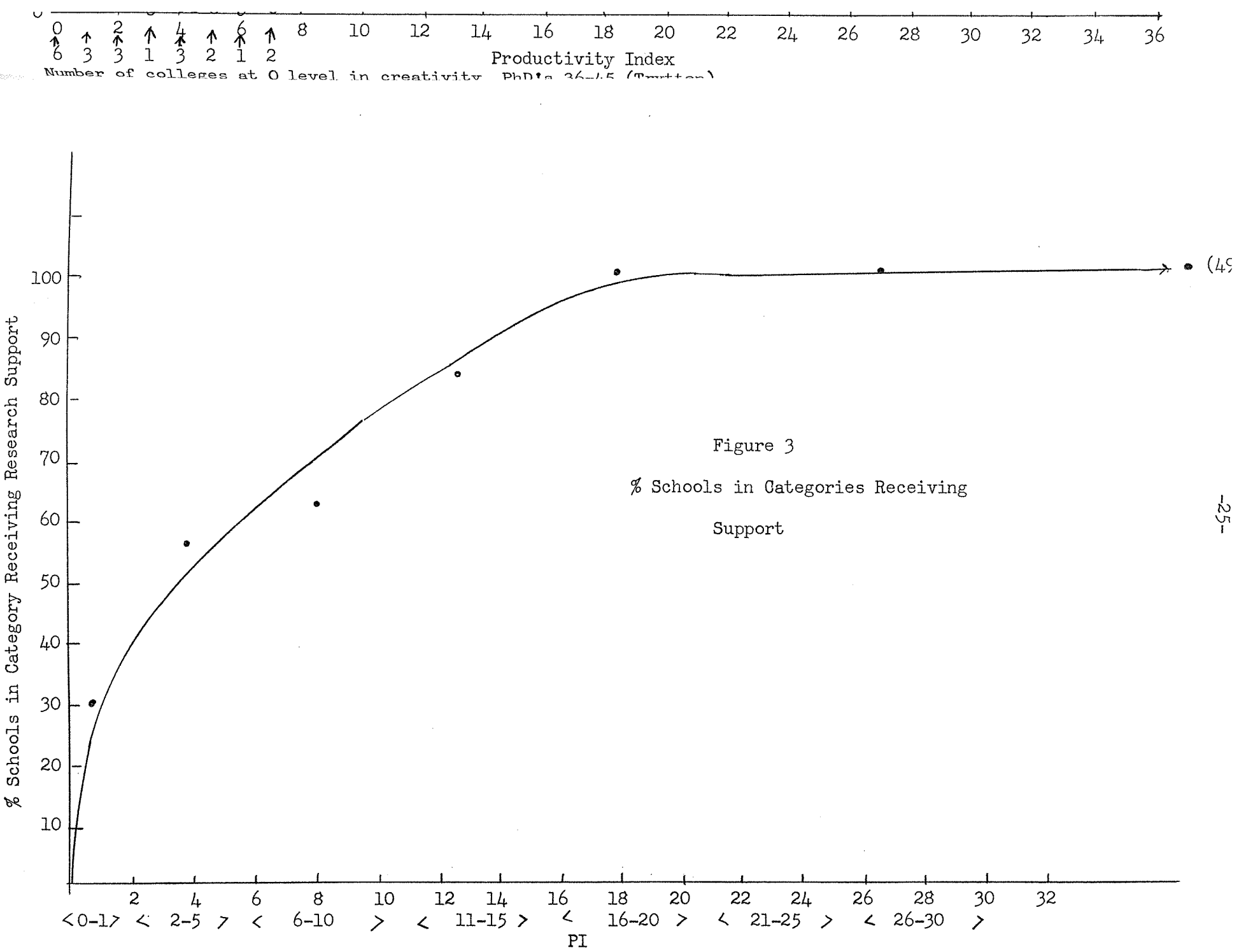


Figure 3

% Schools in Categories Receiving Support

This is again a rather clear illustration of the fact that creativity and productivity go hand in hand in the colleges.

So now we have the scenery in place and will go ahead with the panel. It seems to me that at least we have agreed as to the need for trained, high-class chemists and have seen that the rate at which these are produced is related to the research interest of the specific department. Our panel is gathered today to talk about the ways and means for achieving research in the liberal arts college The ways are represented by five professors who do research of one kind or another. Roy Grady of Wooster, Gerrit Van Zyl of Hope, Ed Hill of Augustana, Irv Koten of North Central, and Garrett Thiessen of Monmouth; the means by Bob Marschner of Standard Oil of Indiana, Walt Kirner of the National Science Foundation, Ed Phelan of the AEC Argonne Laboratories, and Charles Schauer of the Research Corporation.

Each member of our panel will present a short statement of his organization and its interest in college research or in his particular research techniqu

The first member of the panel to speak will be Charles Schauer, Director of Grants of the Research Corporation; following a discussion of the Research Corporation and its activities, Gerrit Van Zyl of Hope will tell how the Research Corporation has helped the Hope research program, and Gerrit represents at the same time all the 24 colleges here who owe the Research Corporation a very real vote of thanks.

Mr. Schauer, I read in a recent issue of Chemical and Engineering News that the Research Corporation was announcing grants at this time to 43 colleges. Have you any idea how many college grants you have made since the Research Corporation started?

Schauer: I have to ask you a question before I can answer that one. Do you mean liberal arts colleges?

Lewis: Yes, I was thinking of the colleges. You have a classification of colleges in your grants.

Schauer: Although we have been working this area only since the war, we have made 500 grants to about 200 liberal arts colleges in that time.

Lewis: That's a good percentage of the five, six, or seven hundred liberal arts colleges in the country.

Schauer: I might say that the quantity of liberal arts colleges is based upon the success of salesmen, such as Mr. Thwaite, who are going around visiting any college they can find, to see if there is something that the Researc Corporation should be doing.

Lewis: Won't you stand up, Mr. Thwaite. Everybody look at him so he'll not have to go about in vain. What are the aims of the Research Corporation?

Schauer: It has been the purpose of these grants to help stimulate science teaching by supporting faculty research in the liberal arts colleges. We are convinced that the liberal arts colleges are the real backbone of our civilization and that the teachers in these colleges must be afforded the

opportunity for research--to keep them alive and abreast of their fields. Frequently we have been faced with the job of helping the teacher sell this concept to his dean or president; fortunately, this has been less and less frequent a job. There seems to be a growing acceptance on the part of college administrations of the real need to provide some time for faculty research and a willingness beyond mere acquiescence to share in it.

If an individual has a reasonably feasible research problem and his institution has normal laboratory facilities for him and a willingness to see him pursue his problem, Research Corporation is willing to consider his specific financial needs. An inquiry to one of our offices (in the east, 405 Lexington Avenue, New York City; middle west, 122 South Michigan Avenue, Chicago, Illinois; western states, 225 Santa Monica Boulevard, Santa Monica, California) will produce added information, application forms, or arrangements for personal discussion if it seems necessary. There are no set deadlines for applications during the academic year as our Advisory Committee meets about every other month to review and take action on pending proposals.

Lewis: What constitutes a feasible and acceptable project for the Research Corporation?

Schauer: We reserve the right to determine the feasibility--economically and otherwise.

Lewis: Can you give us a little background on the Research Corporation?

Schauer: Research Corporation's specific and directed interest in the support of research at the liberal arts colleges is very much a post-war development. Since its founding in 1912 (incidentally, Research Corporation was founded by a physical chemist, Frederick Gardner Cottrell, with its sole original endowment being his gift of potentially valuable patent rights in his processes for the electrical precipitation of particles from gases) Research Corporation has made grants totalling around $8,000,000 to about four hundred different colleges, universities and research institutions. While our archives bear interesting testimony to the effects of some relatively small grants for such things as the first cyclotron, the first Van de Graaff generator, a variety of projects in organic synthesis, free radicals, hormones, steroid chemistry, pharmaceuticals, photosynthetic work, low temperature work, etc., most of our grants prior to 1941 were to the universities.

During the war years there was no outlet for Research Corporation's funds, and our directors evolved the Frederick Gardner Cottrell program of grants to use the accumulated funds to provide added incentive for the professionally and technically trained people to return to teaching in the smaller and less well-to-do liberal arts institutions when they were released from their wartime activities. Conceived as a five-year $2,500,000 program, it is now near the end of its eighth year and has invested nearly $4,000,000 in this activity.

Thus, since the war, we have considered seriously about three thousand (3,000) applications for grants in support of research in the physical sciences. About two thousand (2,000) of these have been from what we considered smaller colleges as contrasted with the relatively big universities and technical institutions having some research reputations. Arbitrary classification of this

kind is made more complex by the modest willingness of some institutions of fair r nown to be regarded as "small" if it will help in raising funds. Accordingly, the may seem to be some anomalies in our listings of grantee institutions under our Frederick Gardner Cottrell program, with some very well-known universities include with colleges not even fully accredited for four years by anybody. We believe tha the continuing visits of our field representatives, to colleges where we have made no grants as well as to those at which grants are active, provide us with much more satisfactory and up-to-date information on need for the kind of assistance we can afford than can any listing of size, enrollment, accreditation or what have you. The number of participants in this conference who know Mr. Thwaite, our mid- western representative, from his visits to their home campuses, bears evidence of this.

Lewis: Now let's get over here to the other side of the table. Gerrit, how did you go about getting something from the Research Corporation, and what hav you done with it, etc.?

Van Zyl: In 1948 at the Chicago A.C.S. meeting I noticed there was a talk by Dr. Williams of the Research Corporation in one of the groups. The topic of the talk was "Research in Small Colleges." After he got through I introduced myself, and he said "Yes, I've heard of Hope College. Would you be interested in something like this?" I said I would, and he said "I'll send you some literatu Almost before I got home I had lots of literature and an application blank. About two weeks later I got a telephone call from somewhere in Ohio from Mr. Schauer of the Research Corporation during which he said, "I expect to be in Holland next wee on Wednesday afternoon. Will you be available?" I said I surely would be and wou be glad to have him come. Mr. Schauer came and we had a nice talk. After he left I filled out the application outlining the project on which I wanted to work. Of course, I fooled him a little; I had been working on the project for three or four years before I ever put in the application, so I practically had a paper all done by the time I got the grant.

Since that time Mr. Thwaite has been calling on us, and we have had a very pleasant relationship. We have had four grants in the past five years. I have always been somewhat interested in research, although we have so much teaching to do in a small college that we can only peck at it a little here and there. You don't get much, if anything, done. This research grant gave me an opportunity to get a little help.

Most of our work is carried out during the summer. During the first summer I worked almost day and night myself. Helping me were two of my seniors who had just graduated. One of these young men went to Harvard University on a scholarship the following year. The next summer he came back and worked with me-- in fact, for three successive summers after that, he was back in our laboratory because he liked it better than working in the Harvard laboratory. This man (Eugene E. Van Tamelen) is now an Assistant Professor at the University of Wiscon George Zuidema, who received his M.D. degree from Johns Hopkins University last June and is now an intern at the Massachusetts General Hospital, likewise worked in our laboratories for four summers after his graduation from Hope College. Pau Cook and Earl Huyser were both with us for two summers. Cook is now in his third year of graduate work at the University of Illinois, and Huyser is in his second year at the University of Chicago. Another student, Paul Kromann, who is now an assistant at the University of California (Berkeley) concentrated on research

during the last half of his senior year and worked with us for one and one half summers. John F. Zack, Jr., did a limited amount of research during his senior year and worked full time last summer. He is now an assistant in the Department of Chemistry at the University of Illinois. He plans to return next summer. Robert Langenberg, who is a senior this year, served his apprenticeship this past summer and will be working on another project during his senior year and next summer. He is a recipient of one of the fellowship grants from the Standard Oil Company of Indiana.

Lewis: Do you pay their stipend out of this grant--the student stipend?

Van Zyl: We have received a total of $9,500 in four grants--$2500 three times and $2000 another time. We pay first year students $40.00 for a forty-hour week out of the grant and raise their stipend $5.00 a week for each year thereafter. It isn't a very high wage, of course, but they are very much interested in the work and are happy to do it. From this $9,500 we have paid out $7,500 for fellowships and $2,000 for items of equipment, such as distillation columns, a hydrogenation apparatus, constant temperature bath, polariscope, and a new Coleman pH meter. Chemicals, ordinary glassware, etc., are furnished by the College. Of course, my salary is rather large--$500 for the entire summer (except for a stolen afternoon now and then for golf).

Lewis: Who gives you the $500?

Van Zyl: The College pays that.

Lewis: You can't get yours out of the Research Corporation?

Van Zyl: No.

Lewis: Just one thing more--publications.

Van Zyl: Yes, as the result of this work we have eight published articles in the journals in the last five years. One more has been submitted just recently and I know it will be accepted because one of my former students is the referee. We have another article about ready to be sent in. I think work of this kind done during the summer can be continued, to some extent, throughout the year. You can parcel out little bits of it to your senior students; we have a course in advanced organic chemistry and also one on special problems. We have these students make preps for the work we are doing during the summer. We also have them try out some reactions which we hope will work. If the reactions look promising we work on them the following summer. This experience teaches the student to use the Abstracts and Beilstein and to look up articles in the journals. They really feel that they are doing a little searching. It is easier to just pump information into the classroom atmosphere, i.e., to do the student's thinking for him, than it is to make him think. Our laboratory manuals tag almost everything with a red label. On a research problem, however small, the student really has to get out and dig and search and research. I agree with the fellow who said that he hoped we never would have luminous lipsticks for girls to wear in the dark. Because--the search is half the fun.

Lewis: We appreciate that, and I think you all will agree with me that to the Research Corporation the liberal arts colleges really owe a lot. Well, let's move along. You are going to have lots of chance to ask questions if we move fast enough. A second source of research income, as you see up here, is this $100,200 from the government. Now I didn't try to get a man here from the Office of Naval Research; that would have probably been a good thing to do, but it seemed to me that it would be better for our purpose if we could get a man from the Argonne National Laboratory, a part of the Atomic Energy program. They have also been interested in the activation of the research potential and have done some things for the colleges, so now let me introduce to my left, Dr. Earl Phelan. Earl, won't you please tell these folks a little about the interest of The Atomic Energy Commission in college research.

Phelan: The Atomic Energy Commission sponsors research grants similar to those described by other members of this panel. Most of them, however, have gone to large laboratories rather than to small colleges. In addition, the AEC supplies the funds for three national laboratories which do provide openings for chemistry teachers.

While these laboratories are national in scope, and with individual objectives, they necessarily attract personnel predominantly from their local areas. Brookhaven, on Long Island, had 85 faculty members from 36 different colleges in residence this past summer. One-fourth of them were chemists, and interestingly enough, from one-third to one-half of them paid their own expenses. Their only reward was the opportunity to do research. They evidently wanted to learn and to produce.

Oak Ridge Institute of Nuclear Studies is primarily interested in the South, from Virginia to Texas. They had some 51 faculty members from 33 colleges spending approximately three months there this past summer. Of these, 19 were chemists. All of them were paid by the laboratories at Oak Ridge for which they worked.

While it is true that there were men from the Midwest both at Oak Ridge and at Brookhaven last summer, it is natural that this area looks first of all to Argonne for its opportunities. In the operating policy for Argonne is the statement that one of its functions is to serve as a focal point for the stimulation of research in nuclear energy in the Midwest. Last summer we brought to Argonne some 28 faculty members and students, mostly from institutions in the seven states represented here. Of these, eight were chemists; in turn, four of those eight were from liberal arts colleges and four from universities.

I just looked over Dr. Lewis' shoulder, so I am anticipating one of the questions he is planning to ask me. We have here this afternoon one man from North Central College and one from Wheaton College who worked with our chemists last summer. We also had one from Calvin College in Grand Rapids and one from Central College, Pella, Iowa. You can see that we are offering opportunities to just the sort of men who are here this afternoon.

We have had very good experience this year in bringing in men for the summer only, and we are encouraged to expand the program for the future. I do want to emphasize, however, that we have demanded high qualifications. We have

picked men who were capable of doing good research and would fit into our programs. Since we have a wide variety of activities going on in all forms of spectroscopy, nuclear reactions, solid state, physical, and inorganic chemistry, we can in turn offer opportunities to men with a variety of interests.

As a result of last summer's program, a number of papers have been started and will be published shortly. Some of these men have found problems that they can and will continue at their own institutions during the coming years.

Another phase of our work has brought in men who have come on sabbatical leave for from six to fifteen months. We have also made it possible for a limited number of graduate students to spend full or half time on research on their thesis problems.

Salaries for our academic visitors are adequate but intentionally not too attractive. We want them to go back to their colleges and continue their work back home. There are plenty of phases of nuclear energy in which a man without too much money and equipment can do useful work. One of the men who spent a sabbatical year with us picked up an idea at Argonne which inspired him to go to Walter Thwaite to get a grant from the Research Corporation. He has gone back to his college to establish a radioactivity laboratory, and he is responsible for the leadership in that field at his school.

I should like to say in closing that we hope that more of you who are here this afternoon will come down to see us. Argonne is located about 26 miles southwest of the Chicago Loop. While we do have security restrictions, we can arrange for visits with little difficulty. If we are given a couple of weeks' advance notice we are glad to welcome people, show them what we are doing, and attempt to stimulate them to go out and be assistant missionaries. Our mail address is Argonne National Laboratory, P. O. Box 299, Lemont, Illinois.

Lewis: Dr. Phelan shouldn't have looked over my shoulder because I had a good question all set for him. Now we will go ahead with the questions anyhow and see how he feels about it. I was going to ask him whether he was sympathetic to the idea of a college man recharging his intellectual batteries at the Argonne Laboratories in sufficient amount to turn over his starter when he returns to the more frigid research climate of his own research laboratory.

Phelan: The answer is that I am more than sympathetic.

Lewis: I was a little afraid that starter had to go on its own if he was going to get out of Argonne, but he is willing to help him recharge the battery, so that's fine. How many in the audience have gone to one of these Atomic Energy recharging operations? Well, there are two or three around.

Down at Monmouth last year I talked about research in teaching and suggested that as one way of doing research if you lacked funds for research and teaching. That's one way for everybody in the room--research in teaching. We have a couple of experts up here on the panel on research in teaching. I had originally asked Irv Koten of North Central to be the stellar example of a man doing research without financial support, then found out from his report he had gotten some financial help, but possibly this financial support does not

relate specifically to the program about which he is going to talk. Irv, tell us how you go about "research in teaching" down at North Central College in Naperville, Illinois.

Koten: The research activity in which we are interested at North Centr College involves students in the second semester labboratory work in Organic Chemistry. For a number of years we have received samples of organic compounds from various manufacturers. We now have available for our research projects about 200 selected compounds from 64 companies. These samples are usually accompanied by data sheets and excellent literature concerned with known reactions and possible uses for the various compounds.

Each student is given a sample and the descriptive material. The student then does a thorough library search for information concerning the compound. It is frequently necessary to do reading in German or French. This experience serves to emphasize the importance of a foreign language to a budding chemist. Because of our proximity to Chicago, students find it easy to make frequent use of the John Crerar Library.

The abstracts which the student has prepared are then reviewed. This is followed by the selection of a synthesis for detailed study. This assignment usually involves the preparation of a homolog or a derivative of the sample. In this way, the student frequently experiences the thrill involved in the prepa tion of a new compound. The compound is then analyzed. We are equipped to do micro carbon, hydrogen and nitrogen. If the compound appears to have an interes ing structure or medicinal possibilities, it may be submitted to one or two manufacturers who are interested in screening our compounds for possible uses. The student also prepares a detailed report covering all the work done, including total time spent on the project and cost of the compound prepared. Frequently a student has the opportunity of reporting at the local meetings of the Affiliat of the A.C.S.

This research procedure is of benefit to the student in the following ways:

1. Since there is no assignment of the usual experiments, each studen feels free to perform as an individual working on his own problem. This stimula interest so that additional time is spent in the laboratory.

2. We encourage students to observe what others are doing in the laboratory, thus making it possible to learn additional material.

3. They acquire experience in research procedures.

4. They learn the use of the library in searching the chemical litera ture.

5. It affords experience in building varied and intricate equipment set-ups which make it possible for the student to do original designing.

In closing, I should like to say that any instructor who is tired of seeing students perform "Ex. 21 on page 180" and who is desirous of "keeping out of the rut" will find this laboratory procedure immensely stimulating and

rewarding. As is to be expected, the instructor must also be prepared to give additional time to the course.

Lewis: All right, fine. Now we have another fellow who is doing research in teaching quite successfully. He has the largest quantitative analysis class this year he has ever had--a good example of $P = kC$. Last year I went down to Wooster College for a panel meeting on the pulp and paper industry, and the large lecture room was full of students interested in research and graduate work. So, people, meet Roy Grady of Wooster College. Roy, what's going on in the Chemistry Department at Wooster?

Grady: We have at Wooster College what we call the Independent Study program. Every student in the College, regardless of the department in which he is majoring, must take three credit hours a semester of Independent Study in his major field throughout his junior and senior years. Today, I am not concerned with the other departments, we will talk about what is done in chemistry. These twelve credit hours in Independent Study are in addition to the regular course work in chemistry. If the student is meeting the A.C.S. requirement, he must get his 38 credit hours in course work as well as the Independent work.

The College will not allow more than 44 credits in any one department to be included in the 124 that are necessary for graduation. This means that the chemistry major will have to present more than 124 credits. This, however, is no great handicap as most chemistry majors are better than average students and can therefore carry a heavier load. We expect (and get) nine clock hours of work a week from our majors in this special work. Many students voluntarily put in more than the required amount.

In the junior year we get the majors acquainted with the chemical library (which is located in the chemistry building). This involves learning to use the journals and reference works effectively. They prepare bibliographies and write reports and papers. In addition the student does some very intensive work, much more than could have been done in the regular courses, on certain subjects such as "Atomic Structure," "Acids and Bases," etc. He prepares a paper of at least 5000 words on some subject. This paper is not just a compilation of information from several papers which he may have studied; he must make his own interpretation of what he has read. If his general topic were atomic structure, he might, for example, write a paper on "Complex Ions and Atomic Structure," or "The Transition Elements and Atomic Structure," etc. These papers are severely criticized by the staff as to English, form and content. The papers are written in a form like that required for publication in chemical journals. Some of these papers after proper condensation have been published in the Journal of Chemical Education.

Lewis: I saw one in the Journal of the American Chemical Society.

Grady: We have had student papers published in other journals, but they were senior, not junior, papers.

In March of the junior year the student selects a problem for his senior year. We present a list of approximately 30 problems from which the student may make his selection. We encourage the student to present his own

problem, but it is seldom that he can present a suitable one.

The following are representative of the problems that are being studied this year by our seniors.

1. Distillation of Binary Mixtures--an investigation of the phenomenon of azeotrophy in mixtures of aromatic hydrocarbons with cellosolves. This involve the use of a precision fractionating column and the refractometer.

2. Titrations in Nonaqueous Solvents--the titration of strong acids by strong bases using either basic solvents like N-ethyl morpholine or dimethyl aniline or ethers such as dioxane. Potentiometer and color indicators are used.

3. A Study of the Kiliani Reaction as Applied to Starches--HCN will react quantitatively with sugars, in this study starches are used instead of sugars. Some glass blowing is necessary.

4. The Dithizone-Metal Ion Complexes---the polarograph is used to determine the metal ion concentration remaining in the aqueous layer after extraction with a benzene solution of dithizone.

5. Radioactive Isotopes and Chromatography--separation of inorganic cations and the study of the rate of migration by use of radioactive isotopes. Scanning with the Geiger-Müller counter and radio-autograph techniques are involv

We attempt to formulate the problem in such a way that the student will get some phase of the problem solved during his senior year. Many problems extend over several years--various students studying different phases. This year we have 26 seniors working on problems.

During the remainder of his junior year, after he has selected his problem, the student makes a literature study to determine what has been done and with his advisor's guidance, plans his method of attacking the problem and writes out his plan. He must also tell us what apparatus and chemicals he will need in his work. He is thus ready to start on his experimental work at the beginning of his senior year. This work is very carefully supervised at all times. After the experimental work has been completed, the student writes up his work in the style and form that would be acceptable for publication. Before his paper is accepted it must be approved by at least two members of the staff and we are rather critical. In addition the student must pass an oral exam on his problem and a comprehensive exam on all of the work he has taken in the department.

As you can see, this program is very time-consuming for the staff.

Lewis: How large is your staff?

Grady: We have three professors, one assistant professor, and one instructor in the department. We are allowed three credit hours on our teaching load for every eight students we direct in either junior or senior independent study. This plan is working very satisfactorily at Wooster.

Both the staff and the students are enthusiastic about the work. We believe that, as a result of this independent work, our students have a better foundation in chemistry and that they are better equipped both to carry on and to make reports on the work which they will be required to do both in graduate school and in industry.

Lewis: We have heard research in teaching in two different varieties. How would you fellows like to have to get 25 or 30 or more research subjects every year to offer to your students?

Grady: Since some of the problems are continued for several years, we actually do not have to present that many new subjects each year.

Lewis: I was not going to say that; it's a better story my way. At any rate, a fine job of research in teaching is being done at both of these places--at North Central in the regular course in Organic Chemistry, at Wooster as a special program.

Now we see from the table presented earlier that industry supported research in 60 per cent of the colleges receiving help. In preparing for this panel I became curious to know what industry's feelings would be in the matter of stimulating and supporting research in the liberal arts colleges, so I wrote last week to responsible individuals in 39 of the large chemical industries in the United States. I asked for their responses to some questions, as follows:

Has your company during the past ten years helped stimulate research in the small college by supporting such projects as

1. The synthesis of new compounds...for your testing or screening program.

2. The "farming-out" of small sections of your company research program.

3. Temporary employment of college faculty during the summer on projects such as might stimulate further research in their college laboratories.

4. Inclusion of local small college faculty in meetings of your research staff to listen to discussions of your research programs .....

5. Direct, unrestricted grants to college chemistry faculty to support projects of their own devising.

6. Other ways.

7. Do you feel that the encouragement of research in the liberal arts college is a worthy enterprise? Etc., etc.

To my surprise, a quick and ready response came back from 27 corporations. With one exception, they all believe in the encouragement of research in the college. That made me feel good. The one negative to this came from an

individual who seemed to be afraid that research would interfere with good teachir and that I might add would be too bad to have happen in a liberal arts college. A you see, I asked whether any of them asked you college professors to synthesize ce tain new compounds for their research programs. Six of the group had provided fir ancing for that particular type of research, for it is research, witness the work at North Central College. It represents something new--new compounds and even nev processes. In answer to the question of how many had farmed out small sections o their research programs to the small college, I was surprised to find that eleven did. Since these answers came from all over the country, there is liable to be s uncertainty as to what is a small liberal arts college. One response was that th company had had such a program at Princeton, but Princeton falls outside of our definition of a small liberal arts college--it's a little larger than small. Ele had supplied summer employment for people such as yourself in their college labor and I asked particularly "Did you put them on the sort of thing that would stimul them to go home and do some more of the same when they got there?" These eleven they did; I am going to write them a little further and find out what they did. had even invited faculty men from nearby colleges to sit in on the research confe ences as they discussed their programs. That is pretty good and certainly stimul a research desire. Seven had made direct grants to colleges without strings. Th replies are summarized in Table IV.

TABLE IV

INDUSTRY RESPONSE TO THE QUESTIONNAIRE ASKING WHAT THEY WERE DOING TO STIMULATE COLLEGE RESEARCH

Questions	Yes	No	Comment
1	6	21	--
2	12	20	One reported that the idea had merit.
3	13	13	One would consider.
4	2	25	Probably there as consultants.
5	7	20	Consultation or equipment grants
6	6		--
7	26	1	--

The almost unanimous response to question 7 suggests that responsible management in the chemical industry is aware of the need of support and encourage ment for research in the colleges. The industry replies expanded on this point. Time will not permit coverage of all of these items, but one or two deserve menti One research director in a leading chemical company replied in answer to questior that he was very much in favor of encouraging college research but went on to say "While the primary initiative for contacts and help must come from industry, it seemed (to him) the faculty members could do a great deal themselves in making opportunities for getting better acquainted with industry." Ways and means for t suggested rapprochment might be a part of the 1954 panel. Another suggested a listing of the special research interests of the chemistry teachers in local are in order that industry of the section might be aware of where to go to find spec assistance. This is another concrete suggestion and one which could be carried through the state representatives on the executive committee of this organizatio

[a listing of college chemistry teachers in a state or part of a state--followed by the submission of the list to the industries in the region].

The matter of primary interest, however, is not so much to provide income-producing consultation and project research (important as that may at times appear) but rather is to help inactive professors of chemistry undertake the type of research which will provide most nearly a creative experience and reflect itself in improved teaching and high quality productivity.

With this as a background, let's consider for a few minutes specific support from industry which has had a wholesome effect on the activities of chemistry departments in Middle Western colleges. I refer to the grants from the Standard Oil Company of Indianaand from the Du Pont Company. I had hoped that Dr. Julian Hill of the latter organization would be here to speak for himself. In 1953 these grants went to 19 liberal arts colleges to advance the teaching of chemistry; the grants of $2500 could be spent as the particular school decided---whether for equipment, books, lectures, trip, student aid or faculty aid in support of research. It is gratifying to note that nine of the 19 were assigned in the Middle Western area. Other industries are in their own way at work on programs of college support---these two have already borne fruit in our area.

We're happy to have Bob Marschner, Senior Research Associate of the Standard Oil Company of Indiana here to speak for industries' stake in this activation and reactivation program.

Marschner: It's a long story, Harry. I'll give you the story as briefly as I can. You were one of those responsible.

Lewis: I wasn't thinking of that.

Marschner: The Middle-Western liberal-arts colleges that have made such outstanding records in producing science Ph.D.'s are our neighbors. The thought of helping them in some way has been in our minds for a long time. The main problem was that of mechanics---which ones most deserve help? The studies of Mr. Trytten at the National Research Council and of Knapp-Goodrich at Wesleyan on productivity of schools, and your interpretation of Trytten's data for chemists, all helped to show us that here was a good mechanism for choosing the most deserving colleges. Selection among such complex organizations as colleges cannot be an open-and-shut question, but at any rate these data provided a clear and self-evident basis.

By the way, one shouldn't underestimate this problem of mechanics of selection. For example, we are in the petroleum business, not the education business. We hear about the needs of colleges but we don't pretend to be experts in education. But when those who are experts collect and present facts on education in the same way that we use facts on petroleum, they and we stand upon more common ground. The studies I have mentioned presented facts that made it easy for us nonexperts to help. That's why our scholarship program started when it did.

We selected the top fifteen liberal-arts colleges from among those who had a record of graduating at least one future Ph.D. chemist each year. To each of these we provide a scholarship gift of $1000, which goes for two things. First of all a stipend of $500 goes to a student--a senior that the college selects--who expects to go to graduate school. Second, an equal amount goes to the college for the Department of Chemistry to improve its facilities in the way they see most fit. Their interpretation of that varies widely, and quite properly so under the nature of the award. The scholarship interests and attracts younger students who are wondering about the professio of chemistry and the problem of graduate work. The award helps the college to prepare them.

Lewis: How long have you been going?

Marschner: We're in our second year now. I am glad to say that al of last year's scholars are in graduate school now. We hear reports on them every now and then; most of them are doing very well. Of course time will te

Lewis: Well that certainly is a wonderful thing. I know some of the schools here have been stimulated by your grants, Bob, out of all proportion to the size of the grant. I've heard from most of the recipients. I kn the students selected for the awards feel that they have been honored, the colleges receiving the awards report a boost to the departmental morale, and we doff our respective hats to you, Bob. Since Bob is here to talk about his company's part of the program, I'm skipping a faculty report on how the Stand Oil money was spent in favor of a report from one college receiving a Du Pont award. Monmouth College will be that representative, and I'll now ask Garret Thiessen to tell how the Monmouth College Chemistry Department has used their Du Pont grant of $2500.

Thiessen: We got it with no strings attached virtually, and so our department and administration went into a huddle and drew up a proposed budge for use of this money, which budget was checked with the donor who was very easily satisfied. The greater part of it has been spent in one way or anothe in support of research; one thing of interest to this group is the fact that we set $600 of that $2500 aside to pay the salary of one of the staff for summer research.

The current research program at Monmouth College is built around the Kolbe electrolysis, first accomplished in 1849. In this reaction, an acid R·COOH is converted into a salt (usually potassium) and dissolved as suc in an ionizing solvent (usually, though not invariably, water). The anion $R\cdot COO^-$ is brought to a bright Pt anode, and there if possible discharged, forming the free radical, R·COO. This odd electon "molecule" (free radical) disintegrates into CO_2 and R, which may form R.R or (R minus H), most typical although other reactions are also possible. If R contains a vinylene radical the anion R·COO- loses the competition to be discharged at the anode, and OH- discharges instead, evolving oxygen rather than carbon dioxide; unless the vinylene radical has at least three methylene groups between it and the carboxyl group. Benzenoid vinylene groups likewise inhibit the action, apparent ly by raising the discharge potential of the organic anion; thus benzoate ion will not discharge in water, but will in pyridine. Following the Lewis

"research in teaching" suggestion, an organic chemistry student, Colin Hamilton, using directions in Organic Syntheses, during 1952-53 synthesized gamma-phenylbutyric acid. He further converted this to a potassium salt, and electrolyzed this in the Kolbe manner, recovering much oxygen but no perceptible carbon dioxide at the anode. Since this is like the delta hexenic acid which Fichter found would give the Kolbe electrolysis, except that the delta hexenic structure is made cyclic as a benzene ring, it is concluded that three double bonds count as more than one in inhibiting the Kolbe reaction.

One member of our staff who teaches our general chemistry courses has in the past supplemented his income by such labor as he can get (e.g., corn detasseling) during the summer. From the $2500 grant generously given us by Du Pont, $600 was taken to pay for his time during last summer. He was then set to the task of preparing delta phenyl valeric acid, so as to move the phenyl group one degree further from the carboxyl group, and to convert this to the potassium salt, and electrolyze the same, with prime concern as to whether or whether not CO_2 was evolved. Preparing the acid was difficult. He has succeeded, we think, in making a crude product; this has not as yet been converted to a salt and electrolyzed. He is to try to accomplish this during the Christmas holidays. Our ultimate goal in this direction is to find the critical chain length at which benzenoid vinylenes just cease to inhibit the Kolbe reaction; and then to hang electronegative groups on the rings of the critical compounds, to see if these increase or decrease the ease of discharge of the anions. This is supposed to reveal if the vinyloid inhibition is electrical or mechanical.

It is hoped that a grant may be possible from other sources for a continuation of this project next summer. This will provide a salary for the director of the project and for two other staff men. One of these will continue with the preparation and purification of compounds, the second with a study of the problem of decomposition potentials. Since the Kolbe system is irreversible, the Kolbe reaction must be detected chemically as gradually increasing voltage is applied, according to the ancient procedure of Preuner. We propose to make a small-scale version of Preuner's equipment and use pyridine as the solvent with the dimethylammonium salts of the acid and try to discover a relationship between the vinyloid condition of R and the discharge potential of R·COO-.

Lewis: Sounds like a fine research program. More power to you! I'm interested to hear that you obtained money through your Du Pont grant which is available in part for summer staff support at a time when the teaching salary has stopped. You told me I think that you also bought some equipment and used a part for attendance at technical meetings.

Thiessen: Yes, that is another use which may not be directly connected with this research program. I was able, through the grant, to attend a meeting of the Electrochemical Society in New York, and others from our staff went to the Chicago meeting of the American Chemical Society. We also purchased a polarizing microscope and were able to finance several student assistantships.

Lewis: Did you give a paper at the Electrochemical meeting?

Thiessen: Yes, on the very subject of "The Role of Double Bonds in the Kolbe Electrolysis."

Lewis: Maybe some of you (but not the professors) wonder why I have stressed this matter of support for the professor. In my paper in Los Angeles I tried to point out at least three things that prevented professors from getting research done in small liberal arts colleges--one was time, one was ideas, and a third was money, and the time available for research by many small college professors is the summer period, when some professors have to milk cows and do other things to keep body and soul and the family together and pay for the eye glasses and the tonsils that the kids had to have out in the winter time. As long as this is what our professor has to do with his summer, he'll never get a chance to do a good job of research when it might have been done. For this reason I stress the need for grants going to college professors for support as well as for books, special equipment, student assistants, and the like. The professor can generally get money to buy the ordinary equipment and chemicals on his departmental budget. It should be pointed out that there are colleges so well financed as to be able to provide a supporting salary for summer work; there are in the middle western group many others where this is not the case.

Let's return to our panel members and hear from the National Science Foundation. It was unkind of me to put that zero on the table of grants as representing the interest of this organization in the problem we are discussing. They have really been so busy getting things going in one way or another that they haven't looked into the liberal arts colleges. We're glad to have Walt Kirner, In Charge of Chemistry for the Foundation, as a panel member. Walt, you are not feeling on the defensive, are you, about this whole business? Tell us about the National Science Foundation and its concern for research by the college professor.

Kirner: The National Science Foundation has an Advisory Panel for Chemistry. At a recent meeting of the Panel one of the members commented on the significance of the initial letters of the Foundation's name. You may have seen them imperforated in a check which has bounced back from your bank.

While it is true that the Foundation has not yet awarded any Chemistry grants to the institutions formally represented at this conference it has awarded two grants amounting to $7700 to liberal arts colleges in Ohio (Kenyon College and Central State College) which Dean Lewis regards as an extension of Indiana. However, it is also true that the Foundation cannot award research grants unless it receives proposals requesting support. From all of the colleges represented at this conference the Foundation has received a research proposal from only two of them.

It should be pointed out that the National Science Foundation is a very young organization having been created in 1950. Its first Chemistry grants were made in April, 1952. As indicated in my opening remarks the Foundation has been operating with very limited funds. However, encouraging progress is being made on the budget problem.

The Foundation is charged to support basic research and education in the sciences. It therefore has a direct and real interest in the problems of the liberal arts colleges. Increasing attention is being paid to these problems by the Foundation not only in chemistry but in all of the scientific disciplines. As an illustration, the Physics program of the Foundation last May sponsored a conference on physics research in liberal arts colleges. This three-day conference was held at Amherst and was attended by 25 physicists representing liberal arts colleges located in all parts of the country. They discussed thoroughly the problem of conducting physics research in the institutions which they represented and prepared a report containing their recommendations of the types of support which should be provided. The Foundation's Chemistry Advisory Panel has appointed a committee to submit recommendations concerning a similar conference on chemistry research in liberal arts colleges. It is believed that the general problem of conducting physics and chemistry research in liberal arts colleges is very similar if not identical. Consequently, the proposed chemistry conference may devote itself to a problem such as "Undergraduate research in chemistry." It is planned to hold this conference next Spring. The location and representatives to attend the conference have not yet been determined.

Lewis: We'll be glad to have you hold it here if you'd like--and this is an invitation. There isn't any question but that the National Science Foundation has been doing a fine job in this whole business of stimulating science, and we wanted to have Walt here to tell you something of their function, their problems, and their plans.

As the college counterpart of the National Science Foundation, I have a panel member here who is operating his own National Science Foundation, only it's called the Augustana Research Foundation. This is a little different kind of a National Science Foundation--it's not tax-supported. It is incorporated under the laws of the State of Illinois. Ed Hill of Augustana College is the man who made my statistics take an awful beating since the productive index of Augustana College is very low [not Ed's fault--he started there after 1945, the last year of the Trytten report figures]. In spite of his low P.I., he led the list by a large margin in the C.I. side of the equation; his k is down in the sub-cellar. Will you please tell us, Ed, about the Augustana Research Foundation.

Hill: At Augustana College, the administration encourages research by its faculty members, and as far as is physically possible allows its staff freedom for such investigations. The primary purpose of the college is to do a good job of teaching in the respective fields of the liberal arts program, in a wholesome atmosphere conducive to good teaching. It is recognized that research is one of the tools available to the professor through which he can greatly improve the effectiveness of his teaching.

To promote research at Augustana College the Augustana Research Foundation was organized and incorporated as a nonprofit corporation in the State of Illinois, May 1947. The Foundation, although a separate corporation, is affiliated with the college. Its office and laboratories are located in Wallberg Hall of Science, Augustana College, Rock Island, Illinois. The reasons for a separate corporation are (1) to protect the college from being liable in case of any legal difficulties involving the Foundation; and (2) to insure the establishment of a board of directors for the Foundation

consisting of men who understand research (both fundamental and applied), and its relation to industry.

The Augustana Research Foundation is organized to conduct both fundamental and applied research in the fields of science, such as chemistry, physi geology, and biology. Its staff is made up of (1) faculty members of the coll (2) full-time research men, and (3) advanced students at Augustana College.

At the time the Foundation was organized most of the research grants given by foundations or by industry to the colleges and universities, furnishe funds for only the research assistants (or graduate students), and supplies an equipment. No financial remuneration was given for the direction, supervision and ideas contributed by the men in charge of these programs. The assumption is made that these men are adequately paid by the school so that they are not included in the research budget.

For many years before organizing the Augustana Research Foundation the author had a growing conviction that there is a tremendous untapped resear potential in the liberal arts colleges. As time went on it became more obviou that these resources could be tapped. There were two main obstacles in the wa of this accomplishment (1) the fact that there are very few, if any, liberal arts college teachers receiving adequate salaries, and (2) the heavy teaching load required of many teachers. A man with these handicaps cannot afford to u his time outside that required for teaching, in activities which would not hel augment the family income.

In almost every liberal arts college many of the male staff members find it necessary to take part in some activity other than teaching, which wil augment the family income during the year. For this reason the Augustana Research Foundation could not depend on the usual research grants which do not supply funds for the men in charge of the research programs. It was necessary for the Foundation to go after the type of research contract which would inclu the director and supervisors of the research program in its budget. So far it has been successful in obtaining such contracts.

The research conducted at the Augustana Research Foundation is of hi caliber. The professors involved in the research programs are kept more alert to what is going on in the sciences because of the necessity to keep abreast with the literature. This supplies much information which the teachers may us to make their teaching more inspiring and fruitful.

The Augustana Research Foundation is a genuine asset to Augustana College. The college has been able to keep a very good science faculty, several of whom could not afford to remain at Augustana if it were not for the research foundation. The research provides these men with challenging work ir their own respective fields of science which is a stimulus to them and their teaching. Special apparatus and reference books purchased by the foundation are available and used by the science division of the college. Advanced stude of the college, when qualified, are used as research assistants in phases of the research programs.

There has been some criticism of doing applied research in the liberal arts colleges. Although we agree that the bulk of the research should be of a fundamental nature, we feel that a limited amount of applied research should also be conducted in these schools. One of the big jobs in teaching is to give the student some understanding of how to use the fundamental information acquired in the classroom. A teacher who is applying these principles of chemistry to a practical problem can best show the students how this may be done involving other problems. Perhaps a simple illustration of this can best be shown in the teaching of mathematics. So often mathematics is taught in such a way that the students acquire great skills in the manipulation of numbers. These students know the fundamentals of pure mathematics but too often cannot apply their knowledge of numbers to practical problems that may, and often do confront them. This is given in support of our belief that some applied research is an asset to good teaching.

Many know that good research is being conducted in some of the liberal arts colleges. As was mentioned, the two main obstacles which prevent more research from being accomplished in these and other institutions are the necessity for augmenting the family income, and the necessity of reducing the heavy teaching loads. Since the present tax situation has cut off most of the private individual donations to the liberal arts colleges, these colleges are looking to industry for financial aid. Industry is slowly awakening to the fact that something must be done to keep these colleges alive. These schools have in the past, and are now, furnishing industry with much of its key personnel. It can not afford to let these schools die from lack of support. Some of the companies have already taken steps to help these schools and others are giving it serious consideration. To be most effective, industry as a whole must work out some effective plan to aid in the support of these institutions. It is too early to predict what this plan will be.

Until a complete and feasible plan can be mutually agreed upon by industry and the liberal arts colleges, this aid, at least in part, might be given as research grants in the different fields of the liberal arts program. These grants should include the directors and supervisors of the work in the research budgets. When such aid is given the liberal arts colleges, better teachers will be found on the faculties of these schools, and young potential teachers of merit will be tempted to remain in teaching. These research grants would not only improve the family income of the teacher and permit him to devote all his time to his profession but it would make possible the hiring of more teachers and thus reduce the teaching load. This would allow time to do a more inspiring type of teaching, and, at the same time, encourage creative work on the part of the teacher.

At Augustana the above general plan is the aim of the research program. We have proved, as has been done at other liberal arts colleges, that better teaching can be accomplished in these schools by teachers who are also doing creative work. Our plea to industry is that it make available more research grants of the above type to the liberal arts colleges.

Lewis: Thanks a lot, Ed. The time is passing, the Chairman of the meeting is fidgeting. We've been hearing about the ways and means of research. At Los Angeles I suggested that one bar in the way of a college research program is a lack of ideas. For anyone in that boat there is also a way. There is an organization which is called the NCUCRP. [If you read it fast, you can pronounce it.] This current year NCUCRP is operating 18 separate research programs. I am going to ask Dr. Cortelyou of Roosevelt College to high point that program rapidly.

Cortelyou: Typically the corporations and foundations which give grants in support of research require that the project for which the money is to be used must be described in considerable detail as evidence of the originality and organizing ability of the local research director.

Many teachers who ought to be encouraged in beginning a little research have not yet reached this level. They need suggestions of topics for research and methods of organizing it.

Also there are many situations in which a teacher with original ideas and organizing abilities does not have at hand enough students to carry out the details of his planned research.

The purpose of the National Cooperative Undergraduate Research program is to bring these two kinds of people together.

The method for doing this is described in some detail in the September, 1953 issue of the Journal of Chemical Education.

The essential idea is that research projects should be for cooperative development and are described annually in the Journal of Chemical Education. Teachers who may wish to have their students participate in one of the projects then write directly to the originator of the project, known as the Project Director. He usually assigns the same project to students in two or more schools in order to have independent confirmation of the results. Anyone who may wish to become a Project Director is encouraged to get in touch with the authors of the annual listing. The article in the Journal of Chemical Education describes the rules involved.

Lewis: How extensive has been the participation in this program?

Cortelyou: Roughly about 30 schools; one paper resulting has appeared in the Journal of the American Chemical Society.

Lewis: Fine. Still another source of stimulation for the college researcher seems to me might be in his own state university. In the twenties when I was on the staff at Cornell College, the State University of Iowa had a number of grants available to the Iowa college professor who wished to research for the summer in Iowa City. The amounts were not large but were enough to keep the professor alive for the period of the grant. Much more important was the feeling behind the grant that at least a college professor was part of the constituency of the state university. The men who received the grants I know profited by them.

So with that in my mind, I wrote to the department heads of the state universities in the states included in this conference. In essence, I asked them whether members of their department had co-operated with college researche on the college campus--whether they had special summer scholarships available t professors, whether they had arrangements whereby college men on sabbaticals might research, on a stipend, at the university, or did they have other ways of stimulating research on the part of the professors in the colleges in their sta

There was little regularity in answer such as might permit a tabulati but in only two cases was it evident that the college professor could look to his state university for a short-term research appointment for reactivation. The one exception is the State University of Iowa which still maintains its summer "Honorariums." Each college in the state may nominate one full-time member of its staff who is at liberty to carry on any work he pleases at the State University. Twenty-five are currently available--the stipend is $125 with freedom from tuition and fees. The other is Purdue, where research fellowships are available for college professors; one such was used by a DePauw professor last year.

In no case did it appear probable that formal machinery had been set up whereby a university professor and a college professor might work together as colleagues on a research problem of the university professors— in the colle laboratories. There did seem to exist a real interest in the problems of the college professor and a feeling that the matter of closer co-operation deserves real consideration.

The value of such co-operation might be determined by means of a roun table discussion at some future meeting--the ways and means might follow. In view of the many fellowships, industrial grants, government grants, and the lik available in the university for graduate and postdoctoral students, it would seem as though some of the concerned agencies might set themselves to the task of providing the means after college and university men had outlined the ways--and this might be done at a relatively low cost.

As this report was being put in final shape, a good letter came from Michigan State. I am quoting part:

"It is a basic philosophy of Michigan State College to serve the peop in any way that they want to be served. This may be a problem of training teachers, of developing television programs, or as we in chemistry are now doin carrying on graduate work by extension. (We have a considerable enrollment in graduate courses that we conduct at an Extension Center in Midland, Michigan, for the graduate chemists employed by Dow, Dow Corning, etc.)

"I don't know of a particular college policy which would be college-wide with respect to helping departments in smaller colleges. I would assume that if such an issue came to the administration, the answer would be to do everything possible to help.

"I shall try to answer one or two of the specific questions that you Personally, I have on many occasions, volunteered to help staff members in the chemistry departments of the smaller colleges in Michigan in any way that we in our department could help. I have suggested to them that if we have equipment

that they would want to use to make measurements and which would not be available to them, we should be happy to have them come to the department and use ours. In this connection, I am thinking of the larger expensive pieces of equipment that a small laboratory could not afford. We have had a few instances of staff members coming to the department to make readings on some of our spectrographic or other similar apparatus.

"As far as I know, we have never set any sum of money aside to purchase equipment which could be used in a co-operative program, but I do feel rather positive that if we got a program under way, equipment would be made available by some means or other.

"We have attempted, in our department to encourage the smaller departments to ask members of our staff to present seminar discussions for the college chemistry department and its students. We have not had many calls for assistance of this type. Most of what we have done has been more by word than by action. We have expressed on many occasions that we in the department are willing to co-operate in any way that we can. We don't feel, however, that we should attempt to force a program to get under way. It is our feeling that we should do whatever we can to stimulate the programs of the college chemistry departments because it is from those sources that we get our very best graduate students. If we do nothing else than stimulate one of the members of such a staff to try to improve himself professionally, we will have made progress.

"In Michigan, there is a good feeling among the instructional staffs of the different college chemistry departments. Twice a year the Michigan College Chemistry Teachers Association meets. We try to rotate the meetings from one school to another. We have a very good turnout from all of the colleges. We have made it a point here at Michigan State to have a relatively good attendance at each one of these meetings. At these meetings, we try to get as well acquainted with the staff members from the smaller colleges as possible and to create an aura of good will with the idea that if we can be of assistance to them, we stand ready.

"My personal feeling is that our chemistry department has a definite stake in what the small college chemistry departments are doing. This thought I can extend even further. We feel that we have an obligation to start even in the high school area in assisting in the training of scientists. Several of us are participating in high school-college day programs because we feel that we must give as correct an impression of what the scientist does at as early a date in the young person's training as possible, and also that if we can co-operate in such programs, there will be a far better feeling between the high school science departments and the college departments. It takes time to participate in such programs, yet we feel that dividends are being accrued.

"It is our thought also that we have an obligation in helping those who have already taken jobs to continue improving themselves professionally or at least in helping them be good citizens. It is for that reason that we undertook, under considerable apprehension and with reluctance on the part of many people, the graduate program at the Midland Extension Center. The fact that our courses carry enrollments of 15 or better every term is a good

indication that the program is being well received. Within the next year, we will probably have two persons obtaining their Master's degree under the type of program which we have developed."

It would seem to me that Michigan College chemistry professors would find a very sympathetic ear and potential help in ideas, equipment and in other ways--but you should make the advances.

An extension of this idea is the E. Emmett Reid research program carried on in the colleges of the South for so many years. As I have said before and repeat again--would that there were more E. Emmett Reids. Single-handedly he carried on a personal reactivation program which has been extremely successful.

Lewis: The time has come for a few questions from the floor addressed to specific panel members.

Floor: I'd like to know the size of the staff and scope of the projects at Augustana College.

Hill: We have a staff of three in the Chemistry Department. We have one full-time chemist working with us and then senior students. They fit in the program wherever possible. We pay these students $1.25 an hour for the time they give us. They get a lot of valuable training.

Marschner: I would like to ask a question, and it's a question that is much better phrased by a quotation here from Dr. Robert M. Hutchins, Ex-Chancellor of the University of Chicago. Some people don't agree with his educational ideas, but at least he expressed them very well. He says "There is an essential conflict between teaching and research. Education is synthetic and generalized. Research is analytical and detailed. Education is becoming more generalized. Research is becoming more specialized." In other words, in all this stuff we have been talking about there is a little danger too, I think. I think that while the educational process continues along with the research it is all well and good, but not so well and good otherwise.

Lewis: Anybody want to comment on that? Do you believe this will happen in the creative liberal arts college?

Fuller: I think there is an interesting point there which was borne out in one of the conferences in Chicago on the improvement in college teaching. At a meeting of the conference on the preparation of college teachers at the University of Chicago a year or two ago this relationship between research and teaching was taken up--not only of course in the sciences but in other fields, and there was I think an idea presented which is worth thinking about. It has been pointed out that research is continually getting ahead of textbooks and that there is a need for bridging this gap. One very important function of a liberal arts college teacher is to interpret broad new developments in his subject so that his students are aware of progress beyond that stated in the textbook. This involves extensive reading in a wide field rather than intensive reading in a narrow specialty. The interpretation of original

research papers, reviews, and monographs so that they make sense to someone other than the specialist is an important job--a scholarly job. Perhaps we should think of the sequence: original research, scholarly interpretation, teaching the student.....or research, scholarship, teaching. The creative teacher can make a real contribution to the teaching of chemistry by writing papers which correlate a lot of developments in research along a given line and which present these developments in language that the upperclassman majoring in chemistry can understand. Such papers have appeared from time to time in the Journal of Chemical Education and can be of great help to chemistry teachers in bridging the gap between today's research and today's textbooks. The writing of textbooks is also a creative and scholarly activity.

Smith: While the aims of research may be detailed information, I think the methods of research are educational as well as interest developments.

From the Floor: The small liberal arts colleges should definitely not plan to be graduate schools and research institutes because they cannot, but one of the things it will do will be to keep the teacher alive, and I think Dr. Hill over there--the thing he has been doing has helped keep him alive. What if he does a little bit of applied research if it helps keep him alive; professionally then it is worthwhile. It seems to me that is the chief aim because none of us operate farms or anything like that. If, on the other hand, through liberal arts college research we can keep ourselves intellectually alive, it contributes directly to our chief job of being good teachers.

Lewis: I like the statement that Dr. Hartman made in this article in SCIENCE magazine. He said the liberal arts college professor who does research reconnoiters on the frontiers of learning, and that is about what he does. Hartman also calls him "the day laborer of science who adds stone on stone and sand grain on sand grain to the building." You ought to read this article. It will be found in SCIENCE, April 26, 1946, No. 2678, 493-496. Anyone else?

SCHAUER: You drew a bead on the Research Corporation a little while ago.

Lewis: Did I draw a bead on it? It must have been unintentional.

Schauer: I am a little sensitive. I feel a little bit like a sheep in wolf's clothing in this gathering. It was on the question of paying some type of a salary for faculty time. That problem I feel very strongly goes back to the university and college system itself. It's not one that an organization like ours can solve; it isn't one that I feel can or should be solved by any of the subterfuges that are very common at the time, very helpful too but are not broadly a solution to the problem. It's a matter of education of the administrations in helping them to raise funds, possibly to raise the salary levels.

Lewis: I suspect that we are up against two situations. The one is represented by the college possessed of inadequate resources; an increase in the general salary scale will of necessity be slow. Men in these colleges have the same desires for the creative experience as do men in the colleges of happier financial environment. Research time *per se* for these men is almost out of the question. That leaves research in teaching or research in the summer as the major alternatives. Hence the stressing of faculty grants-in-aid. Then we have the second situation of colleges with average to good financial environments. Here it is a matter of research stimulation where there is little or none, and grants such as those of the Research Corporation have provided the means and the incentive. It is true and has happened that colleges in the first category have been able to utilize Research Corporation funds through additional funds supplied by the college for the purchase of time. Hope College is a good illustration of this. Some of the others aided by the Research Corporation must likewise fall in the same category.

At any rate let no one think I was being critical of the Research Corporation. It has done a remarkable job.

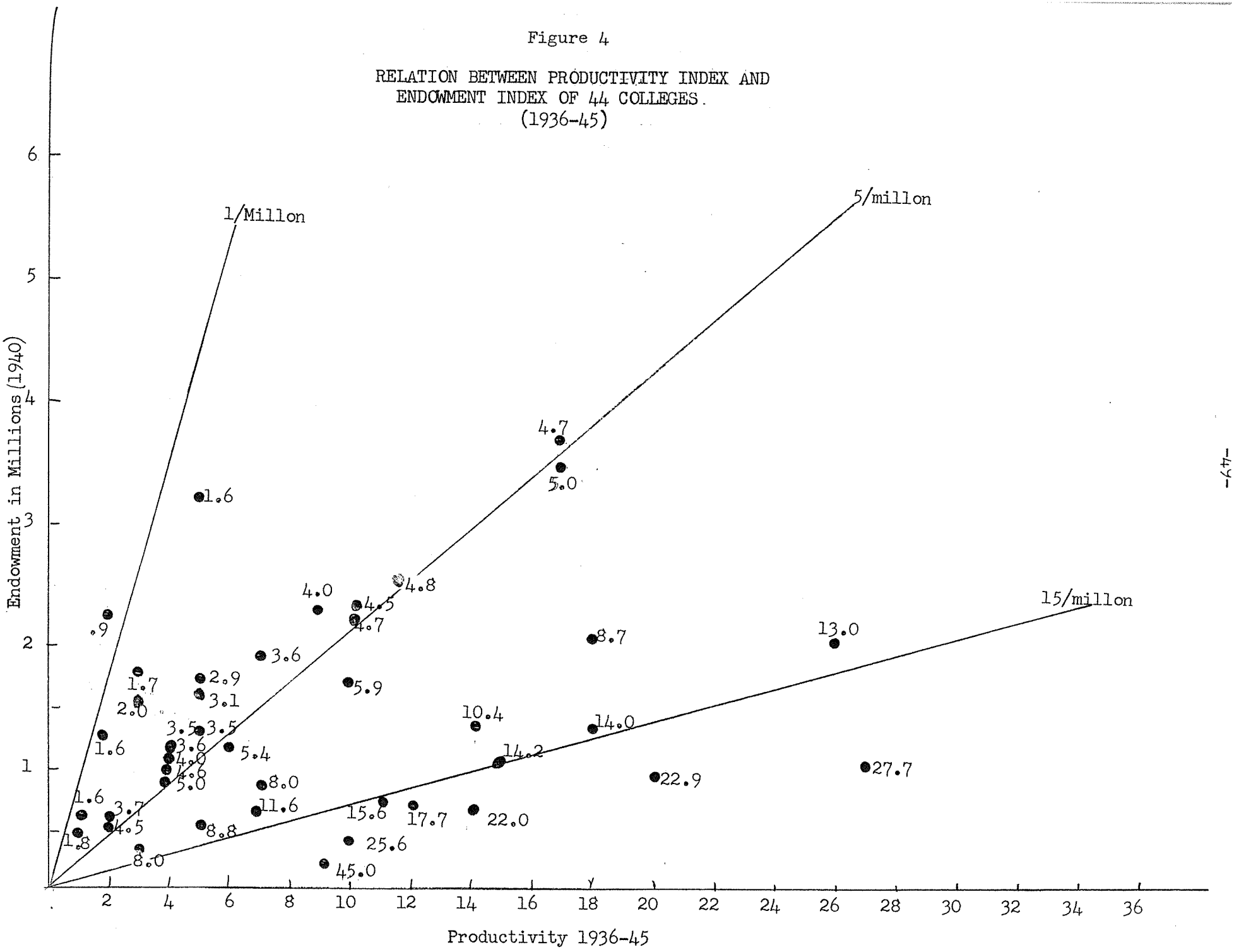
Danforth: I've been wondering as I've listened to the discussion on productivity and creativity whether there might not be a close relationship between the productivity and the endowment of a college--something such as $P = kE$.

Lewis: Maybe so. Let's look into it and write a paper. Actually there are some exceptions which might spoil such a relation--there are the very productive colleges with relatively little endowment, such as Manchester and Hiram. The same applies to creativity--there are very creative colleges with relatively little endowment. Furman is one illustration, Hope another.

Later, as I read the tape recording it seemed to me that I owed Joe Danforth something tangible and specific, so in an idle moment or two I jotted down the endowments of about 44 Middle Western schools for which we had productivity and creativity data in order to develop a new index, the Endowment Index, E.I. The E.I., or Endowment Index, represents the endowment of the schools in millions of dollars for the year 1940; in other words, a school with a $3,000,000 endowment in 1940 has an E.I. of 3.0. I then made a scatter graph of the E.I.'s against the P.I.'s and found not one common pattern but apparently three. There are some 16 colleges centering around a line drawn at a productivity rate of 15 Ph.D.'s per million endowment. A second group of 19 colleges centers around a line drawn through the productivity rate of 5 Ph.D.'s per million endowment. Then there is a group of nine colleges having a productivity rate of around one Ph.D. per million endowment. The values for productivity rates or productivity per million endowment are listed in Table VI, and illustrated graphically in Figure 4. Similar data for productivity for 1946-50 (as furnished by the National Research Council Committee on Scientific Manpower) and endowment have been included in Table VI and in Figure 5. Here the productivity for the five-year period is multiplied by 2 to make the values comparable to the earlier 1936-45 values. Headings for this column in Tables VI and VII should read PI 46-50 x 2/E 1952 (or in Table VII/B. 1952). Please correct.

Figure 4

RELATION BETWEEN PRODUCTIVITY INDEX AND ENDOWMENT INDEX OF 44 COLLEGES. (1936-45)



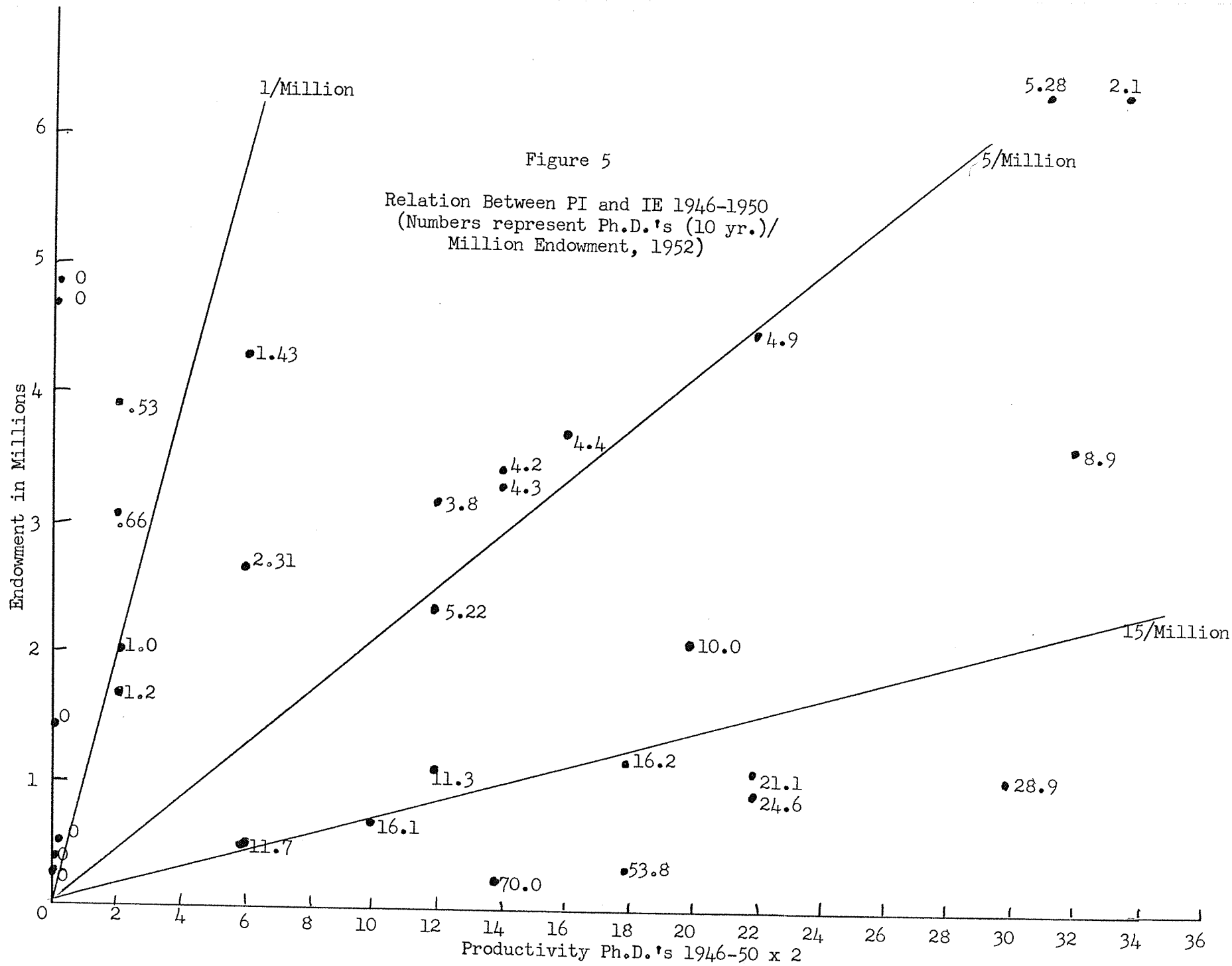


Figure 5

Relation Between PI and IE 1946-1950
(Numbers represent Ph.D.'s (10 yr.)/
Million Endowment, 1952)

Lewis: As we look at the colleges having a high productivity rate, the majority might be roughly classified as being in the "low endowment, high sense of mission" category. The schools in the second group would fall in the category of conventional, well-managed, and well-operating liberal arts colleges. Their productivity rate might indeed not be far off for the high-grade liberal arts colleges around the country. The third class has a number of different types of colleges; one is a college with extremely high endowment, and there certainly must be a point of diminishing return in terms of productivity as the endowment passes a large figure, for the relative amount devoted to enlarging the basic liberal arts course per se becomes constantly less as the figure is passed. As evidence of this, the relative productivity rates of a number of high endowment colleges follow: Amherst 0.83, Yale 0.54, Williams 0.65, and Princeton, 1.27. Random colleges in Ohio and Pennsylvania of ordinary endowments check our own group as follows: Allegheny 5.5, Wittenberg 5.8, Antioch 6.57, and Ohio Wesleyan 3.0. Willamette in Oregon has a 6.9 rate.

TABLE VI

PRODUCTIVITY RATES (Ph.D.'s per million endowment) FOR 44 COLLEGES

	P.I. 36-45/E 40	P.I. 46-50/E 52
Calvin	45.0	70.0
St. Olaf	27.7	16.2
Iowa Wesleyan	25.6	--
Hope	22.9	28.9
Manchester	23.0	16.1
Wheaton	17.7	24.6
St. Thomas	15.6	53.8
Hiram	14.2	--
Central (Missouri)	14.0	--
Monmouth	13.0	10.0
St. Ambrose	11.6	--
Kalamazoo	10.4	21.1
Luther	8.8	11.7
Wabash	8.7	4.3
Alma	8.0	--
Carthage	8.0	--
DePauw	7.5	5.3
Coe	5.9	--
Illinois	5.4	--
Ripon	5.0	--
Wooster	5.0	8.9
Beloit	4.8	3.8
Carleton	4.7	4.9
Grinnell	4.7	4.4
North Central	4.6	--

TABLE VI (Continued)

PRODUCTIVITY RATES (Ph.D.'s per million endowment) FOR 44 COLLEGES

	P.I. 36-45/E 40	P.I. 46-50/E 52
Knox	4.5	4.3
Parsons	4.5	--
Cornell	4.0	0.7
Milliken	4.0	11.3
Augustana	3.8	0
Carroll	3.7	0
William Jewell	3.6	--
Hamline	3.6	1.4
Drury	3.5	--
Drake	3.1	--
Oberlin	2.9	--
Park	2.9	1.0
Lawrence	2.0	5.2
Valparaiso	1.8	0
Albion	1.7	0
Earlham	1.6	1.2
Tarkio	1.6	--
Denison	1.6	0.5
Bradley	0.9	2.31

[P.I. data missing where there are blanks]

The one conclusion that seems to be possible from these data would be that the professor in the relatively financially poor school need not sit and twiddle his thumbs and bemoan his fate. Interest in the student as a person, the vigorous pursuit of professional opportunities in spite of limitations of time and equipment probably can be made to show a bigger return in such schools than in the ones with stronger financial environments.

So at any rate, Joe, $\underline{P}$ does not equal $\underline{kE}$ right across the board. There are at least two equations $\underline{P} = \underline{k_1 E}$ where $\underline{k_1}$ represents the plus factor, the something extra found in certain colleges, and $\underline{P} = \underline{k_2 E}$ where the reaction is in steady state in the absence of the plus factor. Does this sound right, or am I in a tizzy?

Just for fun, I then compared the 1952 "budget for educational and general purposes" against the 1946-50 productivity figures for selected colleges. These are in Table VII.

TABLE VII

PRODUCTIVITY PER MILLION ANNUAL BUDGET FOR EDUCATION AND GENERAL PURPOSES

College	P.I. 46-50/Budget 52
Hope	67.8
Kalamazoo	56.6
Monmouth	52.7
Wooster	41.8
Manchester	33.2
DePauw	32.7
Carleton	29.8
Calvin	25.0
Wabash	25.0
Wheaton	24.9
St. Olaf	24.3
Milliken	22.4
Knox	22.0
Lawrence	21.5
Oberlin	21.4
St. Thomas	21.1
Beloit	16.7
Grinnell	15.9
Luther	13.8
Hamline	10.9
Cornell	4.2
Earlham	4.0
Bradley	3.7

So it seems that $\underline{P} = \underline{kB}$ (where $\underline{B}$ is the budget figure for educational and general purposes) does not hold very much better than $\underline{P} = \underline{kE}$. The wide difference in productivity in terms of educational budget reflects the difference in emphasis, background, student interest, etc., but the same colleges are constantly high.

How Calvin can turn out potential Ph.D.'s at the rate of 70 per million endowment or 25 per million annual educational budget might be worth studying. How Hope turns out 28.9 per million endowment and 67.8 per million educational budget would also be worth investigating, especially since comparable figures for some well-known colleges are a tenth that or less.

The extension of the Trytten report to the 1946-50 period supports in general the belief that the productive schools of the late thirties are still productive schools--more power to them!

A further addendum by Father Pritzl of St. Norberts:

To measure the productivity of a Liberal Arts College Chemistry Department only in the light of the number of its graduates who eventually

complete work for a Doctor's degree or who take additional training in some professional school, seems to overlook the fact that there is also a need for persons with a Bachelor's degree whom the colleges should supply to industry and to research groups. Why should not the education of such scientific personnel be considered along with the above when measuring the productivity of a chemistry department?

Industries with alert research and development organizations seek and need individuals with the Bachelor's degree to whom they can give the opportunity of further development not only in chemistry and allied sciences but also in non-science fields. Such training makes the recipient more valuable to the organization's economy than a person with a Doctor's degree because this training has been in line with the company's policy not only for the present but also for the future. Of course, it is understood that the Bachelor has obtained the full benefit of his Liberal Arts education plus a thorough training in the fundamental courses and a good introduction to research which can be so well fostered in small classes and close contact with research-minded teachers.

This type of graduate will possess the superior mental qualifications of the good graduate student and also the special desire to obtain his advanced training in practical surroundings. He generally has an interest in every one of the fundamental courses of chemistry and the imagination necessary to bring forth ideas in whatever area the problems of industry may arise. He has the attitude that his education does not end in the classroom and therefore welcomes any chance for learning while he at the same time earns his livelihood. Because he has not yet specialized, he learns more from the variety of challenges brought his way than the specialist who too often is interested only in the problems congruous with his previous training. The Liberal Arts graduate with his broad outlook on life usually enjoys the characteristic of knowing how to get along with the technician, mechanic, and laborer, and thus fits well into the personnel situation of an organization.

ATTENDANCE LIST

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