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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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

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

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.

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.

GROUP 3 -- Discussion of the Chemistry Curriculum

L. B. Howell, Wabash, Chairman; Marianna Cherry, Milwaukee-Downer, Recorder.

Participants:

J. A. Campbell, Oberlin College; Marianna Cherry, Milwaukee-Downer; J. B. Culbertson, Cornell College; J. D. Danforth, Grinnell College; Frank G. Edson, William Jewell College; E. O. Ellingson, St. Olaf College; Fritz Fromm, Mount Mercy College; D. W. Gier, Park College; Kenneth L. Hamm, Carthage College; John C. Hayes, Hamline University; L. B. Howell, Wabash College; E. H. Lyons, Jr., The Principia College; Sister Mary Martinette, B.V.M., Mundelein College; F. J. Mathews, Beloit College; Paul A. Merkle, Simpson College; S. Parmerter, Wheaton College; Ben H. Peterson, Coe College; Earl W. Phelan, Argonne National Laboratory, A.E.C., J. J. Sjoblom. Lawrence College; Allen B. Stowe, Kalamazoo College; and H. B. Van Valkenburgh, Iowa Wesleyan College.

The topics considered by this group were chosen from a list submitted by members of the group. There were many other topics which deserved consideration, but which had to be eliminated because of lack of time.

1. The General Chemistry Course and the Place of Qualitative Analysis.

It was felt that a description of the introductory courses offered by the colleges represented to majors and nonmajors would be valuable in starting the discussion. It was found that twelve of the colleges represented at the time of this discussion offer eight-hour courses to majors, with five including some systematic qualitative analysis, and six offer ten-hour courses to majors, five including qualitative. There was greater variation in the offering to nonmajors, with three colleges offering courses with five to seven hours of credit, eleven with eight hours and three with ten hours. In addition, two colleges offer Physical Science courses, one to nonmajors, and the other to both groups. Seven of the colleges offering eight- or ten-hour courses to nonmajors include qualitative analysis. In five cases the same courses are offered to both majors and nonmajors. In general, the only distinction between those students who have had chemistry in high school and those who have not is in sectioning the classes, especially during the first semester. A brief discussion of textbooks used by members of the group in the general inorganic course showed wide scattering of preferences.

Many members of the group felt that Qualitative Analysis should be part of the first year course. Advantages of such a plan were stated to be: (1) It is an excellent method for teaching inorganic chemistry, especially the concept of equilibrium; (2) It is more interesting to the student, especially with regard to laboratory work; (3) It builds laboratory technique (all but one college represented use the semi-micro method); (4) It speeds up course sequence. Ten of the colleges give no further qualitative work, and a few others give less than one semester of qualitative as part of a course in Analytical Chemistry. In one more case, inorganic qualitative work is given in the senior year, with emphasis on instrumental analysis. Another college puts students with high placement test scores directly into Qualitative Analysis upon entrance, with extra help during the first part of the course.

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

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.

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.

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.

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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.

(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.

* * * * * *

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.

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.

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.

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.

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.

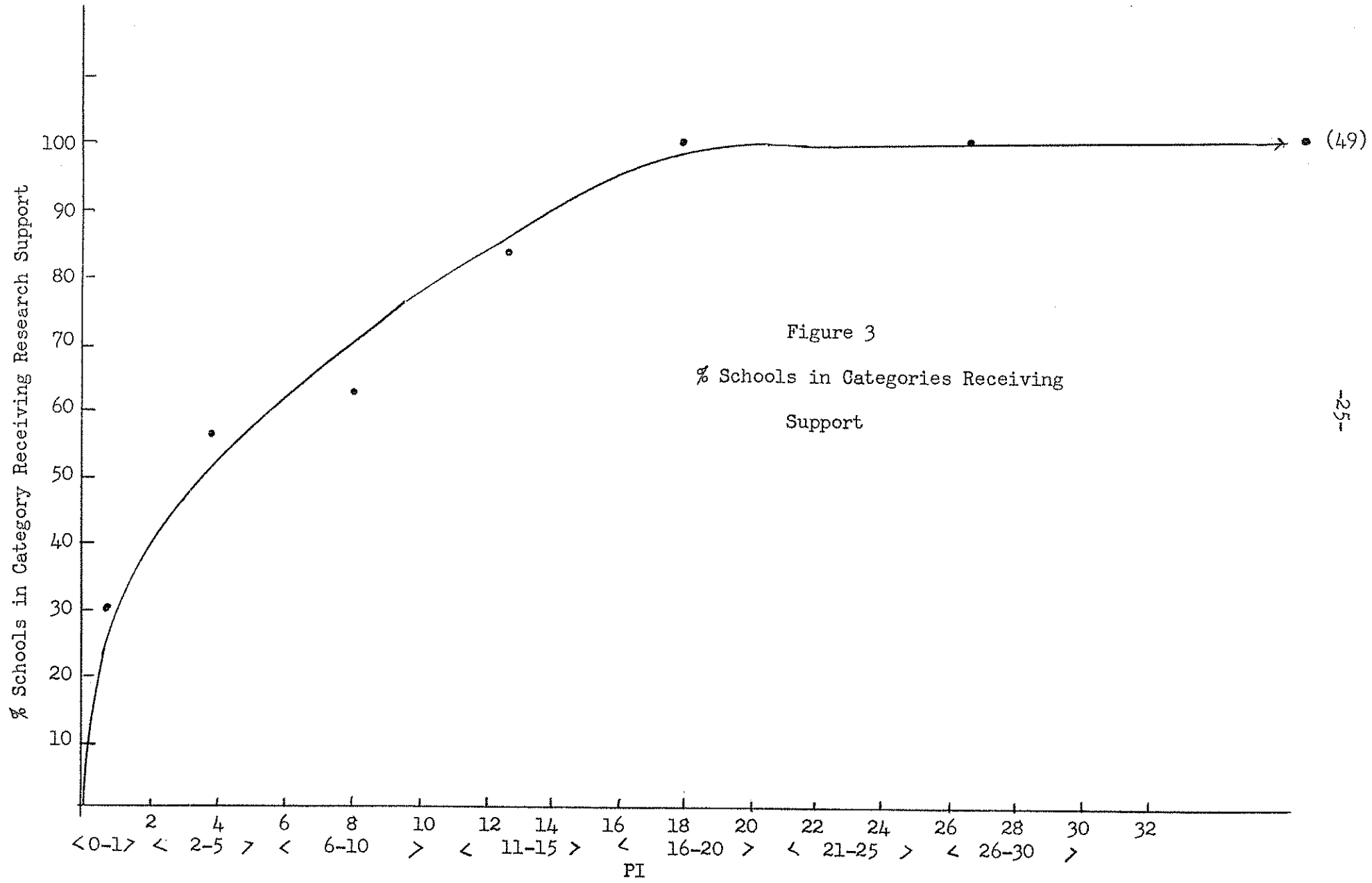


Figure 3

% Schools in Categories Receiving Support

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

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.

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

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

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

[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.

"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.

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

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.

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

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?

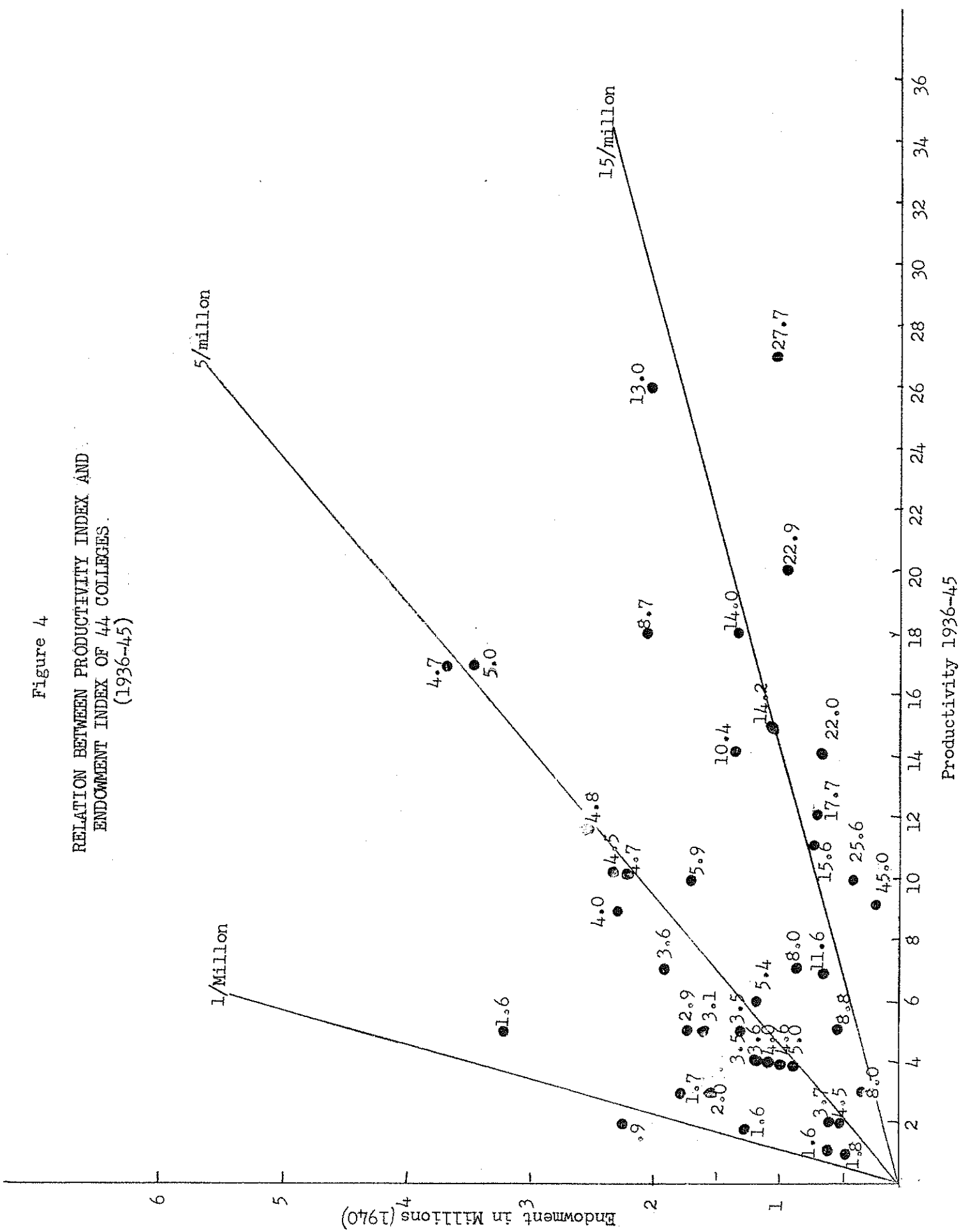
SCHAUER: You drew a bead on the Research Corporation a little while ago.

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.

Figure 4

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



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 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

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Oct. 16-17, 1953

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Sister Marie James	
Saint Mary's College	
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Rev. Peter P. Pritzl *	
Mr. Lawrence Motiff	

Lawrence College is so named in honor of Amos Lawrence, a well-to-do merchant of Boston whose interest and generosity led to its foundation in 1846, two years before Wisconsin became a state. He offered to help establish an educational institution provided certain conditions were met. The offer was accepted; on January 15, 1847 the Governor of the territory, Henry Dodge, signed the charter establishing the Lawrence Institute of Wisconsin. In 1849 the charter was changed by substituting the word "University" for "Institute," and the new institution was formally opened with 35 students. The first college class was organized in 1853. Since that time, Lawrence College has grown in size and influence--it has been, in the best sense of the word, an outstanding Liberal Arts college.

In 1929 a graduate school, The Institute of Paper Chemistry, was organized in affiliation with the College, having as its purpose the training in the sciences and technologies of the paper industry. Qualified students may pursue graduate studies for the degree of Master of Science and Doctor of Philosophy, which degrees are conferred by the College. The College and the Institute, though affiliated, are governed by separate Boards of Trustees and have separate staffs, budgets, and campuses. The President of the College is an ex-officio member of the Board of Trustees of the Institute; he also serves as Chairman of its standing Committee on Academic Policy.

The course requirements for admission to the Institute cover four fields of chemistry, a thorough course in physics, and a working knowledge of calculus. Scholarships are available in amounts of $1450 to $1550; from these tuition and fees are payable. Two years are normally required for the degree of Master of Science in course. The Doctor of Philosophy degree is conferred upon completion of the necessary additional requirements and the submission of an acceptable thesis, duly defended by the student. Since its founding the Institute has sent into the paper industry some 175 men; in that period it has conferred 128 Ph.D.'s and 191 M.S.'s. In addition to the men going directly into the paper industry there are about 65 who will be found in affiliated chemical industries.

Students interested in applying for admission and for a scholarship should write to the Dean of Admissions, J. Edward Todd, The Institute of Paper Chemistry, Appleton, Wis.

CONFERENCE OF MIDWESTERN LIBERAL ARTS COLLEGE TEACHERS OF CHEMISTRY

Institute of Paper Chemistry and Lawrence College
Appleton, Wisconsin

October 16, 17, 1953

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