1957 Meeting of

THE MIDWESTERN ASSOCIATION OF CHEMISTRY TEACHERS IN LIBERAL ARTS COLLEGES

held at

Park College

Parkville, Missouri

October 11, 12, 1957

Park College

1957

SIXTH ANNUAL CONFERENCE

MIDWESTERN ASSOCIATION OF CHEMISTRY TEACHERS

IN LIBERAL ARTS COLLEGES

Park College
Parkville, Missouri
October 11, 12, 1957

The sixth annual meeting of the Midwestern Association of Chemistry Teachers in Liberal Arts Colleges was held on the Park College campus, Parkville, Missouri, on Friday and Saturday, October 11, 12, 1957. The conference was attended by--delegates representing--institutions (list attached). Following registration on Friday morning, the group made brief tours through Midwest Research Institute and Linda Hall Technical Library in Kansas City. The delegates enjoyed a leisure lunch at Putsch's Cafeteria on the Country Club Plaza and then returned to Park College.

Dr. Perry Moore, President, called the first meeting to order and organized the discussion groups, (reports attached). The meeting progressed according to the scheduled program except that Dr. Delta W. Gier, Park College, presented the report on "Five Years of Progress" in the absence of Dr. Harry Lewis.

During the business meeting on Saturday afternoon, the association approved the sending of two telegrams--one message of congratulations to the South Central Independent College Association of Chemists who were holding their first meeting in Louisville, Kentucky, and one of appreciation and best wishes to Dr. Harry Lewis, Institute of Paper Chemistry, Appleton, Wisconsin.

The Executive Committee presented a slate of candidates for the coming year including: President, Dr. Parry Moore, Hamline University; Vice-President, Dr. Fred Mathews, Beloit College; Secretary-Treasurer, Dr. Richard Ramette, Carleton College. State representatives were elected by their respective groups for three states: Minnesota, Dr. Frances Greef, Carleton College; Missouri, Dr. Delta Gier, Park College; Wisconsin, Dr. Stephen Darling, Lawrence College.

Mr. Walter E. Thwaite, Jr., Director of the Midwest Field Office, Research Corporation attended the meeting and met informally with the members to discuss their particular interests in undergraduate research programs.

P R O G R A M

SIXTH ANNUAL MEETING OF MACTLAC

Park College, Parkville, Mo. Friday and Saturday October 11-12, 1957

FRIDAY

8:00 A.M.	Executive Council meeting
8:00-9:00	Registration
9:00	Bus leaves for Midwest Research Institute and Linda Hall Technical Library
12:30	Luncheon at Putsch's Cafeteria on the Country Club Plaza
2:00	Discussion Groups
3:30	Coffee
4:00	Discussion Groups
6:15	Dinner for members, wives, and guests at Park College dining hall
8:00	'Motivation Behind Accomplishment', by Dr. Charles Kimball, President, Midwest Research Institute in Graham Tyler Memorial Chapel. Public is invited.
9:30	Informal reception in Hawley Lounge.

SATURDAY

8:00 A.M.	Chemical and Instrument exhibits, A. S. Aloe and Chicago Apparatus.
	'Gadget' exhibit, by MACTLAC members (don't be modest, bring your favorite!!)
9:00	'The place of a Technical Library in Chemical Education', by Dr. Joseph Shipman, Linda Hall Library
9:45	Coffee
10:00	Discussion Groups
12:30	Luncheon
1:30	Research Inventory, Dr. Harry Lewis
2:15	Business Meeting
2:45	Adjournment

Mr. Walter E. Thwaite, Jr., Midwest Representative of Research Corporation will be present at the meeting to discuss undergraduate research programs with anyone who is interested.

REPORTS OF DISCUSSION GROUPS

I. The Better Student Problem

Chairman--Darling
Secretary--Wray

The meeting opened with the participants agreeing that the better students do present a problem in that they require additional stimulation if their talents are to be best developed. Also the need for special reward for the better students was recognized.

The placement of students in different general chemistry sections according to ability was noted at several institutions. At the University of Kansas (program in 2nd year) this is done on the basis of high school records and the first general chemistry hour exam. This year 40 out of 350 general chemistry students there attend different lectures where they study special topics of interest to the students and have more freedom in the laboratory. Incidently, they take the same exams as the other students "so as not to endanger their grades." This separation is to be continued in advanced courses.

At Evansville College (starting this year) the better students are to be put into a separate lab (but same lecture) in the 2nd quarter. They will carry out organic and inorganic preparations. An emphasis will be put on quantity as well as quality of work.

In the terminal general chemistry course at Wheaton last year 7 better students in a class of 30 were excused from regular lectures in the 2nd semester and sent on an individual problems basis. These students did better than the others on the final exam.

At Cornell the sectioning is on the basis of the Iowa Placement Test. The "upper" course (10 hours) includes qualitative and special problems sessions.

Students for the "Sophomore Studies" group (6 credits) at Lawrence are chosen by invitation of major department. This is a discussion course requiring much independent library research on the part of the student. The discussions on special topics are led by faculty members representing the chemistry, physics, biology and math departments.

Research projects for Juniors and Seniors, including salaried summer work, was of course recognized as stimulation and reward for the better students. Also mentioned were meetings (or dinners) at which students present papers; prizes are awarded and recognition is given to the individual high schools from which they graduated. An active student affiliates of the A.C.S. group on campus offers many possibilities. Getting the students to attend local A.C.S. meetings and having them meet the speakers was mentioned as a stimulating experience for them. Having the students give short lectures on special topics in advanced courses was discussed. The possibility of giving a special grade (A or B with distinction) as motivation to the better student to do extra work was proposed.

Some further pertinent questions whichwere discussed were:

1) How can we detect the better student? Certainly grades are not always a good criterion.
2) Should the better student who could finance his own college education be given a monetary scholarship?
3) Should placement exams be used to place the recent high school graduate into an advanced course?
4) Should the better students be separated from the poorer ones-- or does such a separation only leave the poorer ones without the stimulation that the better student offers in class with his penetrating questions and answers?

II. Research
Chairman-- R.E. Hamilton
Secretary, Frances Greef

Members of the group gave brief reports of research being conducted at their institutions. They ranged from little or no research to very active programs beginning at the freshman level. Mr. W. Thwaite told of the program of the Research Corp., and urged the group to submit to him research proposals. The Research Corp., will, if a proposal is accepted, buy supplies and equipment for a research project, furnish student salaries at college rates, but they do not pay any faculty salaries.

Dr. Phelan of the Argonne National Laboratory described their program. They take faculty for 2 mos. or longer, place them in an existing research team, pay one-ninth their yearly salary plus $100 per month. They take students for summer research at $2.25 per hour.

Dr. L.E. Strong visited the group and described the interdepartmental soil research program at Earlham, supported by Kettering grants and carried out on a faculty volunteer ba s during the school year and summer months. (Over 40 students have had a part in this program over the past few years.)

Dr. D. Gier described how Park College got their initial grant from the Research Corporation which set their program underway. Students participating must take a course in chemical literature and do a complete literature search before beginning research work. This has attracted many to their college.

Discussion brought out the following main problems: Where to get the research problem, the financial support, and the time to pursue it.

Research ideas may evolve from reading the literature, consultation with state university staffs and summer industrial research positions.

To get a good research grant one must have had a grant, and Research Corporation seems to be a good place to apply for that first important grant. Other sources of grants are N.S.F., other government agencies, and industry.

There was no general agreement on what students to use in research--the freshman, the senior; the weak student and/or the strong. Other questions were: Should students be paid? How to encourage research when full academic programs with heavy chemistry and liberal arts graduation requirements are being carried. Is research necessary at the undergraduate level or do we discourage good students by confronting them with possible frustration at this early stage in their careers? How faculty members find time for directing student research.

There will be no student research unless there is first faculty research. Extra faculty are needed in some colleges if vital research programs are to be conducted and grants may assist in obtaining these faculty. Research can be stimulating and attract people to science. Often a weak student who becomes engaged in research develops into a promising chemist. Some type of research program is a necessary part of the chemistry department of our liberal arts colleges.

III. Changes in the Chemistry Curriculum
Chairman--W. Oelke
Secretary--J. P. Huselton

A discussion of the present 4-year program suggested the following outline:

A. Should anything be omitted or added? Would that suggest a rearrangement of course work?
   1. Repetition of high school chemistry. Are students bored?
   2. Articulation of high school with college.
B. Will the newer trends solve the problem better?
C. Can the present 4-year program be adapted to current and future chemistry?

As Professor Strong was present, the discussion quickly moved to the new Earlham program. The first semester, with Whittaker's "Rudiments of Chemistry", is largely inorganic and centers around the periodic table, esp. the first 20 elements. The lab includes preparations, determination of properties, techniques. The second semester, with Cason's "Principles of Organic Chemistry", deals largely with carbon compounds. The second year will cover the ionic bond, coordination number, complex compounds, solution equilibria. The lab will involve inorganic preparations and analytical work. The third year is to include aromaticity, resonance, and reaction mechanism. Strong feels that no industrial process should be introduced if it does not supplement the theory. Concepts and experience should be related, esp. toward making predictions.

Questions asked were: Are the new programs putting in new material and leaving out some less important, or are they giving the same program in different order so the student will have the same background? Is repetition a waste of time or is it good teaching? A discussion on course sequence followed. It was brought out that liberal arts schools have scheduling difficulties and students often cannot take the recommended program.

In the second session improvements in the approach to the first year lab were discussed. Some feel that too much physical in the first year course and few fundamentals is producing students who are not "chemists." One suggestion was that qualitative analysis could be put into the first semester so that the good high school students would not be bored. A discussion of the various qualitative schemes ensued, also the usefulness in the first or second year.

Preparative aspects of the first year lab suggested a study of substances on the basis of physical and chemical properties. Unknowns may be given in the freshman lab. As grading of lab reports may take too much unrewarded effort, a low emphasis is placed upon the usual reports, more on oral quizzes by some. Others use frequent written quizzes to cover past work. Individual lucid reports in good English could be required. As a primary purpose of lab is training in competant observation, these reports could be turned over to other students as lab directions. Student-planned experiments of project type can be used for creating interest. To introduce the student to proper laboratory and observational technique, the demonstration approach might be used initially. Short films, projectors with transparencies, etc. are supplements.

As to the quantitative and physical labs, to keep these from being "cook-book," the students should outline steps previously, and limits of error and precision of measurement should be used. Perhaps this mathematical treatment should be initiated in the first year.

IV. Curriculum

Chairman--J. D. Danforth
Secretary--A. L. Hanson

The group was first polled to learn reasons for special interest in curriculum study; most of the fourteen present wished to improve present courses and sequences, a few stressing placement of organic in the second year. As to procedure we agreed to limit consideration to the program for chemistry majors, important as other courses (e.g. terminal) might be. We decided to analyze the chemistry curriculum by subject topics, disregarding traditional groupings and courses (and found the latter hard to do even for mere purpose of discussion).

Eight arbitrary categories were set up and essential chemistry topics were listed in them with the thought of discovering logical groupings and sequences which would comprise courses. A tentative offering in the First Course might on this basis contain the following:

History: (science chronology; atomic theory; 19th century basic laws; periodic table; Avogadro's work; relativity and quantum theory)--all treated in elementary fashion;

Descriptive: (Properties of solid, liquid, gas; solutions; colloids; electrochemistry);

Reactions: (Preparation and properties of selected elements and compounds);

Kinetics: (Reaction speed factors; reversibility; catalysis; equilibrium);
Thermodynamics: (Heat; energy; temperature; reaction heats; entropy)--all broadly descriptive;
Techniques: (Simple quantitative operations; manipulations; separations; gas preparation and collection; handling of reagents);
Structure: (Atomic; valence; bonding);
Research: (Unknowns).
Similarly coursed for succeeding years could be built up. We found our inclusion for the first year differed little from current practice. Teachers will always stress what interests them. Many felt that Structure should receive greatest emphasis and that much of Kinetics and mechanism could be deferred to the second year. This was especially true if the second year course dealt with organic, as is the current trend. Many thought thermochemistry as well as equilibrium fit well into organic applications. In search of "dead wood" to eliminate from the course some suggested that the gas laws are overstressed; others noted the need for working knowledge of gases in the laboratory. Many wished to delete equivalent weight and normality from first year work.

Not all general comments can be included, but the following seemed to meet the best response. 1) Descriptive vs. structural approach in the first course. Most seemed to favor the latter, but B. Shawver cited success in the Monmouth plan which begins descriptively with the atmosphere, leads to structure after 3-4 weeks, features many demonstrations (e.g. liquid air), uses study outlines and daily quizes.

2) Qualitative analysis got its usual going over, inconclusively as usual, with agreement on the research aspects of unknowns and drill value in inorganic reactions as important features.

3) Mathematical preparation before college was seen as being especially important to a combined physics-chemistry course as is used at Wabash. Improved mathematical ability among freshmen was noted at Grinnell, possibly due to increased rejection of admission applicants.

4) The possibility of alternating chemistry courses and thus lighten teaching load was suggested, but the importance of certain course sequences makes this difficult to do.

5) Several expressed interest in the case study presentation of historical chemistry. At St. Olaf, Case 4 of the Harvard series, i.e. L. K. Nash: The Atomic Molecular Theory Harvard University Press, Cambridge, Mass.) is used in one rather intensive development.

6) Analytical chemistry received attention, particularly in its applications to sound organic chemistry and other courses. One proposal suggested elimination of quantitative as a separate course and incorporating the teaching of analytical principles in inorganic and organic chemistry over a three-year period.

7) The importance of research training was stressed, e.g. use of unknowns, At Calvin, students have re-worked in detail experiments which failed; some received extra credit in the course, and continued work on their own the next year because of the interest developed.

It was generally felt that much material is repeated in the usual chemistry curriculum. Repetition may sometimes be wholesome and necessary but if it is superficial treatment of the subject that necessitates repetition, the first investigation should be more thorough. We must develop the essentials soundly even if we do not explore widely enough to provide our students with all the answers to problems which will later arise in graduate school.

The following goals were suggested as being worthy of effort toward change in curriculum: a) Make chemistry more interesting to the student; b) Provide greater efficiency in teaching; c) Keep offerings up to date--introduce new concepts and experiences when they become known and discard the old when it ceases to be a good teaching tool or becomes obsolete in practice; d) Provide offerings which progressively enable the student to judge whether he should remain in chemistry as a life's work.

V. Miscellaneous
Chairman--C. B. Coleman
Secretary--Sister Mary Martinette

A small group of MACTLAC members petitioned for the privilege of discussing any and all topics presented at the general meeting for discussion. In spite of some objections the committee was allowed to form and was composed of seven members. They wish to go on record as having found the opportunities for discussion and exchange of ideas exactly to their liking and extremely beneficial. They followed the general plan as formulated at the general meeting and found that their discussion seemed to follow quite logically from one topic to the others.

Interest centered around sequence in the TEXTBOOKS used in a first course. It was agreed that a textbook with the approach to chemistry which began with the structure of atoms was most desirable. Dr. Bever of Milwaukee-Downer emphasized the important advantages of high mathematics rating and reading level to the first year college chemistry student. Mrs. Simmons of Barat told of a basic physical science course required of all of their first year students. They do not begin their formal chemistry courses until sophomore year and find that the program works very well. Much discussion ensued regarding the best way of dividing the freshmen groups on the basis of ability. Dr. Pennington of Coe College was particularly anxious for a solution to the problem but the group could only present their ideas and extend their sympathy. It is admittedly a difficult problem with each one of us.

In the discussion of freshmen work the importance of THE SUPERIOR STUDENT was introduced. First it was pointed out that in laboratory work he can be challenged. Dr. Coleman of Knox College felt that such students could be given special problems which would prove both challenging and instructive. Whether they should be introduced to library searching in their first year was questioned. Dr. Bever felt thay should be referred to other texts, etc., early in their careers. Dr. Pennington

spoke of the Wabash College program of concentrating course work. Everyone agreed that scheduling and faculty problems arose from such a program. THE NORTHWESTERN UNIVERSITY CONFERENCE ON THE SUPEPIOR STUDENT, June 1957, was cinsidered. Dr. Davidson of Kansas University, who was at the conference, had discussed it with one of this group who then relayed the points of interest. Dr. Coleman said that Knox College is committed to give the superior student consideration. Mundelein College is on record as willing to do so also. Research opportunities in the small colleges are considered a good outlet for superior students. Dr. Harris of Knox College suggested an instrumental analysis course in senior year.

This led into the subject of the STUDENT AND UNDERGPADUATE WOPK IN RESEARCH in general. Knox College offers a maximum of 5 hours of credit for research. Mundelein college offers research opportunities, without credit. Dr. Coleman said he felt research should be an "elite proposition"... admittedly not all undergraduate students should undertake it. Dr. Harris pointed out the importance of "group effort" in research as a realistic approach. Mrs. Simmons asked if the group was aware of the CORTELYOU PROGRAM with which they at Barat have been cooperating in their student research program. Dr. Pennington felt that student research should be very basic, original and express individuality. Dr. Bever called attention to the fact that senior research was of motivational value for the lower division students. Sources of research grants and equipment were tabulated. Dr. Pennington pointed to the need for some type of research subsidy for small college professors which would not take them from their own homes and campuses during the summer.

At this point the committee came back for a moment to the question of textbooks as they wished to compare the textbooks and manuals used in other courses on their respective campuses. Dr. Wolfe of Evansville College asked about textbooks for courses in chemistry for nurses. It was suggested that more stringent courses should be required in view of the chemistry asked in the state examinations. The CHEMISTRY COURSE FOR NURSES was discussed. Sister Mary Martinette described the college degree course in MEDICAL TECHNOLOGY offered at Mundelein in which students spend their third year in training at a recognized hospital.

The group was asked about SENIOR COMPREHENSIVE EXAMINATIONS in chemistry. Barat has six hour written examinations. Milwaukee-Downer, Knox and Evansville Colleges do not give senior comprehansive examinations in chemistry. Mundelein has a six hour written examination. Knox College has an HONORS PROGRAM which Dr. Coleman explained. Mundelein College offers departmental honors in chemistry.

When considering the topic, SEQUENCE OF COURSES, the group recalled the various changes which have been proposed and subsequently experimented with in some places. The advantages and disadvantages as they saw them were pointed out. However, they favored leaving the present sequence alone.

Finally, the SCHOLARSHIP PROGRAM at Knox College was described and the availability of scholarships in general was considered. This led to methods of interesting students in science as a major and the national need for awakening interest.

MOTIVATION BEHIND ACCOMPLISHMENT

The Importance of Creativity in Research

Dr. Charles N. Kimball
President, Midwest Research Institute
Kansas City, Missouri

"There really haven't been very many spectacularly productive applied research organizations--civilian or military," says Dr. Lee DuBridge, President of California Institute of Technology. "Wherever you find a highly successful group, I suggest the seek the caudes for its success not in the organization chart, not in the budget, not by counting uniforms or rank, not by the splendor of buildings or equipment, but by finding a man or small group of men who have created the spirit of the place and who know how to preserve that spirit."

Creative effort has been described as "The imagination that looks forward, foresees, supplies, completes, plans, invents, solves, advances, originates." It is significant that there is not a single passive verb in this whole list.

Many a company has stated that if it discontinued its research program it would be out of business in a few years. Others say that the majority of their present products have been developed in the last decade or so. There is no question about the economic value of research. It is big business today, with about $3 billion being spent annually in this country. Twenty years ago less than 1/50th of this sum was expended per year for research and development.

Competition Will Require Better Research

There is increasing competition among larger companies, and the smaller ones are striving to grow. Industrial research is entering an era which will require much better research. Since there will be more of this activity, specialists in the field will become harder to get. This means there will have to be more productive ideas per research man. These results cannot be achieved merely by building larger laboratories or spending more money for expensive equipment. Results will be achieved by virtue of great creativity and improved scientific thinking; in other words, more research results per dollar expended.

In fact, we can look forward to a situation which does not discriminate merely between the companies which do research and product development poorly and those which do it well. Rather the distinction will be made between organizations doing a good job and others performing in quite superior fashion. This places a great responsibility on the man in charge of research, whether he be the corporate vice president assigned to this activity, or the top man in an "outside" research laboratory or institute.

I can sssure you also, that there is no better way to waste money than to do research or development without a blueprint for action. There are as many tricks to the trade inthis field as in any other. There are research techniques, short cuts, ways of saving time and

money, which one cannot learn from books, but which are incorporated in the point of view of any mature research organization, whether it is entirely in the employ of a corporation or, as is often the case, exists in the form of "outside" research and development laboratories or institutes.

Creative Power

Only recently have scientists really recognized the part played by creative power. Kettering of General Motors has done much to stimulate this recognition, and so have Dr. Suits of General Electric and many of the younger leaders. The American Society of Mechanical Engineers has conducted seminars solely "to emphasize the importance of creative ability in engineering." The American Chemical Society's Committee on Professional Training recently reported: "It is lack of ability in original thinking that makes far too many men of doctoral training unsuitable for industrial research."

Most of us are highly imaginative in childhood, and yet many of us grow up to be non-creative. One reason for this may be that as a nation we have not made enough of the importance of ideas. Another reason is that many parents are guilty either of active discouragement, or at least of lack of active encouragement of their children.

Ralph Waldo Emerson once said that the hardest work in the world is creative thinking. Dr. Willard H. Dow, Tom Edison, and E. M. Statler, all considered by others as geniuses, have said that the basis of most of their creative output was intense concentration and application.

One of the best devices to activate imagination is to make a start. To shove off on a creative voyage is not easy--our brains are so prone to drift. As William James pointed out, "In the dim background of our mind we know what we ought to be doing, but somehow we cannot start. Every moment we expect the spell to break, but it continues, pulse after pulse, and we float with it."

Time Out for Thinking

He said also that if we set aside a definite period for creative thinking, we can best lure the muse. This rule should govern those of us in research. We should take time out for thinking up ideas--nothing else. Too many businessmen tackle routine first, usually because it is easier. Morning should be reserved for thinking, afternoons for routine. Creative thinking must be planned.

Our thinking mind is mainly two-fold: (1) a judicial mind which analyzes, compares and chooses; (2) a creative mind which visualizes, foresees, and generates ideas. Judgment can help keep imagination on the track, and imagination can help enlighten judgment.

Judicial effort and creative effort are alike in that both call for analysis and synthesis. The judicial mind breaks facts down, weighs them, compares them, rejects some, keeps others--and then puts together the resultant elements to form a conclusion. The creative mind does much the same, except that the end product is an idea instead of a verdict.

Then, too, whereas judgment tends to confine itself to facts in hand, imagination has to reach out for the unknown--almost to the point of making two and two equal something more than four.

It is generally accepted that men can be motivated to be more creative, but some people will never be creative. They plainly do not have the mental ability to do so. Perhaps we should not waste out time trying to stimulate them. Some other people are lazy, but have the latent talent and can be taught by exposure and example.

Once having created something it is often useful to trace back one's thought patterns to see if he can trace the thought process resulting in the creation.

Five Types of Research Organizations

Before discussing creativity in research, we ought first to realize that we do not mean solely "invention" but include scientific ingenuity and resourcefulness. The five different major types of organizations in which research is carried on in this country are:

1. Industrial research laboratories wholly owned by corporations, which maintain research and development groups varying in size from a few men to several thousand, where the object is the evolution of new processes and products for these corporations.

2. Government agencies, which have extensive research and development facilities operated by the nation's military agencies, Agriculture Department, Bureau of Standards, and many others.

3. Universities, where much fundamental research work is carried on by individual staff members.

4. Commercial research and development laboratories.

5. Nonprofit industrial research institutes, which were organized to fill specific needs in serving industry, government, and the general public.

The Midwest Research Institute

These remarks should be applicable to all successful research and development groups, but the specific background is based on the 10 year experience of Midwest Research Institute in Kansas City, which was founded in 1945 by public spirited industrialists in the Middle West to do research and development work on a nonprofit basis in the broad fields of chemistry, engineering, and economics.

The initial objective was to up-grade the industrial and agricultural economy of the six states of Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma. This institute, in these ten years, has completed 1,400 different research and development assignments for over 600 companies throughout the country with some 75% of them being located in the states

I mentioned. A few typical groups for which assignments have been completed successfully are: Carey Salt Company, Converted Rice Inc., Carpenter Paper Company, Spencer Chemical Company, Corn Products Refining Company, Ethyl Corporation, Goodyear Tire and Rubber Company, Hallmark Cards, The Maytag Company, Olin Mathieson Chemical Corp., Shaeffer Pen Company, Sparks-Withington, and Trans-World Airlines.

We have a staff in Kansas City of 245 people, of whom 180 are professionally trained research and development men and women, who come from 67 different colleges and universities and who work in 15 different scientific fields, the major ones being chemical engineering, organic chemistry, food technology, home economics, applied physics, mechanical and electrical engineering, metallurgy, operations research, market research, and applied mathematics, including our computation center. With nearly a million dollars worth of equipment, and employing a clinical approach to the solution of all its problems, this means that the average client or sponsor has at his command equipment and men of great technical diversity. The Institute has a net worth of nearly $2 million, its capital funds having come from tax deductible contributions from 720 different corporations and individuals throughout the Middle West.

Work is done on a completely confidential basis for our sponsors, who engage us on an at-cost basis, with the maximum estimates of time and money agreed upon in advance, with all patent rights becoming the property of the client.

Selection for Creative Ability

Having a relatively small group as we do, we not only try to, but have to, follow certain procedures, both in selecting people for creative abilities and in up-grading the creativity of the older hands. With respect to selecting creative people, there are no defined tests that one can give. By and large, this is a matter of awareness, motivation, frame of mind, psychological background, and in some cases, economic background.

An analysis of almost all the psychological tests ever made points to the conclusion that creative talent is normally distributed--that all of us possess this talent to a lesser or greater degree--and that our creative efficacy varies more in ratio to our output of mental energy than in ratio to our inborn talent. People who are creatively alert are much more interesting than those who are not. They seem almost to belong to a different species, or perhaps to a higher level of evolution. They seem almost what is but what might be; and the power to see what might be is one of the chief traits that distinguish human beings from one another.

We first have to determine that the man has adequate technical competence, which latter point is relatively easier to ascertain. We make wide use of references for new men. We call these references on the phone and ask questions about the man's technical ability, point of view, and frame of mind. The major question that has to be answered is this: How responsive is he to the stimuli which we explain to him and which I will explain to you. By means of interviews, we expose applicants to

people of established creative ability on our own staff in order to get the reactions of our own staff members concerning the creativity of the applicant.

Independent research groups such as Midwest Research have stimuli to creativity which exist perhaps to greater degree there than in the usual research organization. First of all, Midwest Research Institute, while it is a non-profit organization, is also non-loss in that we have no endowment and we must make our own way. Its net worth of $2-million is a capital, not an operating fund. Therefore, successful research, creative research, is absolutely essential since we get our assignments, usually at the rate of only one at a time, from the 75 or so companies we are currently working for. That is, we have to get the first assignment successfully completed before we get the second.

The average scientist at Midwest and other research institutes has perhaps more complete responsibility for project performance than he would in a captive laboratory. While he may be reporting on the Institute organization chart to one of our directors or managers, at the same time he is also reporting to one of the top technical men in the sponsoring company. He therefore sees his problems firsthand, and similarly visualizes his opportunities for accomplishment. This intimate contact with people who are paying directly for the work is a tremendous stimulus. Additionally, our technical men are daily comparing ideas with sponsors. In a sense, our men keep in good tip-top mental state. The analogy of athletic competition is obvious here.

Additionally, we have gone a long way toward upsetting the caste system. New ideas, maturity of point of view, and ingenuity of solution are what count more than does rank.

Change in Projects Creates Variety

Another point which bears discussion here is the relatively rapid turnover in projects which keeps our people from going stale. The average length of project is about 6 months, although some are considerably longer. Therefore, our people are dealing in new technical situations on the average of every 6 months. The need for ingenuity is obvious to a marked degree. If you give us a new graduate who has had only average marks in school, but who has shown he can think creatively, we can make a better practicing scientist out of him than if he were an unimaginative valedictorian of his graduating class.

As you may know, these research institutes get most of their research assignments by writing proposals at the request of potential sponsoring companies. I would say that the writing of a lucid and compelling proposal is as much a test of one's creativity as is laboratory work. In fact, I think we will all agree that a sensible outline for a research project is half the battle. Incidentally, writing can do much to train imagination. Scientific tests rate "facility in writing" as a basic index of creative aptitude.

All of these factors mentioned above are multiplied several times when we refer to our senior people. They have multiple responsibilities to several projects and therefore the creativity extension is obvious. There is, therefore, in our type of acitivity, a premium placed on ideas for new projects. We are competing, if you will, or comparing mental abilities almost daily with some of the best technical minds on the American corporate scene.

Too many research workers are problem solvers, and are concerned more with the niceties of techniques than with the leaping imagination which results in brand new concepts.

Much Creative Potential Lost

It is my conviction that creative abilities are not primarily a fift of the gods, but rather are the fruits of opportunity, stimulation, and growth. Much creative potential never emerges, a condition caused by faulty educational methods in early life and subsequently furthered by the demands of the work-a-day world, which is primarily concerned with the practical use of ability rather than the development of potential ability. Bearing on this point, H. G. Wells once said: "England alone in the last three centuries must have produced scores of Newtons who never learned to read, hundreds of Darwins, Daltons, Bacons, and Huxleys, who died in stunted hovels, or never got a chance to prove their quality. All the world over there must have been myriads of potential first-class investigators, splendid artists, creative minds, who never caught a gleam of inspiration or opportunity for every one of that kind, who has left his mark upon the world."

In a similar vein, A. H. Maslow, in an article titled "Problem-Centering vs. Means-Centering in Science" makes some observations which bear upon creativity. The creative scientist is primarily problem-centered, but the technician is usually means-centered, The latter is concerned with polish, apparatus, buildings, titles, and prestige symbols, and the former is concerned with meaningfulness, vitality, and the significance of problems in general--in short, with creativity.

Technicians tend to be apparatus men and methodologists, and creative workers are question-askers and problem-solvers. The first are concerned primarily with how a problem should be solved, but the latter want to know what problems should be solved. The technician becomes overconcerned with quantitative facts and the way in which they are expressed; the creative scientist is interested in results and valuable contributions, The man whose primary interest is methodology tends to fit problems into his techniques rather than find or invent techniques which will supply solutions to problems. Those who emphasize means foster the building of walls that divide science into discrete and separate territories; these people become engineers, chemists, physicists, psychologists or mathematicians, The creative man has little concern for the walls of a discipline or or even for departments when such dimensions get in the way of problem solving. Scientists who are creative find more similarities among their fellow scientists than they find differences, thus a creative spirit finds other creative workers mutually collaborative, irrespective of

their degrees, their titles, or their labels. Someone has pointed out on this angle that the degrees a man has accumulated indicate only degrees of exposure rather than a guarantee of creativity.

In public life or in business, creative thinking is vital to leadership. Although a research leader must possess judicial judgment to a marked degree, he cannot be solely a judge--he must also excel in resourcefulness. Then, too, he needs to recognize the value of creativity, and to know how to tap and encourage the creative power of his associates.

One of the needs of big business is to bring up the creative power of second-line executives. They sit in plenty of conferences, but are too often tempted to use their imaginations merely to anticipate how their associates will react. Such anti-creative tendencies can often be overcome by active encouragement on the part of those at the top.

The eight outstanding characteristics of people with outstanding achievement records are:

1. They can get along with other people. They can see and understand people objectively. They deal with them impersonally to accomplish goals.

2. Their intelligence level is well above average, but not necessarily tops.

3. They have a high level of psychic and mental energy. They have drive and aggressiveness. They are willing and able to work long hours with intense concentration to get things done.

4. They want to be better than their competitors.

5. They have innate ability to explain ideas simply in words that others can understand.

6. They have self-reliance. They have no doubt of their own abilities to do a job and do it well.

7. They possess empathy. They have sensitivity to the ways others feel about things and the way in which other people think. Empathy is not to be confused with sympathy. Empathy indicates understanding but not necessarily agreement.

8. They possess "closure" ability. This is the ability to bring apparently unrelated things together conclusively to form a distinct solution or picture. That is, they can see the forest instead of the trees.

The material for this article was obtained from three sources:

1. Extensive experience in this field by the Midwest Research Institute staff.
2. Discussions with Mr. Lyle Spencer, President of Science Research Associates, Inc., Chicago, whose firm has worked extensively in the field of motivation research.

3. An excellent book entitled "Applied Imagination," by Alexander S. Osborn from which I have drawn some of the data concerning creativity.

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Manuel, William (AM), Ohio Wesleyan U., Delaware, Ohio
Marschner, Robert (AM), Standard Oil Foundation, 910 S. Michigan, Chicago 80, Illinois
Martinette, Sister Mary, Mundelein, Chicago, Illinois
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