UNDERGRADUATE RESEARCH IN OUR COLLEGES AND UNIVERSITIES.

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The purpose of this paper would have been better expressed if the title had been the relation of industry to undergraduate research in the schools of Indiana. The point of view is that of the scientific man in industry who would draw our educational and industrial institutions closer together.

The Scientech Club of Indianapolis has been interested in promoting Research from the time it was organized, though we are yet in early childhood, having first seen light in 1918. The membership of this organization which is drawn from the professional, scientific, and technical men of the state of Indiana, consists almost entirely of university and college trained men. In our directorate are included representatives of ten or twelve national and state scientific and technical societies. We believe that our organization composed as it is of professional men from the industries, is appreciative of the points of view of both the university faculty and the directors of industry.

Consequently, when I say that the Scientech Club is vitally interested in Research in our schools, it means that our national and state scientific organizations are alive to its value. Most of the national organizations are prevented by their constitutions from participating in local issues and consequently the sentiments of their members are being voiced through the Scientech Club.

It has been the general experience in the past that too many of our technical and scientific graduates are unable to stand on their own feet when they meet relatively simple problems. They seem to have bounded their courses on the north, south, east and west by the backs of their text books. A recent cartoon depicted a graduate groaning under a load of books marked "Knowledge" and unable to accept the volume of "Wisdom" offered him. The wisdom and judgment secured from using this knowledge acquired, is lacking. Their knowledge is too often unorganized and disconnected. They know their theories, perhaps, but they do not know how to apply them. We do not expect the universities to turn out men in four years who are capable of solving hard problems, but it is discouraging when a chemist cannot prepare a simple soap without being minutely instructed, or when an engineer is unable to apply his theories to a bridge which differed from the one in the text.

Is it the student's fault that he lacks the quality of judgment? Rather is it not the result of how he is trained? Is it not absurd to give all the details of work to the undergraduate and then expect him when a graduate, to show initiative or creative power?

When a man has thoroughly thought out and worked out his first problem in a logical manner, we find him able to apply his theories to the next with less trouble. It is not imposible to teach a man how to solve problems when in the plant, but it is unprofitable and unnecessary if our schools are fulfilling their mission. The university is far better fitted to accomplish this than is the industry, for in the latter the student, now an employee, must be a secondary consideration.

A guess that is wrong is much better than no guess at all—the positive is better than the negative. There is hope for those who have been trained to think. The usual routine of lecture, quiz, and laboratory work, too often on separate parts of the same course, is not conducive to the best training in logical thought. The questioning, inventive, creative spirit must be aroused to a greater extent than it has been in the past. To say that we haven't a place in our curriculum for such training, where the student may find himself, indicates all the greater need for a more fundamental rearrangement of our college courses. The student may have been fortunate enough to have found the profession best suited to his abilities, but very few find themselves in that profession.

How can we overcome the prevalent view that a college training is a series of disconnected facts? Wouldn't the presentation of a gas engine to a group of freshmen engineers be of value in correlating numerous subsequent pages of algebra, physics, and theories of dynamics? As most courses are now arranged, we have ample time to forget all by the time we are introduced to a concrete example of our profession. Again the realization that few chemical reactions go entirely as represented by the equation requires a rearrangement of the mental attitude of the chemist at a time when he needs to have his faculties at their best.

It may be that our point of view errs. We do not appreciate all of the complexity existing in our universities, and we therefore do not presume to dictate any policy to our schools. We do look for results, however, and industry makes its judgment on that basis—something seems to be lacking in our college trained men.

After discussing the question of undergraduate research with representatives of the schools of Indiana, the Scientech Club adopted the following resolution:

> RESOLVED: That the Scientech Club through its Research Committee exert its influence in promoting and encouraging a research atmosphere in the educational institutions of this state. As one means to this end, be it
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> FURTHER RESOLVED: That efforts be made through the Research Committee for the inclusion, as part of the curriculum in all scientific courses of such institutions, of an approved thesis as a requirement for graduation; such thesis to embody the results of investigation carried on during the fourth undergraduate year of study under proper faculty direction, and be it
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> FURTHER RESOLVED: That in the fulfillment of such requirement, emphasis be laid upon the training of the student. The investigation should be designed to ground the student in the fundamentals of scientific inquiry, irrespective of the application of the study to industrial or other immediate practical uses.

Before proceeding further, we wish to emphasize the fact that we realize how essential is the cordial cooperation of the heads and faculties of the educational institutions of Indiana. Without that we cannot hope for progress.

The spirit of the resolution was favorably received by the schools at our

first meeting and they expressed as deep a wish to cooperate with us as we did with them. Too often in the past, research work has been considered only in the light of its immediate results and we have found that our resolution has been so misconstrued. Consequently, we have made the following explanation and introduction to our resolution.

"The Scientech Club desires to emphasize in connection with the thesis requirement for graduation its conception of the term "investigation" as distinct from the commonly accepted concept of research. It recognizes clearly that the knowledge and ability necessary for a real contribution to human knowledge cannot be expected of many men of senior standing in our universities and colleges; that the ability to do research work is possessed by few, and in varying degrees. To demand a piece of real research of the student as a thesis is not the aim of the Club. It desires that the student undertakes during the fourth undergraduate year of study the solution of a scientific problem which will afford the means of developing in him initiative, resourcefulness, power of logical deduction, and the ability to think for himself. The objective need not be research in the sense of a new contribution, but should be original to the student with respect to his previous knowledge thereof and should consist of his individual efforts in the solution of such a problem and not alone of a compilation or review of existing literature on the subject.

"The Club believes that the fulfillment of the above thesis requirement under the conditions laid down in the resolutions, will in all instances prove a great mental asset to the individual *irrespective of his future activities*, will induce in great measure the development of latent research ability in the student body, and will distinctly promote the research atmosphere of the institution.

One of the university representatives compared the chemical department of Johns Hopkins University with its few courses and stimulating creative atmosphere to that of the University of Minnesota where countless courses only, seem to abound. Education should consist of training in judgment, resourcefulness and the ability to create rather than to encourage merely the amassing of facts. It does seem useless to give courses in obsolete industrial technique at the expense of investigation and yet we are told that our curricula are too crowded to include research. Any student who has had a thorough course in quantitative chemistry need not spend a half year applying that knowledge over again in a course of water analysis. Our educational institutions must furnish the spark to kindle the tinder of creative ability wherever it exists.

It is not commonly accepted by educators that the student will most rapidly develop the right mental attitude by discovering facts for himself—even if they were known before? Are we conserving our greatest resource, the power of creative thinking? My own university experience says "No." Each man must acquire the fundamentals of scientific inquiry to succeed no matter what profession he takes up. We are not asking the universities to produce genius, nor that the undergraduate research be of practical value—but we do ask for better trained men—men who have found themselves in a slight measure at least in their vocation.

We do feel that our schools as a whole have not been doing all within their power to utilize their equipment in the past. Nor has industry done

its share—closer cooperation and the establishment of industrial fellowships must be secured. The training whereby the student is taught to think logically and observe details and by which his resourcefulness and creative ability is developed can be given without requiring a large expenditure of money. Undergraduate investigation must be carried on in our schools and carried on in an atmosphere that stimulates and inspires. We do realize that increased financial aid from the state must be had in order that our schools may even exist and we pledge ourselves to assist them by every means at our disposal in securing an increased appropriation.

We believe that our organization is in a position not only to discern the weak points in the present system of training, but to cooperate with the universities and colleges in correcting any faults that may exist, and that it can bring the schools and industries into a closer and more cordial relationship.