THE MICHIGAN MEMORIAL-PHOENIX PROJECT

BY

HOMER FERGUSON, *U. S. Senator*

The Michigan Memorial-Phoenix Project in essence is the creation of a university center dedicated to a comprehensive study of the possibilities of atomic science for peacetime progress. It will consist of a functional building—with laboratories, equipment, an auditorium, lecture rooms and a library—to serve as headquarters for scholarly and practical study of the new frontiers and peaceful application of atomic science. Some $6,500,000 will be devoted to the project, two million of which is for the building and the remainder of four and a half million will be used for the varied research projects.

The project excites interest because of several unusual features which have gone into its conception.

Phoenix Looks to the Future

First, the project starts at the point where the successful discovery and military application of atomic energy leaves off. The principles of atomic science are already well known the world over so that the discovery stage is past. What the people are asking today is, What now? In other words, the great problem facing the world now is how to develop this remarkable science and how to apply it for the advancement of civilization and peace.

This is the problem on which the Michigan memorial project will go to work. Through a broad program of research atomic science will be projected into the fields of the biological and physical sciences such as medicine, genetics, and biochemistry. By coordination with the social sciences, the project will seek to determine the implications of atomic science for economics, architecture, engineering, law, community organization, and social welfare. Thus the project will not only serve as a center for technical and scientific research, but will draw together all other branches of knowledge of the university in a coordinated effort to explore the significance of atomic science in all human endeavor.

The grand sweep of this conception becomes clear when it is realized that in the past every discovery of new forms of energy resulted in tremendous changes and confusion because mankind was unprepared to deal with revolutionary discoveries. By beginning now, at the threshold of atomic science, to explore its implications and uses in peacetime life, the Michigan project hopes to shorten the time for adjustments and to dispel the widespread public fear and helplessness in the face of the unknown. The spirit back of the project is that where the light of knowledge shines, the darkness of fear disappears.


HOMER FERGUSON

A Free Enterprise Project

Second, the project typifies the resurgence of private enterprise. For a time before and after the great depression of 1929, private enterprise in America lost sight of the pioneering and initiative which in our earlier days contributed much to the greatness of our country. The tendency was to drift and to sit back and allow government to do the things for our people which progress demands. As we see totalitarian governments arise out of too great public reliance upon government, many of us are awakened to the dangers and unwisdom of such a course. The time is ripe, therefore, for a return to the great role private enterprise and initiative did play and can again assume in developing the world and serving its people.

This is what the Michigan project now seeks to do in the new field of atomic science. The project seeks no money from government. That bears repeating. The project seeks and will accept no money from government. The alumni of the university will raise the funds required. The vast resources of the university already in existence will be enlisted in the job. The faculty and students of the university, together with scholars and technicians invited from the outside, will do the work. The whole project is designed to stand on its own feet.

Cooperation

And yet, there will be complete cooperation with all others working in the field of atomic science. While no secret or military research in atomic science is contemplated, if anything of such a nature is developed it will be turned over to the Government as Michigan has already done during more than 20 years of pioneering in nuclear physics. There will be complete cooperation with the Atomic Energy Commission which is fully informed of the Michigan project and heartily endorses it. There will be cooperation with other universities and foundations at work in the field. Above all, there will be close cooperation with private industry and with public and private agencies which are vitally interested in the peacetime development of atomic science for the benefit of mankind.

Here, then, is a combination of research and education undertaken by a great university with private funds. It is an instance of private enterprise once more resuming the role of pioneering at the frontiers of new problems in a new day. Here is a project which, in cooperation with all others, promises to make a substantial contribution toward lessening the public fear and disruption which a revolutionary science tends to generate. At the same time the whole spirit of the Michigan undertaking is its dedication to the search for the benefits which atomic science may hold for the peaceful advancement of civilization.

I can conceive of no more fitting memorial than this great university undertaking which proposes to serve the living in honor of the dead.

PROPOSED RESEARCH IN THE PHOENIX PROJECT

With the advent of atomic energy in 1945 many people prophesied the forthcoming of a utopian era—an era brought about by the harnessing of the fundamental energies of matter. Now, five years later, the prospect of such an era, from a non-political viewpoint, is much closer to reality. The realization is closer because of the broader understanding now enjoyed of the problems involved in harnessing the atom. The Michigan Memorial-Phoenix Project is a great step closer to complete realization of the utopian era.

To aid in this vital work, a number of departments of the College of Engineering, U. of M., have submitted proposals of research problems suitable for study under sponsorship of Phoenix Project. Most of these proposals concern directly or indirectly the use of atomic energy in power development. The remainder of the proposals concern radioactivity in one form or another, and are probably most important from the short range point of view.

In presenting these proposals, some in more details than others, it is hoped that the versatility of the uses of atomic energy, as they will be studied under the Phoenix Project, will be realized.

The information, while restricted to technical nature, is not intended to belittle the great importance of the social, political, and economic problems brought about by atomic energy.

The Atomic Power Plant

Of its many applications, atomic energy can find few more promising uses (from the long-range point of view) than in the field of industry. There it can be of paramount importance as a great source of energy and power. However, its successful utilization provides many complex problems. What will be the shape and construction of the power producing units? What of fuel? How will radiation be coped with? What of the enormous heat generation? There is also the question of measuring devices, of energy conversion, and of materials used in the various processes.

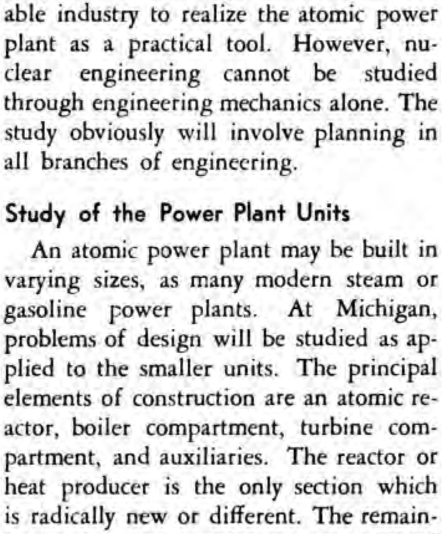
The solution of these problems involves a new type of engineering called nuclear engineering. At the U. of M., the Department of Engineering Mechanics of the College of Engineering has made definite preparations for the atom through the Michigan Memorial—Phoenix Project.

Engineering mechanics previously has dealt with the effect of forces upon matter of appreciable size. Now it must delve, however, into the effects of forces and reactions involving atomic particles. It must provide formulas, relations, and properties of atomic power that will enable industry to realize the atomic power plant as a practical tool. However, nuclear engineering cannot be studied through engineering mechanics alone. The study obviously will involve planning in all branches of engineering.

Study of the Power Plant Units

An atomic power plant may be built in varying sizes, as many modern steam or gasoline power plants. At Michigan, problems of design will be studied as applied to the smaller units. The principal elements of construction are an atomic reactor, boiler compartment, turbine compartment, and auxiliaries. The reactor or heat producer is the only section which is radically new or different. The remaining sections are common to any coal fired power plant, and therefore attention must be focused on the reactor.

This reactor is, in effect, nothing more than an atomic fuel burning device. However, atomic fuel involves no burning; rather heat is evolved in the processes of nuclear bombardment and fission. Problems of design involve (a) most efficient dimensioning of reactor, (b) method of fuel entry and outlet, (c) design of radiation and heat resistant structural elements, (d) connection to energy conversion mechanism, and (e) design of cooling mechanisms. Development and design will be based on research and trial and error methods.



Today, 1950, the actual Synchrotron nears completion . . . often referred to as Michigan's 300,000,000 volt "race track" capable of producing radiation and particles similar to cosmic rays . . . a valuable research instrument.

The eventual solution of this problem will provide the skeleton of a compact and efficient power plant. When this has been accomplished, the next step will be to provide suitable fuel composition.

Study of Fuel Composition and Atomic Reactions

In order to give the power plant maximum efficiency, a proper fuel must be developed. It must provide maximum heat energy and minimum waste. Uranium is the basic element in atomic disintegration because of its newly atomic weight. It is derived from ores of pitchblende. However, use of uranium isotopes might cause too rapid depletion of pitchblende reservoirs. There are many lesser ores providing fissionable materials of inferior quality.

The method of attack will fall into several categories:

(a) Trial and error
(b) Scientific tabulation of compounds and heating values
(c) Comparison of availability and geologic distribution of fuel ores

Study of Radiation Shielding

Once the heat providing process is provided in a suitably designed container, the next step is to provide shielding of humans and other susceptible materials from the dangerous radiation.

Problems arising for study in this category come under the general idea of safety precautions. Human protection is almost assured if the assembly shield is adequate. This shield will surround the entire reactor device and will either absorb or reflect the harmful radiation, or both. Future work in developing shielding material would settle many pertinent issues:

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THE STUDENTS' PART IN THE PHOENIX PROJECT

BY

MARVIN J. LUBECK '51 LS&A

Student Chairman, Michigan Memorial-Phoenix Project

The Michigan Memorial-Phoenix Project is a student undertaking. It was the idea of students to have a *living* memorial for the 579 members of the University family who were killed in World War II. It was a student committee who pressed the University to action on the matter, and who urged the regents to accept the idea of the Phoenix Project after this idea was approved by a student group to whom it was first submitted. When the National Executive Committee for the Proenix Project was formed, care was taken to include a student as a member of this committee in order to co-ordinate the student campaign with the national campaign, and in order that the students be represented in planning the drive. Throughout the planning of every phase of the Phoenix Project students have been very active, and have added immeasurably to the final product.

The Students' Responsibility

It is no more than fitting that the students should play this large role in making the Phoenix Project drive a success, for this is a project that concerns all the members of the University of Michigan family, and the nearly 20,000 men and women who are students here now, are the most immediate members of that family. It is the students who are on campus now, who are the flesh and blood of the University, and they must carry on what former students have begun. It is now the responsibility of the present student body to do the utmost in making the Phoenix Project campaign a success.

The Students' Benefit

The student body at the University has in truth a double interest in the Phoenix Project. Their first concern lies in seeing that the drive is a success, that the Michigan Memorial-Phoenix Project becomes a reality. Their other interest in the Phoenix Project stems from the fact that it is the generation of today's students and that of their children who will reap the long term benefits from the Phoenix Project. Today's students and their children who will have a better chance to live without fear of such dread diseases as cancer, leukemia, arthritis, and hyperthyroidism. Doctors, biochemists, and pharmacologists working together, and pooling their knowledge and research skill in the Phoenix Project will have a much better opportunity to study the causes and cures for these maladies than they would by working separately. By the same token Michigan's engineers, physicists, and chemists will be finding new ways of using atomic energy to develop new products. Engineers will be doing much of the research to find ways of using atomic energy to turn the wheels of industry; and to explore the possibilities of using atomic energy to power automobiles, planes, and ships. Such advances as more efficient communication systems, fresher and more palatable foods, along with better food preserving methods, and greater soil productivity are in the offing for the student's generation, and for the generations to follow. These scientific advancements along with research in the social sciences on such topics as curriculum revisions in elementary schools, new teaching methods in high schools, and adult education programs, all designed to prepare the people for life in an Atomic Age; organizational as well as physical changes in the structure of businesses; and the legal aspect of atomic energy control, will be discussed by the most learned men in each field who will be brought to the University of Michigan by the Phoenix Project. This research, and the discoveries which issue from it, will better the lives of those who are now students in three ways. First, as individuals; second, as users of industry's new products; and third, as members of a better society.

MARVIN J. LUBECK

The Students' Part in the Drive

The derivation of a better life from the results of the Phoenix Project is only one of the two ways in which the students are connected with the Phoenix Project, and can only follow after the drive for funds has been successful. In this drive the students perform a double function by giving money themselves, and by stimulating the national drive. The student body is being asked to raise between $100,000 and $200,000 for the drive fund. Approximately 1,500 students have given time and effort in order to contact every one of the students now on campus. As a part of this campus drive a program of education about the Phoenix Project has been carried out, and part of this program is being used to stimulate the national campaign, and along with student enthusiasm and support will aid greatly in achieving the $6,500,000 national goal.

The Students' Responsibilities

The present student body is playing a vital part in bringing new distinction to their University, for the Phoenix Project is unique among research centers. It reaches far beyond the traditional scope of state sponsored education. There is no provision in the state budget for the research planned by the Phoenix Project, and so for the first time in its history the University is turning to its students, alumni, and friends for money in order to carry out this plan. A large share of the responsibility for the success of this drive rests on the students. They, as the group who will receive the benefits from the Project, and as the force which has seen the Phoenix Project through from inception to constructive action, must follow their obligation to completion.

Speaking on the

DR. ALEXANDER G. RUTHVEN

President of the University of Michigan

"I have repeatedly called the Phoenix Project the most important undertaking in our University's history. It is even more. At a time when a poisonous ideology would reduce life itself to a commodity of low value, the Phoenix Project stands as a trading post where hope can be freely exchanged for fear."

. . . . "I would also like to point out that the Phoenix Project is no longer a dream. From preliminary funds that have been contributed by alumni and other friends, we have already been able to start 20 separate research projects of a fundamental nature. At a time when the threat of atomic destruction hangs over us, the University is beginning a special study to develop ways and means of protecting human beings against radiation. This applies not only to the possibility of atomic attack but also to the thousands of people working daily with radioactive materials."

. . . . "I am proud of the alumni, faculty members and students of the University of Michigan for proposing the Phoenix Project. I am proud that our University has undertaken to do the great humanitarian work it embraces."

CHESTER H. LANG

National Executive Chairman
Michigan Memorial—Phoenix Project

"The Michigan Memorial—Phoenix Project is no ordinary memorial."

"In all the years to come, it will, of course, memorialize the men and women of Michigan who died in the war. But it is far more than an eternal reminder."

"The Phoenix Project represents *a job to be done;* a job those men and women would have wanted done, perhaps above all else. We are honoring them by taking up the greatest challenge of our time. We are paying tribute to their sacrifice by accepting a momentous responsibility. Because of our efforts, man may be better able to handle the cataclysmic force that has been turned loose upon the world—a force that was born in the same flaming deluge that swept away the lives of those this project honors."

MARSHALL E. DIMOCK

Former Assistant Secretary of Labor

"The Phoenix Project at the University of Michigan, being the first bold and constructive effort to focus the potential of both the physical and the social sciences on the possibilities and problem of the atomic future, deserves the generous support it is receiving from the public, from industry, the federal government, and the privately endowed foundations. I know of no place where the great foundations can invest the funds that have been entrusted to them with greater assurance that they will bear compound interest in almost every field of human endeavor."

". . . . there is no department or school in a great university like the University of Michigan that is not, in some way, with differing degrees of importance, involved in the social uses and problems created by atomic energy. That is why the Phoenix Project is so imaginative and yet so practical in its design."

Phoenix Project

GENERAL DWIGHT D. EISENHOWER

President, Columbia University

"The work planned by your University is a part of the biggest job of our lives—the battle for freedom." . . .

. . . . "In this kind of contest—and the contest is world-wide in scope and seemingly endless in duration—we must count and husband all of our resources, whether they are the product of our hands or of our hearts.

When I say we must husband all our resources, I mean that we must not only be frugal with what we already possess, but employ what we have to even greater advantage. All you Michigan men and women are focusing your attention on the plans of your University for expanded atomic research. Here is a tremendously important exploitation of our national resources.

Few causes are more urgent today and more noteworthy of your support. I commend you for your interest in it. . . . Because I believe that, in war or in peace, the atomic research being done at the University of Michigan, and at many other centers of learning, will strengthen America through better utilization of its natural resources."

WARREN R. AUSTIN

U. S. Delegate to the United Nations

"This is a grand testimonial to the free way of life. It shows the sense of individual responsibility of educated men for the expansion of education, the vitality of *voluntary* cooperation, the possibilities of private initiative for human welfare. By your acts you give proof to the world that your university not only informs and instructs its students, but develops the whole personality, releasing it to function with imagination in the up-building of a free society." . . .

. . . . "Your Michigan Memorial—Phoenix Project is designed to accelerate research on many ways to use atomic energy for constructive ends and to apply the principles of atomic science. There are many non-dangerous activities in the application of atomic theory for constructive purposes. But whenever you are dealing with the atomic fuel itself in critical quantities, you are inevitably dealing with a powerful explosive. It can be packaged in a simple bomb-container which can be made in any machine shop in short order."

H. R. CRANE

Professor of Physics, University of Michigan

. . . . "Those industries that are first to establish relations with nuclear physics laboratories in schools, colleges and universities across the country will be the first to find applications in their own industrial problems." . . . .

. . . . "Ever since the end of the war the government agencies. notablv the AEC and the Navy, have associated themselves with nuclear physics work in educational institutions and have made first-hand contacts with students who are getting their degrees in that field, . . . Industry would do well to develop its own pipe lines to the sources of trained men and information on radioactive materials. . . . organizations such as the Phoenix Project offer industries an opportunity to ge an inside track to this field and get newly trained men."

THE HISTORY OF THE PHOENIX PROJECT

BY

ERICH A. WALTER

Dean of Students

Michigan's memorial to its 507 students and faculty who lost their lives in World War II actually had its beginning in June, 1946, at the time of the annual alumni reunion. After the memorial service for its war dead, there was mention among the alumni that the University should concern itself with a memorial. In December of the same year, the student legislature clearly stated its attitude that there should not only be a memorial but that it should be a functional memorial. Hence, it is obvious that the first concept of a war memorial was a student-alumni one.

In May, 1947, Professor Karl Litzenberg, Dean Charles Peake, Mr. T. Hawley Tapping and the author—all alumni of the University—met at the Union and concluded that the time had come to give serious study to the idea of a memorial. It was decided to suggest to President Ruthven that he appoint a committee to study the problem. The suggestion was presented to the President September 15, 1947, and upon his recommendation the Board of Regents, at its meeting of September 29, appointed the following committee: Robert C. Angell, Roscoe C. Bonisteel, Arthur R. Der Derian, William Haber, Christian Matthews, Marvin L. Niehuss, Arthur M. Rude, E. Virginia Smith and Erich A. Walter (Chairman). Mrs. Jacqueline K. Adams acted as secretary to the committee.

It should be noted that the membership of the committee included three students (all veterans of World ar II), Miss E. Virginia Smith ('50LSA) who served as a nurse in the Pacific area, Mr. Arthur R. Der Derian ('45-'48) who served as an aviation cadet, and Mr. Arthur M. Rude ('42LSA-'49LL.B) who served as a first lieutenant in the Army and who also was the originator of the Bomber Scholarship which benefitted 254 veterans during the academic years 1946 to 1950; two representatives of the faculty, Professors Robert C. Angell and William Haber; one representative of the Board of Regents, Mr. Roscoe C. Bonisteel; two representatives of the administration of the University, Vice-President Marvin L. Niehuss and the Dean of Students.


ERICH A. WALTER

On October 21, the chairman had the privilege of meeting in New York, Fred Smith, an alumnus of the University who always wants to know "what's cooking" when he meets someone connected with the University. Told that a committee had been appointed to study the question of a war memorial, he offered a suggestion which he pursued in a letter that very evening, addressed to the chairman of the committee. The following quotations from his letter clearly indicate his plan:

"Now how can we do something that will reassure our veterans—that will give them a measure of confidence that somebody, at least, is doing something constructive? That, it seems to me, is the starting point from which to consider possible ways of creating a memorial.

"Certainly the most startling outgrowth of the recent war was the release of atomic energy. People are becoming calloused to the idea that the harnessing of atomic energy is the crucial achievement of mankind: it can eliminate civilization, or can provide the means of building a civilization that outstrips anything in any sane man's imagination.

"It is my feeling that the University might take unto itself the administration and coordination of research in some specific phase of peacetime atomic research and construct a building to house the administrative and scientific staff necessary to do this coordinating job. It is my feeling that only a fragment of the work would be done at the University, and that the chief function would be to coordinate the literally hundreds of thousands of doctors (if we choose this particular phase of atomic research) who are now experimenting with isotopes throughout the world.

"But the organization of this memorial should go beyond the building. It should include the maintenance of the administrative staff, which would be closely coordinated with the government's Atomic Commission. Moreover, one student should be chosen every four years or so to become a lifetime worker in this field. He could be an outstanding student in research, in administration, or in any of the fields vital to the practical operation of this perpetual research and development project. The student would be carefully picked, and should agree to give their lives, or a substantial portion of their lives, to the pursuit of the betterment of mankind through research achievements in this field—and should be given lifetime jobs free of financial worry.

"In the first place, I believe that the Government would make available funds and equipment to maintain such a project, if the initiative and original investment were taken by the University. At least to my knowledge, there has never been a life time project such as this devised; about the only organized effort at the present time that permits people to dedicate their lives is the church; and it is not far-fetched to say that the pursuit of atomic research is as vital to the future of mankind as the continuation of religion; and the devotion of the people involved in it should be no less unstinted.

"I think that a foundation set up in this way would have such strong appeal, and would achieve such public support, that the Atomic Commission would have little trouble securing money from Congress to help support it. If Senator Vandenberg could be interested in this project, and it is my belief that he could, he

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The Dean's Page

DEAN IVAN C. CRAWFORD
College of Engineering
University of Michigan

NUCLEAR ENGINEERING AT THE UNIVERSITY OF MICHIGAN

Developments

In December of 1948 the Standing Committee of the college appointed a special committee, the Nuclear Engineering Committee, "to make a study and report on the subject of Nuclear Engineering, covering such questions as: Is there such a field as nuclear engineering? If so, how may it be defined, how differentiated from physics, and what subjects should be included in a program of study."

In its report the Committee stated that the term " 'Nuclear Engineering' is now used to include all phases of applied science which are involved in the design, construction and operation of nuclear reactors to produce power or useful radioisotopes, of radiochemical plants to recover the full material or by-products and of waste storage and disposal systems."

The committee recommended that programs be established in this field leading to graduate degrees in several of the engineering departments. A beginning course, Elements of Nuclear Engineering, was developed and placed in operation for the first time during the present semester. Other courses—Instrumentation of Nuclear Energy, with laboratory, Storage and Disposal of Radioactive Materials—will follow.

The beginning course is limited to a small number of seniors and graduate students.

A final course in nuclear engineering, as the program now stands, is Nuclear Engineering Practice School. The committee in its second report notes that "one of the basic difficulties in offering a suitable program in Nuclear Engineering is the exceedingly high cost and inaccessibility of radio-active materials and equipment suitable for handling such materials." The Massachusetts Institute of Technology has set up an Engineering Practice School at Oak Ridge in the atomic energy installations operated by the Carbide and Carbon Chemicals Corporation. M. I. T. admits to this practice school graduate students from other universities. Credit earned there would apply toward the degree at the student's home institution. The committee strongly recommends that the University of Michigan participate in this program.

Opportunities

At the present time this field does not offer the number of job opportunities presented in even the less populous engineering fields. Without doubt nuclear engineering will furnish more employment to especially qualified engineers as larger numbers of industries participate in the Atomic Energy Commission program. Presently this program is largely confined to the Los Alamos Scientific Laboratories, the General Electric plutonium plant at Richland, Washington, the Oak Ridge installation, Argonne National Laboratories, theKnoll's Atomic Power Laboratory of the General Electric Company, and the Brookhaven National Laboratory; also several other laboratories operated by private corporations under contact with the Atomic Energy Commission. In addition to the opportunities present in these organizations, mining engineers find employment in searching for, mining, and concentrating uranium ore, and other engineers engage in the development and manufacture of radiation instruments.

Those really interested in nuclear engineering and willing to spend the necessary time in graduate work, will in all probability, find plenty of opportunities.

Effects of the Atom

A publication by this name prepared under the direction of the Los Alamos Scientific Laboratory has become a best seller. Without doubt, all engineers should be familiar with the subject matter treated in this book because they, as members of the engineering profession, are expected to know about the effects of these weapons and the measures which may be taken to reduce and perhaps counteract the effects.

The chapter headings indicate clearly the several divisions under which the subject matter is treated. These are: Principles of an Atomic Explosion, Description of an Atomic Explosion, Shock from Air Burst, Shock from Underwater and Underground Bursts, Physical Damage (From Air Blast, Ground and Underwater Shock), Thermal Radiation and Incendiary Effects, Initial Nuclear Radiations, Residual Nuclear Radiations, Decontamination, Effects on Personnel, and lastly, Protection of Personnel.

Engineers who are engaged in the design of structures in areas which may become targets must take into consideration the forces unleashed in an atomic explosion. It is stated that "there were no reinforced-concrete buildings of earthquake-resistant design in Nagasaki that suffered serious damage to the frame at distances of 2,000 feet or more" from a spot immediately beneath the bomb explosion.

All engineers and other persons concerned with civilian defense will be interested in the information presented relative to radiation phenomena.

THE UNIVERSITY AND THE ATOM

BY

GORDON DEAN

Chairman, U.S. Atomic Energy Commission

The Atomic Energy Commission salutes the Phoenix Project of the University of Michigan and wishes that it may flourish. Atomic energy development on its industrial side is in the main a Government monopoly. This has come about because the fissionable materials that are the basis of an atomic energy industry have to be kept in public custody and under public management to safeguard the security of this nation.

But the accomplishing of this necessary end should not, must not bar private initiative in atomic energy research, nor free academic inquiry seeking policies and practices that will best guide the public and private use of atomic energy.

We wholeheartedly welcome Michigan's lead toward more privately-financed atomic energy research in unclassified fields. This is basic to speedy progress.

These ultimately most important decisions on atomic energy will be made by the people in our democracy. Through such studies as the Phoenix Project is getting underway in economics, political science, psychology and the other social disciplines the work of the scholars will light the way to sound decisions by their fellow-citizens.

A Resource

These special contributions to progress are over and beyond the primary service of universities to the nation—the training of the technical manpower on whom we so utterly depend for success in waging war and advance in the arts of peace. Scientists and engineers are a national resource of major importance. It is imperative that we make sensible, effective use of their skills.

One consideration is to see that we "keep the seed corn coming" for future growth and development by maintaining in full vigor, year-in-year-out, in wartime as well as in peacetime, the staff for scientific training in the universities. The corollary of this is that we also maintain the flow into the universities of the talented youngsters who can carry scientific and engineering training over to new accomplishment.

GORDON DEAN

Times of emergency require that special thought be given to ways and means of making the best use of the scientific manpower already on hand. The activities of any mobilization or war period make heavy drains on the technical economy of the nation. The needs of such times require that the men of science be so apportioned as to make their maximum contribution to the war effort. It is essential to follow general policies and specific procedures that will insure the effective distribution of scientists to all categories of the national economy. Hand in hand with this procedure, industry, education, the Armed Services need to take care to insure that the supply of scientists in each line of work reaches as far as possible in the same way that they would conserve any other valuable and scarce resource.

Research

One of the contributions of scientists in wartime, as in peacetime, is the carrying on of basic research. Now, arguing the relative merits of applied versus pure research is one of the most fruitless occupations known to man. Actually, and particularly in a field developing as rapidly as atomic energy, the distinction is vague. The president of a leading eastern university recently announced that after many years devoted to study of this question he had found the answer. "Applied research," he said, "was that for which it was easy to get money."

While this may be true, it is also true that nowadays the lag between discovery and use of knowledge has all but disappeared. That is one reason why it is hard to draw the line between basic and applied research.

Fifteen years ago no field of scientific study appeared of less practical interest than the chemistry of the rare earths. This wayward group of elements did not fit properly into the periodic table. Closely allied in chemical properties, they were extremely difficult to separate from one another. Even graduate students were discouraged from working in a field which so obviously led nowhere.

Fortunately, a few men persisted in rare-earths research and during the war their work paid off. It just so happened that the rare earths were among the most abundant products created in the fission of uranium 235. Plutonium, itself closely allied to the rare earths, is associated with them in the uranium slugs taken from the reactors at Hanford. Today rare earth chemistry is probably the most important process in the plutonium industry.

Canning Problem

Another example occurred here at Michigan. For many years Dr. Floyd Firestone, now in Washington, was a member of the physics staff of this University. His primary interest law in the field of accoustics and ultra-high-frequency sound waves. Again it so happened that one of the most troublesome problems in building the Hanford plutonium reactors was the canning of the uranium slugs. This had to be done to prevent deadly radioactive materials from getting into the cooling water and atmosphere.

Through his studies of ultrasonic propagation in metals, Dr. Firestone was able to detect defects in the bond between the slug and the can. During the hectic period when scientists at the Metallurgical Laboratory in Chicago were trying to lick the canning problem, they turned to Firestone, and his special technique gave the clue to the answers.

We use nuclear reactions to produce energy but our knowledge of the force that holds nuclei together is scanty and unsatisfactory. We process various types of ore to obtain uranium but the methods of processing used are empirical and many of the chemical and physical details that effect them are little understood. Almost every step in our entire program from digging the ores out of the ground to exploding bombs and designing power reactors bristles with questions, the answers to which we do not know.

Let me, in brief, stress these two general points: First, that our scientific manpower must be regarded and employed as a national resource; second, that in such times as these, it is important to continue to increase, rather than to decrease our fundamental research. I state these principles with a conviction that grows from study of the history of atomic energy development. As I've indicated, the atomic energy program at the start may fairly be said to have sprung full panoplied from the brains of university research men. Atomic energy history points up strikingly the debt of the people of the country to the universities of the country.

Our strength lies not simply in our weapons; it lies, at the core, in our understanding of the forces of nature. The Phoenix Project of the University of Michigan will, I am sure, contribute to that knowledge and thus increase our strength.

Government Control

There are some who ask: Why doesn't the public treasury finance all research on atomic energy? Why ask for private funds to support such work?

The complete answers, like answers to all broad policy questions, are complex. But at the risk of over-simplifying, let me state some general considerations that seem pertinent to me.

First of all, it is obvious that research that under the Atomic Energy Act must be kept secret has to be controlled and financed by Government.

Secondly, a considerable body of fundamental research which gives prospect of applying sometime to the solution of problems in the atomic energy industry, but does not need to be kept secret in its early stages at least, still should be financed by Government. This we are doing. We have in force more than 100 contracts with universities, hospitals, research institutes for carrying on such research. It forms a part of the programs in the national laboratories built and financed by the Atomic Energy Commission. This phase of the Government-financed program, as I have indicated in my earlier remarks requires to be maintained and, indeed strengthened continuously now and in the future. Emergency points up the need to press ahead with basic research that gives a lead into the solution of urgent technical problems.

Thirdly, there is the general field of study in the basic laws of nature that govern atomic phenomena of all sorts. This is the "pure" type of research. At its beginning it seems to have no relation to the solution of production and operating problems. But as I have stated earlier, time and again the facts and theories that it produces have made possible sweeping advance in technology.

Some of this research requires machines of great size and cost—cost past the capacity of private financing. Government has taken on the building of such machines—particle accelerators at universities and national laboratories, reactors at national laboratories. Government also operates these machines and finances some of the work done with them. The machines are available also for the use of independent researchers, as in the case of the reactors just coming into operation at Brookhaven National Laboratory.

But there is much research out on these frontiers of physical, chemical, biological and medical knowledge which can be carried on with equipment that is within the reach of privately-financed or State institutions. This is the field where individual gifts and current State appropriations can and should broaden the scope and stimulate the spirit of free, independent inquiry into natural phenomena and the laws to which they conform. I believe that on reflection no one who cherishes the traditions that have built the sciences would wish to put all or even a major part of basic research in any field completely in the hands of the central Government. To do so would in the end slow our progress and leave us a very different people.

In short, there is much that can and should be done in atomic energy research by universities, individuals, and private institutes, and that should not be controlled or paid for by Government. Those who contribute to the support of such research are truly serving America.

Atomic energy products—the stable and radioactive isotopes—play a part of rapidly growing importance in research on problems of the life sciences, including those dealing with health and agricultural production. Here, again, the Atomic Energy Commission feels an obligation to carry on some special projects which can be best managed and operated at the installations in the program, and to give aid to hundreds of research institutions through providing special equipment and materials that are not available to them from other sources. Let me cite two examples—research in cancer and research in soils and fertilizers as related to improving crop production.

Radioactive Phosphorus

Because few agricultural experiment stations now have facilities for mixing radioactive phosphorus with fertilizers, the AEC is currently financing the making of such research materials by the United States Department of Agriculture at its Beltsville, Maryland, research center. During the current year this radioactive material for soils research has been sent to 22 state argricultural experiment stations for use in 67 different studies. The studies were financed by the stations.

According to the director of this program, more has been learned in the past four years about phosphate fertilizers than had been achieved by other means in the previous 50 years.

Some 15 million tons of phosphate fertilizer costing over $300,000,000 are used yearly in this country. Efficient use of phosphates is extremely important to farmers. Among the questions to which the research people are finding answers are these:

How do crops vary in their use of fertilizer phosphates?

What soil conditions promote good use of phosphorus?

How do various types of phosphate fertilizers compare?

How do plants utilize phosphates?

Through use of radiophosphorus the experimenters have learned that potatoes take up phosphorus from the added fertilizer throughout the growing season. Young corn will take up fertilizer phosphate but the older plant obtains most of its phosphorus from that fixed in the soil. The research men believe this may suggest that potatoes should be heavily fertilized before and during the growing season; while for corn the best practice might be to apply phosphorus as long as a year before the growing season; to raise gradually the phosphate level of the soil by long-time application of less soluble phosphates which will not leach out.

These suggestions of course must be tried out before they are established as fact and put into farming practice.

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RADIOACTIVITY RESEARCH

BY

KENNETH P. CHASE '52E

Kenneth Chase is a junior in the Electrical Engineering Department and plans to receive his B.S. degree in June 1952. He is majoring in the electronics option of the electrical engineering curriculum. Prior to entering the U. of M., Ken served as a Radar Technician in the U. S. Navy. The material he uses in this article was obtained largely from Dr. Henry J. Gomberg, Director of the Phoenix Project Laboratories. Dr. Gomberg has pioneered research in this field and is recognized as an authority in radioactivity research.

With the advent of the Atom Bomb the world's thinking people realized that there was a new and powerful scientific tool available to them—radioactivity.

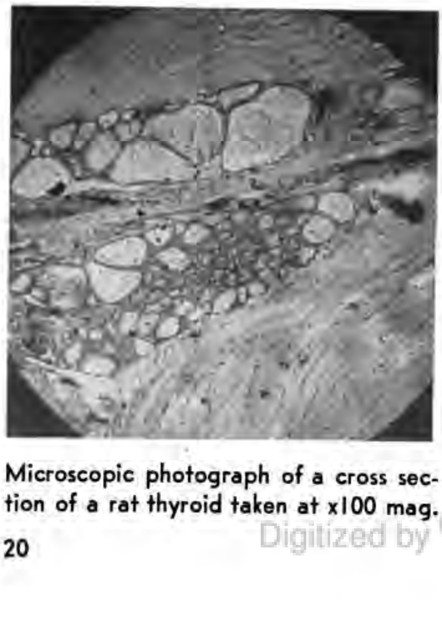
As always, however, with the passage of time the period of prognostication rises and falls and it is then that progress begins to appear. It has appeared and is now appearing in such places as the laboratories of the University of Michigan and will likely appear in the laboratories of the Phoenix Project.

Applications

There are two known possible applications of radioactivity: The production of usable energy for commercial purposes and the implementation of radio-active particles for purposes of research. The latter is being attacked by workers in the Phoenix laboratories.

In these laboratories an attempt is being made to further eliminate the barriers of scientific knowledge; learn facts about the phenomena that cause the known actions and reactions; and perhaps even to identify and define the basic unit of all things if there is such a unit.

It is well known that the smallest particle about which there can be true scientific knowledge is the smallest particle that can be examined with accuracy. Therefore, the devices and processes that may be used for examining the unknown are the main limitations of science. The struggle now is to improve these devices and methods and in so doing, lower the size limits of examination, thus increasing the store of knowledge and perhaps improving the world for peaceful living. The conquest of this problem is one of the aims of those working under the auspices of the Phoenix Project. Here are a few facts about the labors and immediate aims of these Phoenix scientists.



Microscopic photograph of a cross section of a rat thyroid taken at x100 mag.

Examination

First of all, an immediate objective is to accurately examine the structures that we now think of as comparatively basic, such as individual crystals and cells.

An accurate and thorough knowledge of the human cell would be a great advancement in the search for such things as a cure for cancer. The main problem confronting these now searching for this cure is to find a unique characteristic of the cancerous cell that will enable them to combat it without injuring desirable cells. Also, if such a knowledge of the many types of crystalline structure could be obtained, it would mean a great advancement in the science of metallurgy. For example, an accurate knowledge of the distribution of carbon in steel crystals could go far toward clarifying and confirming the metallurgists' theories. For the sake of interest, the size of the average cell is somewhere around 5×10^{-6} meters. It is therefore obvious that to examine its structure we must be able to discern even smaller dimensions. A crystal may be as small as 10 angstrom units (1 angstrom $= 10^{-10}$ meter) across, which is thus considerably smaller than the average cell size.

If these tiny structures are to be examined accurately there must be available devices or processes with a high enough degree of resolution to be able to distinguish between points and quantities separated by the minute distances by which the component parts of these structures are separated.

The limit of the resolution of light microscopy is absolutely ½ the wave length of the color of light used. This is in the order of 10^{-7} meters. As yet methods have not been developed to use light microscopy to its limit, but recent advancements have approached this limit closely.

Even in the limit, however, it can be seen that light microscopy is not enough. This is where the phenomenon of radioactivity is utilized. This is the one application thus far for evident where radio-active materials can be used to greater advantage than anything else.

Autoradiography

The particles emitted by radio-active substances are parts of nuclei of atoms, hence are even smaller than atomic dimensions. If a way could be found to detect accurately the movements and locations of these particles to within limits comparable to atomic and molecular dimensions the limits of examination would have been lowered a great deal. The detection of these particles is officially known as autoradiography and is the specialty of Dr. Henry J. Gomberg, director of laboratories for the Phoenix Project.

Dr. Gomberg has recently developed a method of detecting active particles by light microscopy which is the recent advance mentioned earlier. It is very ingenious and is an excellent example of the progress that is being made by the Phoenix laboratories.

As mentioned previously the objective of this process is to examine accurately the basic structure such as cells and crystals. To do so it makes use of precision microscope photography.

Radioactive Iodine

An example of the manner in which it is used is the tracing of the radio-isotope of iodine in the thyroid gland.

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THE ATOM & ECONOMIC RESEARCH

BY

JOSEPH LOFTUS
Air Intelligence Specialist, USAF

The central economic question which the prospect of atomic power poses is: given a change in the cost and availability of energy, what economic consequences will in all probability ensue for different industries and different regions of the world.

A comprehensive and tenable answer to this central question is imperative for at least two reasons. In the first place, how fast and how energetically a nation in fact overcomes the large and expensive technical difficulties that now impede the realization of the dream of atomic power is at least partially a function of how high are the nation's expectations of the probable economic benefits of atomic power. If great expectations exist, then one can anticipate an energetic and speedy development; conversely, a generally prevailing opinion that the economic potential is limited will be conducive to a leisurely and slow development effort.

In the second place, once the technical difficulties are overcome, there will arise a whole host of specific political-economic questions on the most proper utilization of the innovation. For example: (1) if the industry continues to be a public monopoly, what pricing policy should be pursued, where within the United States should atomic power plants be located; (2) can and should the industry be reorganized so that it ceases to be a public monopoly; (3) should atomic power plants and atomic power fuel and technology be exported and if so to what countries and under what conditions. The answer to each of these questions will largely depend on the nature and content of one's conceptions as to the probably economic consequences of atomic power.

For example, a decision to locate an atomic power plant in the New England area will be strongly influenced by what one anticipates will be the economic consequences of a reduction of power costs and an increase of power availability first, on the level and character of economic activity in the New England area and, secondly, what will be the induced effects of this change in economic activity in the New England area or other areas in the country. Similarly, the decision to export either plants, fuel, or technology to a country.

JOSEPH LOFTUS

Despite the obvious and apparent compelling character of these two reasons for economic research on atomic energy, the five years since Hiroshima have elicited only scant activity on the part of professional economists. In all this time less than two dozen monographic studies of any professional significance have been prepared in this country and in England.

This poverty of attention by those engaged in economic research is commonly misconceived to be the result of a scarcity of quantative data. Typically it is emphasized that until such time as a few nuclear power plants are in fact in operation providing sound experimental data on the physical and cost characteristics of atomic power, no really useful economic studies can be developed.

While it is no doubt true that in recent years many individual economists have refrained from engaging in research on atomic power economics because of a conviction that there is an insufficiency of quantitative data, it is the contention of this observer that this emphasis on the necessity for numerical data (especially data on the precise costs of atomic power) betrays a misconception of the fundamental problem. The solution of the central economic question posed by the advent of atomic power will basically require two things: (1) a knowledge of what atomic power costs and availability will eventually be, and (2) a methodology for tracing out what the economic effects of such a change in costs and availability will produce in a highly complex and interdependent world economy. Of the two requirements the latter is by far a much greater impediment to reliable forecasting of the economic consequences of the atomic power innovation than the former. As will be pointed out subsequently, the problem of what atomic power costs and availability will be can be disposed of quite easily for the present research purposes.

To state the matter in a blunter fashion, if atomic power were today a reality and ample data on costs and availability of atomic power were readily available, the difficulties and barriers to economic research on the consequences of the innovation would not be significantly less than they are in fact today even in the absence of such data. This is maintained for the very simple reason that the task of predicting the economic consequences of an innovation is a task which economists are in the normal course of events not prepared to undertake. This is the sort of problem with which an economist by his tradition and training is not concerned. By and large, the bulk of traditional economic analysis has proceeded on the assumption that either there has been, or will be, no significant change in technology, or that technological change takes place so slowly and imperceptibly that for any given short run analysis it can safely be disregarded as a causation factor. Seldom, if ever, has the professional economist addressed himself to the question of forecasting or "estimating" the effects on a highly interdependent world economy of a substantial change in technology.

In this connection, it is interesting to observe that by and large the varying opinions on the economic consequences of atomic power developed in the meagre studies to date result not so much from divergent assumptions with respect to the cost of atomic power as they result from the methodological differences.

If then, it is valid to insist that the methodological problem is a much stickier impediment to realistic appraisals of the probable impact of atomic power, it is similarly valid to maintain that this problem need not and indeed cannot wait for the actual technical development of atomic

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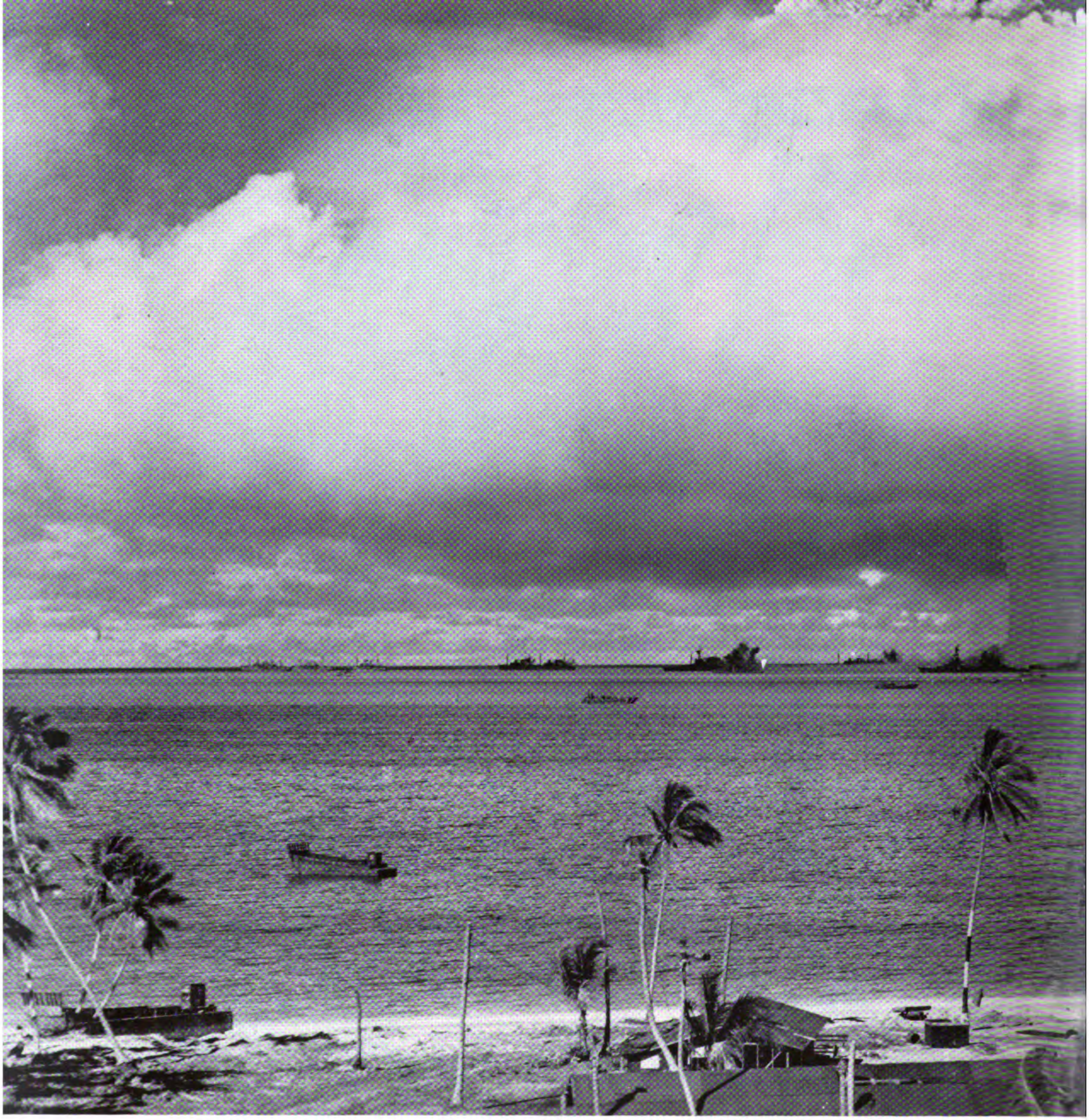
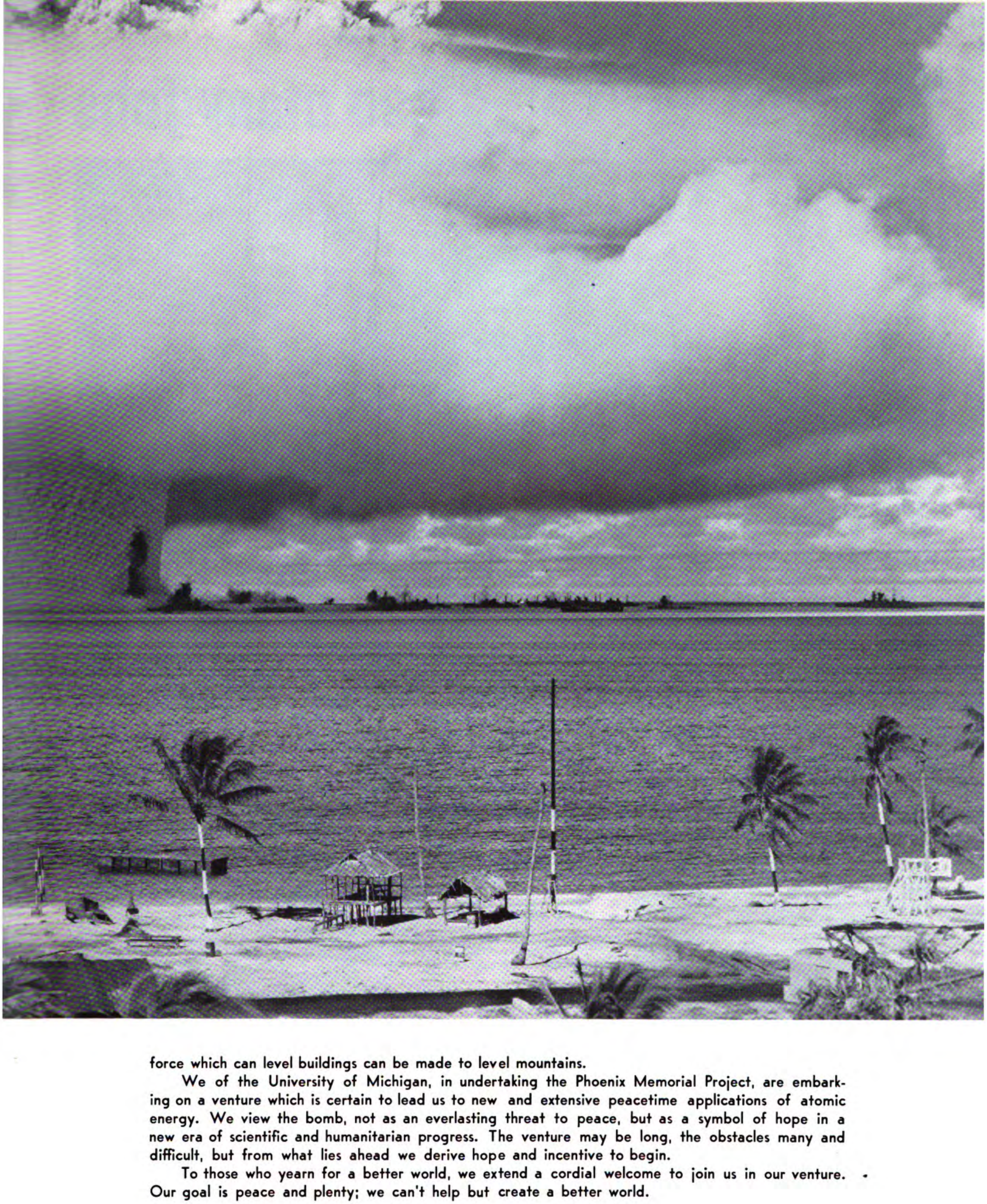


In a small Pacific lagoon in July, 1946, the atomic bomb presented once more its awesome spectacle while an uneasy world watched and listened. The Bikini blast (above) raised the now-familiar "mile-height water wall" above the carefully-placed vessels. What happened to the ships has been published in reports, newspapers, and magazines the world over.

The power of the atomic bomb, unbelievable even in the first few, has been increased many-fold. Today, five years after the awful debut of the bomb, men are convinced that the power which was assembled for destruction can be made to serve man as effectively as they might destroy him. Radiation which can kill and injure hundreds of thousands can be made to heal the sick; the



force which can level buildings can be made to level mountains.

We of the University of Michigan, in undertaking the Phoenix Memorial Project, are embarking on a venture which is certain to lead us to new and extensive peacetime applications of atomic energy. We view the bomb, not as an everlasting threat to peace, but as a symbol of hope in a new era of scientific and humanitarian progress. The venture may be long, the obstacles many and difficult, but from what lies ahead we derive hope and incentive to begin.

To those who yearn for a better world, we extend a cordial welcome to join us in our venture. Our goal is peace and plenty; we can't help but create a better world.

PROPOSED RESEARCH IN THE PHOENIX PROJECT

(Continued from page 12)

The Proton Beam . . . In operation since 1935, the University's cyclotron has produced over 100 rare isotopes.

(a) How can the nuclear pile best be shielded?
(b) What will be the composition of the shield for minimum weight, so as to be applicable to portable power plants?
(c) Does the material in contact with the nuclear fuel require any special form of shield treatment?
(d) What will be the hazards in repair?

Study of Heat Transfer and Radiation

After the heat energy has been derived from the reactor it must be conveyed to the boiler section to turn water into steam and eventual mechanical or electrical energy. The energy may possibly be transferred directly to a specialized turbine. Heat transfer materials must withstand very high temperatures, and they must be creep resistant and corrosion resistant. The actual heat transfer medium must be non-radioactive and stable at high temperatures. i.e. The requirement of high conductivity, rapid heat flow, limits the transfer medium mainly to liquid metals. The following are the conditions to be met; there are many methods of attack:

(a) Determine permanent alteration of properties such as atomic make-up, strength, elasticity, dimensions and conductivity.
(b) Determine alteration of properties that change only while radiation is present, such as creep and chemical reactions.
(c) Determine properties of liquid metals as heat conveyors while under radioactive stress and high temperature, their suitability to forced convection.
(d) Compute heat transfer coefficients from selected solid materials to liquid metals.
(e) Investigate new type alloy materials with extremely high melting points.

Also included will be work on equipment to pump and handle radioactive fluids both during heat transfer and removal.

Study of Measuring Devices and Controls

The atomic power plant because of its revolutionary operation requires specialized instruments for the measurement and control of the mechanical state of its component materials. There must be some means to measure velocities and strains below the surface of the shielding materials and inside the reactor. To accomplish this it would be necessary to develop new techniques and methods of measurement and to adapt existing instruments to new purposes.

The use of radioisotopes emitting counter-radiation from within the specimens offers a possibility of performing these measurements. These measurements, if accurate, will indicate the temperature of reaction, rate of heat transfer, and rate of creep and failure of the materials.

Study of Power Conversion Mechanisms

The heat energy which is being carried by the liquid metal must be transmitted either to the heating of water or directly to the operation of a turbine. The big problem, naturally, is how. The following are a few methods to be considered and tested:

(a) Use of heating coils to provide a uniform and circulatory heating effect at high velocity.
(b) System of pre-cooling the liquid metal before heat transfer is affected.
(c) System of a counter-current flow heat exchanger, and superchargers.

Once this is effected, the transfer into mechanical and electrical energy is relatively simple.

Fossil Age Determination

One important application of atomic energy which is already in operation at the U. of M. under a grant from the Phoenix Project is the determination of fossil age by radioactivity measurements. The work on this newly-developed method for determining the ages of prehistoric remains by their content of radioactive Carbon-14 is under the direction of H. R. Crane, professor of physics. Professor Crane, who is noted for his direction of the construction of the University's 300-million-volt synchrotron, heads a Phoenix Project staff which is measuring the radioactivity of relics. These relics are furnished by Professor James Griffon of the anthropology department of the U. of M. The relics are mainly North American in origin, consisting of bones, charcoal, and shells left behind by the Indians.

Radioactive carbon 14, produced in the laboratory by nuclear bombardment in cyclotrons or in atomic piles, is found in all living organisms, including human beings. It has a half life of five thousand years; in other words it is only half as radioactive after five thousand years. The carbon 14 taken in during life is not renewed but decays slowly after death. Radioactivity of a weight of carbon from organic matter five thousand is half that from carbon in living organisms. Hence, the age of a fossilized wooden tool, weapon, or piece of charcoal can be found by measuring the radioactivity of the object. The age can be determined within 100 years for objects up to 25,000 years old.

Radioactive carbon 14 is being produced incessantly as the neutrons formed by cosmic rays strike nitrogen atoms in the earth's atmosphere. Because the earth is approximately two and a half billion years old, the atmosphere reached a state of radioactive equilibrium ages ago. Therefore carbon 14 is produced at a rate equal to the rate of decay. This decay is the result of the loss of a beta particle (electron), and a beta particle can be detected by a sensitive Geiger counter. A sensitive enough counter was invented by Dr. James Arnold of the University of Chicago,

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PROPOSED RESEARCH IN THE PHOENIX PROJECT

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where this method was first developed by Professor Libby.

Experiments conducted at the University of Chicago have shown a number of interesting facts. Charcoal excavated from hearts and cremation pits of the oldest known Indian villages in the area showed that the Indians inhabited New York State as long ago as 3000 B.C. This is three thousand years before they were previously thought to have entered the Hudson River valley. The Pyramid of the Sun at Teotihuacan, Mexico, dates from only 1000 B.C., not 13,000 as it was formerly believed. The last Ice Age in the Midwest reached its height 12,000 years ago as opposed to the earlier theory that the peak occurred 20,000 years ago.

U. of M. Apparatus

The apparatus at Michigan, located on the first floor of the Chemistry Building, is being operated by Earl McDaniel, a graduate physics student, and Gloria Thornton, who has a master's degree in chemistry. The apparatus is about four feet high, six feet long, and three feet wide. In the very center of the apparatus is what is known as the Libby screenwall counter, a tungsten wire .006 in. in diameter carrying an electric charge of 1200 volts surrounded by thirty-two copper wires each with a charge of 45 volts. Around the Libby screenwall counter goes a hollow cylinder coated on the inside with carbon from the sample to be tested.

The hollow cylinder is surrounded by fifteen anticoincidence Geiger counters to cancel the effects of cosmic rays. All this is enclosed by an iron and lead housing weighing about four tons. The lead is on the outside to block the radioactivity from room objects and also to reduce the number of cosmic rays passing through. The iron is on the inside to stop the radiation caused by impurities in the lead. The Geiger counters are attached to an oscillograph which records the number of radioactive emissions.

The carbon from the sample is burned to form carbon dioxide. This is reduced to carbon with magnesium. After several complicated steps all the impurities are removed leaving the pure carbon. It is then mixed with an agar solution forming a gel which will adhere to the inside of the cylinder.

Three cylinders are in the apparatus at one time: one contains carbon that is infinitely old, such as coal; another has in it carbon from an organism which has just died; the third can contains the carbon of unknown age. The radioactive emissions from each can are counted for an hour at a time; then the cans are automatically alternated so that another can is being counted during the next hour. Thus in the period of forty-eight hours that the group of three cans is being tested each is counted sixteen hours.

Safe Handling

Although it is expected that much good will be derived from Phoenix Project activities on campus, the project also brings with it several problems. One of the most outstanding of these problems is how to minimize the dangers that are ever-present in the handling and storage of radioactive materials.

The three major aspects of this problem are:

1. The protection of personnel using the active materials.
2. Storage of the active material until needed.
3. Transporting the materials.

Obviously the aspect of prime importance is the first.

Protection

When active materials are deposited in the body, any or all of a great many ill-effects may result, such as change in the functions of the organs or fatal burns. Perhaps the worst feature common to all effects is that they may not appear until the dangerous materials has resided in the body for many years and irreparable damage may have been produced. There usually are no definite clinical symptoms which can be relied upon to guard against possible impending injury.

Since radioactive particles may enter into or attack the body in several ways it can be readily seen that safety must be of primary concern to anyone anticipating the use of these materials. Among the precautions that may be taken for the protection of personnel is the use of safety devices such as shields that will absorb active particles, and monitoring devices, such as film badges, that record the degree of a person's exposure to radioactivity.

Also, laboratory workers must follow strict experimental procedures established on the basis of the utmost in safety. Personnel working in positions of possible exposure must practice personal safety precautions and if necessary submit to periodic examinations more or less stringent as the individual case may warrant.

There is, under certain conditions, considerable danger of workers carrying radioactive particles out of the laboratory in such places as under the fingernails and in the hair. These possibilities could be, for the most part, eliminated if the workers followed carefully planned routines of personnel hygiene.

Storage Problem

The storage problem, though not as involved as the handling problem is still cause for concern.

Since it is not practical to activate materials as they are needed, quantities of them must be stored until used. This requires well protected storage facilities in a close proximity to the place of use. Also, there must be some means of regulating the removal of active materials from their storage space. Whoever is given the responsibility of regulation must know at all times where every millicurie of activity is and how it is being used.

In some cases there is radioactive waste from the use of active materials. There must be facilities to destroy this waste or store it until the period of dangerous activity has elapsed. This period is generally considered to be the half-life of the element which is as much as fifty-five days for Strontium 89, as commonly used radioactive material.

Transportation

The last problem mentioned, transportation, can be a considerable worry if the proper facilities are not available and proper procedures not followed. Radioactive materials, just as any other material must be moved both from laboratory to laboratory and from place to place within a laboratory. This could very easily involve the handling of the materials by people inexperienced and not properly indoctrinated in such work. Strict procedures involving packaging and handling must be instituted and inforced.

Now that the necessity for proper safety precautions has been established, what is being done about it? President Ruthven has appointed a committee of seven men, including those men on campus who are best informed on the subject, to weigh

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PROPOSED RESEARCH IN THE PHOENIX PROJECT

(Continued from page 30)

the aspects of the problem and set up the many rules and regulations that are necessary. This committee has just recently been chosen and hence, at this printing is still in the organizational stage. No definite policy has been decided upon as yet.

Other Engineering Proposals to Phoenix

The foregoing examples of the use of atomic energy are, of course, but three of the many proposed research projects connected with the Michigan Memorial—Phoenix Project. Due to the fact that many of the other engineering proposals are yet in the problematical stage and have not yet been pursued with the details of these first proposals, the other proposals may only be indicated here.

For example, the Department of Chemical and Metallurgical Engineering has suggested the following research projects along with their possible application:

1. Development of a method for measuring particle sizes and concentration in smokes and sprays. This method is based on the light scattering properties of spherical particles. Application: Elimination of radioactive mists in stack gases.

2. High pressure, high temperature chemical reactions. Application: Synthesis of new fuels; design of equipment for withstanding severe conditions of operation.

3. Investigation of the streaming potential phenomena in the flow of fluids through small tubes. Application: Measurement of the rate of flow of blood in arteries and veins.

4. A study of the effect of concentration of proteins, salts and other substances in blood plasma on the rate of diffusion through cell walls. Application: A better understanding of diffusional processes in the human body may result in cures for cancer, edema, and others.

5. The construction of a mechanical kidney. Application: Increased knowledge on the functioning of the kidney and possible cure for its ailments.

6. Development of x-ray technique for measuring concentration of calcium in bones. Application: Prevention of decalcification of bones during pregnancy or during recovery from bone fractures.

Other Proposals

Still other suggestions include the following:

A—"Simple" engineering gadgets

(1) Pinhole detector in thin metal sheet, using low energy beta radiation source and Geiger Counter or ionization chamber detector.

(2) "Memory" for calculator or other device requiring information storage using a neutron source and a wire or tape with high capture cross section which becomes radioactive.

(3) Non contact punch card "feeler" using low energy beta radiation to indicate presence of hole in card.

(4) Smoke or vapor alarm based on capture or scatter of beta radiation by heavy particles in air.

(5) Study of neutron scatter as a possible method of flaw detection in metals.

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RADIOACTIVITY RESEARCH

(Continued from page 20)

The first step of the process is to inject the radio-iodine into the living specimen and, after an appropriate length of time to allow the iodine to distribute itself, to place a slice of the thyroid tissue under a microscope.

Figure No. 2 is a microscopic photograph of such a slice. The main requirement of the microscope is that it be of such construction as to allow accurate adjustment of its focal length to within 1 micron (10^{-6} meters).

size of the silver makes possible the accurate localization of the reactions. From this point the process is one of precision photography.

First a photo is taken of the top layer (layer No. 3) at a comparatively small magnification (Figure No. 2 is this type of photo and it is taken at x 100 magnification). This gives the general distribution of the iodine in the gland.

Next, a photo is taken of layer no. 1 at a much higher magnification (x 15). (layer no. 3 is now out of focus). This gives a picture of the cell structure of the tissue. Now by varying the focal length of the microscope but retaining the same magnification a picture is taken of layer no. 3, (layer no. 1 is now out of focus). This gives a picture of the distribution of the iodine by showing the black spots.

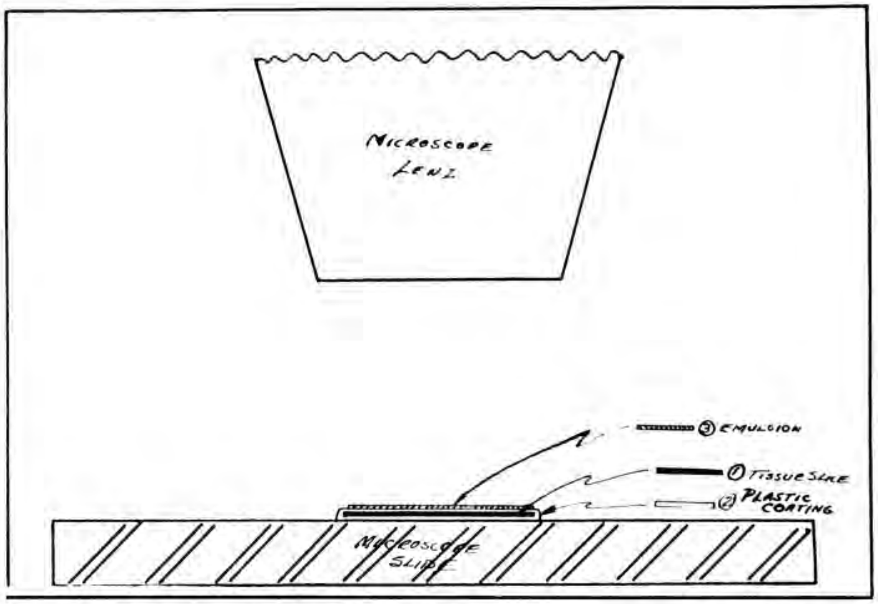


Fig. 1—Thicknesses of layers 1, 2 and 3 are greatly exaggerated relative to the microscope.

The tissue slice (layer (1) in Figure No. 1) containing the radio-iodine is placed on the microscope slide and completely coated with a very thin application of a specially prepared plastic substance (layer no. 2) whose significant characteristic is that it allows free movement of radio-active particles.

A film of photo-sensitive emulsion (layer no. 3) is placed over this plastic coating. This emulsion is composed of very fine grained silver bromide. The realization of these super-small grains that make the whole process possible is a personal achievement of Dr. Gomberg. The plastic layer No. 2 is so thin that it allows layers Nos. 1 and 3 to be intimately associated and yet chemically separated.

The active particles in the tissue react with the emulsion giving the black spots evident in Figure No. 2. The tiny grain

Now it may be seen that, by comparing the last two photographs taken, the spots can be identified with individual cells and the functions of iodine in the cells of the thyroid gland may be studied.

This is an example of but one use of one method. Much better methods and equipment must be and probably will be invented. Realization of these methods and equipment is the tremendous task faced by science today.

It is hoped that the Phoenix Project will be able to accept a large share of that task.

THE UNIVERSITY AND THE ATOM

(Continued from page 19)

Cancer Research

In the medical field, atomic energy has opened up hundreds of new and promising avenues of study. The one of widest interest concerns the effects on cancer of radiation from materials produced in atomic energy facilities.

Radiation has a unique relation to cancer—it can cause cancer, diagnose cancer, and kill cancer. In exploring this important connection between radiation and cancer, scientists have concluded that the cell is the meeting point. They are now convinced that cancer is basically a cellular phenomenon. Radiation also has a very local effect; it kills or cripples the individual cell. Thus a great body of research is now devoted to investigation of cells, of cell metabolism and cell growth. Much of the work supported by AEC to determine how radiation injures cells and how, perhaps, injured cells can be repaired has application in cancer studies.

As part of its contribution to the battle against cancer, the AEC is providing radioactive isotopes at nominal cost for therapy and research. In the past three years the use of these materials has spread from a few major institutions to hospitals and clinics throughout the country.

But some of the radioisotopes are short-lived and will not be useful after shipment. Also, the studies of cancer need to take into account the effects of the powerful radiation available from the nuclear reactors. You can't ship reactors around the country. Therefore, the AEC is building small hospital facilities at Oak Ridge, Brookhaven, and Argonne National Laboratory where the reactors are. There a few score of patients suffering with certain types of cancer may be treated with these means and new knowledge gained.

The AEC also supports five special studies by universities on unique applications of radioisotopes to cancer diagnosis and therapy.

It will be seen that the direct financing of specific cancer research by AEC is but a fraction of the noble effort in this field. Our provision of radioisotopes is aiding hundreds of men and institutions at work on multifarious cancer problems. It is the work of these men which will finally yield the answers and bring more order into the cancer puzzle, greater advance in staying the ravages of cancer.

Data Exchange

One final comment about the importance of the service that the informational clearing house phase of the Proenix Project may accomplish for atomic energy development. The AEC can and does distribute the declassified and unclassified results of its research. But this is not now and never has been the sum of the work being carried on. The greater the growth in the volume of privately-financed basic work, the more headway will we make in development of atomic energy for purposes of the national defense and the general welfare. The lifeblood of present growth in science is information about the results of past research. Its circulation throughout the body of science is imperative.

There has been a past tendency to pull back in the traces on exchange of atomic energy information that is out in the open free and clear of the mark of required secrecy. This has risen, I suppose from the wrong impression that the requirement of secrecy extended much more widely than it actually did. Your project for broadening and speeding distribution of unclassified information should accelerate the desirable trend toward more research not financed by Government in the natural and the social sciences bearing on atomic energy.

I close, as I started, with the Atomic Energy Commission's salute to the Phoenix Project and our wish that it may flourish.

* * *

Motor Cop (after a hard chase): "Why didn't you stop when I shouted back there?"

Driver: (with only five dollars, but with presence of mind): "I thought you merely said 'Good morning, Senator.' "

"Well, you see senator, I wanted to warn you not to drive too fast through the next township."

* * *

Prof: Are you teaching this class?

Student: No sir.

Prof: Well then sit down, and stop acting like an idiot.

PROPOSED RESEARCH IN THE PHOENIX PROJECT

(Continued from page

(6) An integrating machine for polar coordinate plot based on a flat source whose intensity falls off inversely with radius rotated behind the cut out polar chart. Total radiation detected would indicate area on a polar coordinate basis.

(7) High gas pressure measuring system using beta radiation transmission.

(8) Condensation detector using beta radiation to detect formation of droplets.

B—More general research studies.

(1) Study of electric contact performance using radioactive isotopes to detect contact metal transfer.

(2) Study of electrolysis using radioactive isotopes as indicators of material migration.

(3) Study of effect on dielectric strength and constant of radioactive isotopes incorporated into plastic and other suitable dielectric media.

(4) Possible use of graded radioactive sources to produce variable ionization in low pressure cavities. It might be possible to simulate ionosphere conditions in this way.

(5) Investigation of the behaviour of thorium or other activators in activated cathodes. This can probably best be done by micro-auto-radiography.

(6) Development of direct viewing instruments for accurate location of radioactive areas (we already have one such project under way, with the aid of an Atomic Energy Commission grant).

(7) Development of new *rugged* high sensitivity particle detector systems.

(8) Investigation of new energy transfer effects for particle detection.

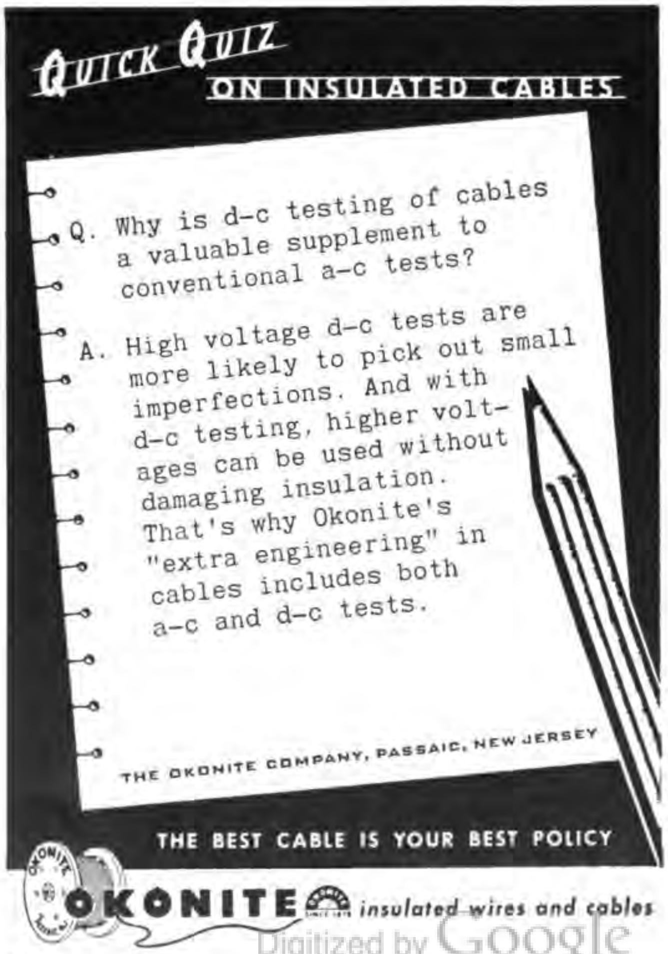
Direct Recovery

One other important phase of atomic power development has received consideration. This is the fact that present methods of energy recovery from atomic piles are all based on heat generation, yet the fission fragments, when formed, possess high electric charges. Direct energy recovery by electric field methods from high energy charged particles is possible (being just the inverse of particle acceleration). Thus it seems that a preliminary study of direct *electric* energy recovery possibilities from fission processes would be a worthwhile undertaking.

Additional Proposals

Still other proposals include (1) investigation of instruments and techniques for measurement of the mechanical state of materials using radioisotope methods; (2) development of a powerful, high-frequency vacuum tube to supply high voltage to an accelerator for production of very high energy electrons; and (3) construction of an electronic digital computer, or mechanical brain.

Thus it seems inevitable that engineering will play one of the most (if not *the* most) important part in the realization of the "utopian era" mentioned at the beginning of this article. By such means as the cooperation of the College of Engineering of the U. of M. with the Michigan Memorial—Phoenix Project, it seems highly probable that countless peacetime uses of atomic energy will be developed within our time.



THE HISTORY OF THE PHOENIX PROJECT

(Continued from page 16)

could champion the cause from the floor of Congress, and the end result might well be a substantial fund and an immeasurable contribution to the dignity and prestige of the University.

"I am suggesting this more as a general formula than as a particular device: that is to say, your own scientists, working in cooperation with your committee might conceivably find some other phase of atomic research, or some combination of phases, or they might even find some other organized course to pursue in an effort to bring more security, safety, or contentment to the people of the world.

"I am only appealing to the Committee to pick out one of the innumerable jobs that must be done, and must be done quickly if our immense achievements are to save us rather than ruin us.

"I am suggesting that this job be a practical, rather than ideological one, and that it be tackled from the standpoint of coordination; for organization will bring to fruition the isolated things that are being done everywhere in pursuit of almost every idea. The atomic bomb was developed more as a result of the organization of good minds, and the parceling out of work than because the Lord suddenly provided us with hitherto unsuspected genius. I am further appealing to the committee to house this undertaking, whatever it is, in the structure that will serve to remind University students forever after that their antecedents in a bloody war, managed to get the ball away from the opposition, and the University of Michigan had sense enough to pick it up and run with it."

The Faculty Planning Committee for the Phoenix Project is headed by Chairman Ralph A. Sawyer (right), Dean of The Horace H. Rackham School of Graduate Studies at the University of Michigan.

The First Resolution

On October 24, the directors of the Alumni Association had their annual meeting and adopted the following resolution:

RESOLUTION: It is resolved that the

(Continued on page 42)

THE HISTORY OF THE PHOENIX PROJECT

(Continued from page 40)

University of Michigan Alumni Association whole-heartedly support and assist the Committee appointed by the Board of Regents to study the advisability of adopting a War Memorial Program and recommends that such a Memorial incorporate the philosophy that it is better to commemorate the memory of those who have made the supreme sacrifice by attempting to develop a project that will aid all mankind in living in a war-free world rather than to attempt to build a mound of stone the purpose of which might soon be forgotten.

When Fred Smith's plan was presented to the committee, it was enthusiastically received. The general reaction was, "This is it! Why should we look further?" Obstacles immediately, however, began to appear, the seemingly insurmountable one being Public Law 585—an act for the development and control of atomic energy—probably the most absolute legal document ever drawn in the United States of America. Since the Atomic Eenergy Commission had absolute control of any activity within the field of atomic energy, the committee obviously needed to secure the most authoritative advice and counsel. It called into consultation, in addition to Vice-President Niehuss of the Law School, Dean Ralph A. Sawyer who had been the civilian technical director of the Joint Task Force One of the atomic bomb tests at the Bikini Atoll in 1946; Dr. Fred J. Hodges, Professor of Roentgenology in the Medical School, who had experimented for some time with isotopes; and Dr. H. R. Crane, Professor Physics, who had played an important role in the atom bomb's development.

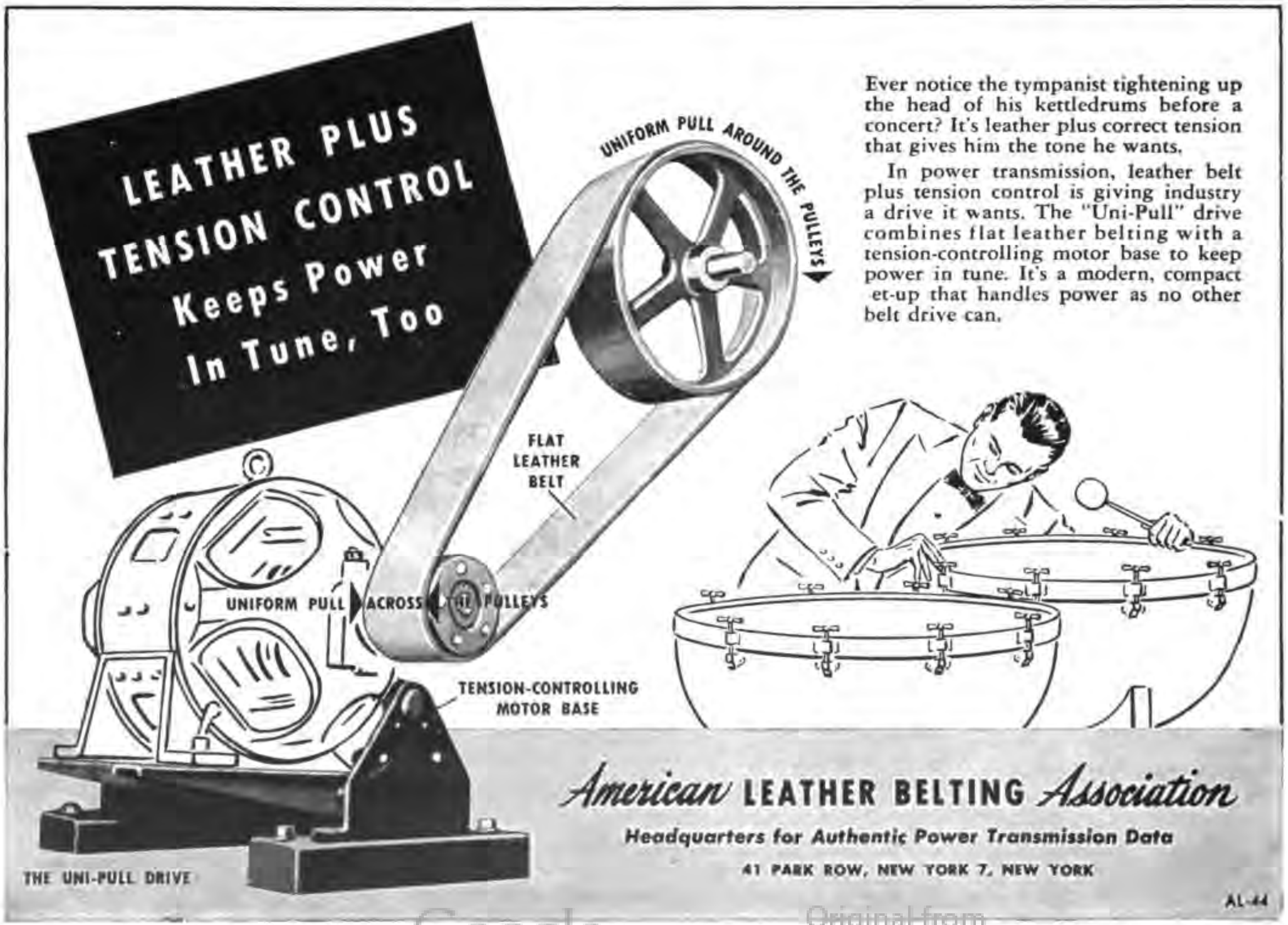
Meeting with the AEC

Although in the course of discussions the committee attempted again and again to consider other meritorious projects as functional memorials, inevitably the discussions always returned to Fred Smith's suggestion, the students particularly being unwilling to think seriously of an alternative until every possible means of effecting his suggestion had been explored. After a series of attempts to arrange a meeting with representatives of the Atomic Energy Commission in Washington, such a meeting was held March 24, 1948, with Dr. Shields Warren of the Commission, and was attended by Dean Sawyer, Dr. Hodges, and the author. As a result of that meeting, the committee received, under date of March 24, the following letter from Carroll L. Wilson, General Manager of the Atomic Energy Commission:

"The Atomic Energy Commission has learned with interest of the proposal of the War Memorial Committee of the University of Michigan to establish on the Michigan campus a permanent living monument to the students, alumni and faculty of the University who served the nation in World War II.

"The aim to create an institution devoted to intensive study of life mechanisms as they exist, together with research into the effects of atomic energy upon man and his living environment, is a welcome addition to the research facilities of the nation. The Commission applauds the decision of the War Memorial Com-

(Continued on page 46)



PROBLEM—You're designing a radio broadcast transmitter. The circuit includes condensers and other variable elements which must be adjusted by the operator. You want to place these elements for optimum circuit efficiency and where they will be easy to assembly, wire, and service. At the same time, you want to centralize the control knobs at a point convenient to the operator. How would you do it?

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ECONOMIC RESEARCH

(*Continued from page 22*)

power for its serious consideration by economic researchers.

It need not wait because methodological problems, by definition, can be engaged in without precise substantive data. Two broad avenues of approach are open to researchers. The one, which holds forth the least attractiveness, is to reexamine systematically the historical literature of economics with an eye to learning from historical efforts to cope with problems of technological unemployment, business cycles, etc. what techniques and conceptual frameworks might be useful in the atomic power context. Although the probabilities are reasonably high that few really valuable lessons will be learned, there is some point in at least a limited effort in this direction. Such an effort has in fact been sponsored by the Social Science Research Council.

The other and more promising approach consists in making, on the basis of the best technical data available, an assumption as to the probable range of atomic power costs. With this as a point of departure, the researchers will find himself in precisely the same position (or predicament!) that a researcher tackling the problem several years to a decade hence when more abundant data from operating reactors is available Although only limited substantive conclusions can be hoped for from such an analytic process (unless by chance eventual atomic power costs should happen to coincide with the assumed points on the range presently employed,) never-the less much can be expected in the way of development and improvement of specific techniques.

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THE HISTORY OF THE PHOENIX PROJECT

(Continued from page 42)

mittee to further knowledge in this new field and the intent to explore the beneficial potentialities of atomic energy. From the proposed center may come an answer to some of the urgent biological problems of today. Funds of the Atomic Energy Commission for basic research, its fellowship program and its training facilities are planned to assist in development of programs of this broad type."

At the suggestion of Fred Smith, the war memorial was named the Phoenix Project.

The Phoenix Project: We have named the memorial the Phoenix Project because the whole concept is one of giving birth to a new enlightenment, a conversion of ashes into life and beauty. The Phoenix Project, as we visualize it, would consist of an academy of scholars recruited from this and other universities. It is our thought that they would devote their full creative powers to the task of converting atomic energy to peace-time purposes and of utilizing it for the benefit of mankind. These men would carry on their researches in a group of laboratories and work-rooms which would be entered through a memorial rotunda or similar structure. This structure would in itself be a constant reminder that the University had effectually recognized the aims for which its students and alumni gave their lives. A functional memorial, it would explore the beneficent aspects and implications of atomic energy with the same determination and enthusiasm as the Manhattan Project explored the destructive aspects.

On May 1, 1948, the committee presented the following resolution to the Board of Regents, which gave its unanimous approval:

The Second Resolution

RESOLVED: That the War Memorial Committee recommend to the Board of Regents that the University create as its War Memorial a Center to explore the ways and means by which the potentialities of atomic energy may become beneficent influences in the life of man.

On May 17, a special edition of the *Daily* announced the project to the student body.

Art Der Derian, one of the student members of the committee, at one of the early meetings, made this comment: "I don't know what form a war memorial should take. I do feel, however, that it ought to be a light, high in the sky, and visible not only to our veterans who are back at the University but to their sons and all future generations of students. They should always see it. It should always remind them of the ideals for which our students gave their lives."

Although the Michigan Memorial-Phoenix Project is not an actual light, housed in a tower, it is a light of much greater intensity. The source of its energy has already been supplied by our students and our alumni. That energy is constantly being increased and will be recognized, as Art Der Derian envisioned that it would be, "not only by our veterans but by their sons and all future generations of students."

* * *

E.E.: "Grab the end of that wire."
A.E.: "All right. I've got it."
E.E.: "Feel anything?"
A.E.: "Nope."
E.E.: "Well, don't touch the one next to it; it's got 50,000 volts in it.

A BRAND NEW FIELD

RAY LADENDORF
Editor-in-Chief

Extent . . .

About 60,000 people are now engaged in the new and potentially large field of atomic-energy work. At present these people are employed directly by the Atomic Energy Commission and its contractors. The expansion of this field appears to be almost limitless and the opportunities now available are quite similar to those that existed in the infant radio industry in 1920.

There are three major fields of effort in the applications of atomic energy: the production of raw materials, the utilization of radioactive materials produced by nuclear reactors in science and in industry, and the production of useful power. In each of these fields opportunities draw the engineer. Between sixty and eighty percent of all the technical positions open will be filled by engineers; the remainder mainly will be made up of physists and chemists.

Production of Fuel . . .

The techniques used so far in the production of raw materials have been mainly adaptations of those common to the mining and ore-refining industries. Although much higher standards of purity are required, the refining of the uranium ore is not very different from the other refining and chemical industries up to the point of use of the material in the reactors. Men with conventional training in mining and chemical engineering probably will be able to handle the jobs.

Isotopes . . .

Radioactive isotopes for industrial, scientific, medical, and agricultural uses are at the present time the main peacetime contribution of the development of atomic energy. Medicine and biology at present constitute the largest fields for the use of isotopes; industrial and metallurgical uses account for ten percent of the shipments.

Most applications of radioisotopes require special instruments and tools for the remote handling of radioactive materials. The demand for these special instruments has led to the building up of a sizeable new radioactive instrument business, and there are now more than thirty firms supplying equipment of this sort. These firms employ physicists, chemists, and engineers who have specialized in instrumentation.

Power Plants . . .

Much work is being started toward developing atomic-energy power plants. The Knolls Atomic Power Laboratory, operated by the General Electric Company, primarily is working on the development of stationary power plants. Westinghouse, sponsored by the United States Navy, is going forward in developing ship and especially submarine power plants. The Fairchild Aircraft and Engine Corporation, sponsored by the Air Force, is working on nuclear energy powerplants for aircraft. In these specific projects many engineers will be needed in electrical, mechanical, marine, and aeronautical engineering; their work will be only indirectly connected with nuclear energy.

Much work is being done to obtain the maximum possible heat transfer from the smallest possible volume, since nuclear fuel is so expensive that it is profitable to invest a considerable amount of mechanical and metallurgical effort in getting the maximum amount of heat out of a given amount of this fuel. Mechanical engineers specializing in heat transfer will be needed for some time to come in this work.

Corrosion problems within the reactors will require the services of many chemists and metallurgists. The conventional corrosion problems are complicated by the difficulty of maintenance of the inner parts of the reactors due to the intense levels of radioactivity.

Civil engineers will also find their work waiting for them in the field of atomic-energy development. Civil engineers will be needed to build the plants and, more important, provide for the disposal of radioactive wastes.

Prerequisites

Almost all the engineering in nuclear energy projects is exactly the same kind of engineering required elsewhere in industry. Atomic-energy development provides engineers with the same old problems but in a new setup and with a different background. Basically the same engineering training is required. However, most of the technical people to be used in the atomic-power effort in the future will need some training in the special fields of current engineering, and in physical, chemical, and metallurgical skills. Perhaps ten percent will need the new fission and neutron knowledge of modern nuclear physics. Some of this they may be able to get in college, but security restrictions and the difficulty of obtaining expensive and restricted equipment and materials will mean that much of the specialized technical knowledge will have to be obtained on the job.

A considerably larger group than the above ten percent, consisting of chemical engineers together with chemists and health physicists, will need practical knowledge of how to handle redioactive materials in bulk. This knowledge also will be obtained on the job.

For You???

Here, then, is a brand new field of engineering, waiting to be developed. Opportunities for the expansion and the development of new uses for atomic energy are great. Atomic-energy development needs men—witness the ads in recent journals. Is this the field for you?