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# "Researching the Researchers" by Edward F. Flynn, UND Summer Commencement: August 2, 1945

Edward F. Flynn
*Great Northern Railway Company*

# Researching the Researchers

*An address given by Edward F. Flynn of Saint Paul, Minnesota, Assistant to the Vice President and General Counsel of the Great Northern Railway, at the Summer School Commencement of the University of North Dakota on the morning of August 2, 1945.*

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Mr. President, Members of the Faculty, Members of the Board, Members of the graduating class, and men and women of North Dakota:

Thank you, Mr. President for referring to me as a lawyer. I am merely an attorney at law. An attorney at law is anyone admitted to the bar. A lawyer is a gentleman learned in the law. When I was examined for a law degree at the University of Minnesota in 1896 one did not have to know very much law. There were 105 in our class and 106 were graduated. We did not even have to take the State Bar examination. We were merely required to appear before the Supreme Court of Minnesota in Saint Paul some eight miles from the University of Minnesota campus, hold up our hands, take the necessary oath and we were admitted to the practice of law. But the next year when I went to Devils Lake in this state to practice, I was required to take an examination to see whether I were qualified to practice law here. As was then the custom the judge of the District Court appointed five lawyers who sat around a table and asked me question after question regarding law generally and the statutes of North Dakota in particular, but unfortunately to every question asked me I replied, "I don't know, I don't know." I thought the examiners would request me to return in a year or so and take another examination, but instead they all stood up, and with smiles on their faces they shook my hand and congratulated me saying: "Mr. Flynn you have answered every question correctly. You said "I don't know" and we all know you don't know, so having answered all questions correctly, we hereby give you a mark of one hundred percent."

Sometimes I speak rather rapidly though I try not to. If I do speak fast today it is because I learned to do so as a youngster while working in a grocery store at Faribault, Minnesota. One day a man came into the store all excited and flustered and asked me in one breath: "How much are those lemons, how much are those oranges, how deep is the river, what time does the next train leave?" I replied: "Two for a nickel, three for a dime, up to your neck, at half past nine."

It is customary for a graduating speaker to advise the graduating class how to succeed in life. I could not take that responsibility at any time, but it would be especially difficult here at the University of North Dakota, for if I have achieved any success as I have traveled along life's highway, such success I attribute to the fact that I had the good judgment to associate myself in the practice of my profession at Devils Lake with two graduates of your Academic Department and also of your College of Law.

*THE GROWTH OF RESEARCH*

Next to doing actual research work in a laboratory at a University or in industry, I believe the most interesting study is researching the researchers, which I have done for many years, and that is the subject of my address today.

*RESEARCHING THE RESEARCHERS*

All down through the ages certain people believed they and we had reached the ultimate. Researchers and scientists have had to dispel that erroneous idea and have to do so still.

You know the gentleman very well whom I am to quote. The statement he made was not said in 1945 nor 1915 but long before that. He said: "The present is an age of talkers and not of doers, and the reason is that the world is growing old. We are so far advanced in the arts and sciences that we live in retrospect and dote on past achievements.

"The accumulation of knowledge is so great that we are lost in wonder at the height it has reached instead of attempting to add or climb to it, while the variety of objects distracts and dazzles the looker-on.

"What niche remains unoccupied? what path untrod? What is the use of doing anything unless we can do it better than all those who have gone before us and what hope is there of this?"

It might seem plausible if some one were to make a statement like this today, though no thoughtful man would do so. However, the statement quoted was made in 1815 by William Hazlitt, a well-known British author, literary critic and essayist, and measured by his contemporaries as anything but a pessimist or doubter.

When Hazlitt made the statment quoted, which seems rather strange today, light houses, homes and business places were lighted with tallow candles. Small pox plague, typhus fever and all other diseases that ravaged mankind were regarded as the visitation of God with which it was impious to interfere.

Microscopic examination of disease and its cause was not within sixty years of its birth. Antiseptics had not been discovered. Anaesthetics were not within 25 or 30 years of their common use. Doctors were still bleeding people figuratively as well as literally, if you know what I mean. But today doctors are performing a great service to humanity. Their profession has advanced rapidly during the past few decades through science and research. They have to be very highly skilled in administering the new sulfa medicines, penicillin and other new medicines.

And it is well to remind ourselves that when our doctors in Canada discovered insulin it was of as much benefit to us here in North Dakota and in the United States generally as if we had discovered it; and when Dr. Alexander Fleming discovered penicillin it was as valuable in saving our lives as those people living in England and that is pretty much true of all scientific discoveries. They benefit all mankind. It has been said that during the time occupied by World War II, penicillin will save as many lives as are lost in this pending conflict. Research pays large dividends.

"The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end." So declared the U. S. Patent Commissioner, Henry L. Ellsworth, in

1844. Men were still goggle-eyed over the recent invention of Morse's telegraph, Howe's sewing machine, Goodyear's vulcanized rubber, McCormick's reaper. Many agreed with Ellsworth that science must be near the end of its rope.

Apparently some people now believe we have enough patented articles for there has been a 41.5 percent decline in patents issued by the United States Patent Office from 1933 to 1943. This decline is of more than academic interest since the number of patents applied for and issued may well be the measure of industrial scientific effort, and hence of future industrial development in this country.

Moreover, the effect of this decline is cumulative, since every patent stimulates further invention, says Arthur D. Little's Industrial Bulletin.

"In general the objective of industrial research is the material objective of life itself—to prolong life, to improve health and comfort, to enhance happiness and to enlarge productive ability and usefulness" according to Harry L. Darby, President of American Cyanamid.

## *CHEMISTRY AND INDUSTRIAL RESEARCH*

According to good authority chemistry has made waste paper of nearly every book ever written on international relations. Increased knowledge and understanding of chemistry will make it possible for some nations now poor in resources to achieve new wealth in the post-war world. Atoms and electrons and plastics materials and alloys are on the march and the brain that does not comprehend them will sink into the dust.

## *THE VALUE OF RESEARCH*

Research is not merely a laboratory full of chemical equipment—it is a habit of mind. A simple experiment may found a new industry; a well considered research may offer the opportunity for the employment of thousands and improvements in health and happiness for untold numbers.

It is estimated that every fourth worker in the United States today is in an industry not in existence in 1900. Every one of these is founded on research.

Charles M. A. Stine, Vice President of DuPont said recently:

> "Already our world of 1940 in which we took pardonable, if not mistaken pride, is so distant in the past that it has become an antiquity as seen through scientific eyes—the inconceivables of four years ago are today's realities."

Today's research is tomorrow's engineering and the next day's industry. Necessity may be the mother of invention, but research is the father.

In an address delivered on January 5, 1945, when he was presented with the Perkin Medal for his outstanding achievement in science, Dr. E. K. Bolton of E. I. du Pont de Nemours & Co. Inc. said: "The effectiveness of research devoted to the development of new products is indicated by the fact that in 1942 almost half of the gross sales of the du Pont Co.—46 per cent to be exact—consisted of products which either did not exist in 1928, or were not then manufactured in large commercial quantities.

The reason Du Pont is so successful is that it now has 33 research laboratories and 3,500 people engaged in research, a substantial number being chemists and engineers.

Minnesota Mining and Manufacturing Company is another example of what research can do for industry. From a very small organization 25 years ago it has grown to one of the nation's best known medium sized industries today. It has about 7,500 employees, a number of plants, laboratories and factories. It employs about 300 researchers most of them being engineers and chemists. It manufactures hundreds of different products. Its Scotch tape, Scotch light, sandpapers, including waterproof sandpaper and roof granules are known all over the world. This company states in its advertising that its success is due to research.

We used to say we haven't scratched the surface of the earth. Now we know we haven't scratched the surface (so to speak) of the air nor of the ocean.

From the air we obtain many chemicals that are the basic materials of plastics and fertilizers and are the very foundation of some of the country's largest industries. These include atmospheric nitrogen, ureas and the "air"

used by Du Pont in its coal air and water process for making nylon and lucite, or methyl methacrylate.

In the ocean we are told there are 250,000 tons of bromine in each cubic mile of the briny deep, and as there are 300,000,000 cubic miles of ocean, the total number of tons of iodine therein is 75 trillion or 150 quadrillion pounds. Bromine is used in making high test gasoline, for making poison gases, and for a thousand other purposes.

In fact, in the ocean are scores of kinds of chemicals and minerals estimated to be worth about one and one half quintrillion dollars.

There is $60,000,000 worth of iodine in each cubic mile of the ocean or a grand total of 18 quadrillion dollars worth. Don't spare the iodine and catch an infection from an injury.

Perhaps as valuable to the winning of the war as any other metal is magnesium. Dow Chemical Company is taking from the waters of the Gulf of Mexico at Freeport, Texas, 400 million pounds of magnesium annually, which is about two thirds of all that is produced in this country today. There are nine billion pounds of magnesium in each cubic mile of the ocean or a total of 2 quintrillion 700 quadrillion pounds in the waters of the seven seas. Magnesium is one fourth the weight of iron, one third lighter than aluminum. When used in a four engine bomber instead of aluminum, it is said magnesium metal eliminates 380 pounds of weight, which is enough for an extra barrel of gasoline or two good-sized men. Magnesium will be used for making cheap and strong furniture and kitchen utensils at war's end and a piano one man can move.

*RESEARCH FOR NATIONAL SECURITY*

Authorities say that when 'the chips are down' American scientists win. Dr. Vannevar Bush and his 6000 United States scientists, known as the Office of Scientific Research and Development, certainly saved the allies from defeat by producing war material which won the 'Battle of the Atlantic' and many another battle around the world.

The Research Board for National Security requested by the Secretaries of War and Navy and recently established by the National Academy of Sciences is to be the

peacetime successor to the Office of Scientific Research & Development, pending possible ultimate authorization of an independent research agency by Congress. The new board will formulate programs of research on National security and will conduct research under contracts whereby existing laboratories and facilities are used wherever possible.

The war has proved the need for the far-sighted contribution of scientific research.

For this reason the new Research Board for National Security includes 20 civilian scientists and 20 high ranking Army and Navy officers. Karl T. Compton of MIT is chairman of the Executive Committee, according to researchers Arthur D. Little, Incorporated.

The late President of the United tates asked Dr. Vannevar Bush to submit a plan for United States science. Dr. Bush and four committees composed of leading United States scientists, drafted a plan and submitted it to President Truman about the end of July, 1945, which recommends that the United States Government spend $122,-500,000 a year to support basic or fundamental research. The plan is:

(1) Government grants amounting eventually to $90,000,000 a year to universities, medical schools, and research laboratories for long-range research.

(2) Federal science scholarships for some 6,000 undergraduates and 300 graduate students each year.

(3) An immediate comb-out by the Army and Navy of all uniformed personnel with scientific training or aptitude (perhaps 100,000) for assignments to schools to complete their scientific education.

(4) Prompt release from censorship of all scientific military secrets which no longer involve security.

(5) United States leadership in international exchange of scientific information after the war, aided perhaps by the assignment of scientific attaches to United States embassies abroad.

(6) Appointment by the President of a National Research Foundation to guide United States science.

Dr. Bush and associates told the United States that despite vast expenditures on war-time research ($722,000,000 in 1944 alone) the United States is on the brink of scientific bankruptcy because it has used up its backlog of basic scientific knowledge.

During the war United States scientists were drafted almost to a man for work on new weapons, gadgets, drugs, etc. and have done virtually no fundamental research. Moreover, the United States unlike every other great power has stopped training young scientists.

Dr. Bush's group estimates that the war will cost the nation 167,000 potential scientists and doctors who would otherwise have obtained degrees.

Although the United tates is the World's No. 1 technological power, most of the fundamental scientific discoveries which its technology has been based originates in Europe.

Even in pre-war years, United States laboratories spent nearly six times as much on applied research as on pure science. In contrast, the British, for example, spent almost as much on pure science as on technology.

Said Bush's group: "The United States must adopt a national policy for science forthwith if it hopes to (1) keep abreast of other nations in military research; (2) get ahead in international trade; (3) achieve full employment." Bush's scientists unanimously agreed this could be accomplished only by federal subsidy. Among those who concurred in this report were representatives of Bell Laboratories, Standard Oil of Indiana, and Du Pont, according to Time for July 30, 1945.

*WHAT RESEARCH MEANS TO NORTH DAKOTA*

While the old pioneer with a muzzle-loading rifle across his shoulder and a coon skin cap on his head has passed away, the frontiers of the modern pioneer have hardly been touched. The modern pioneer carries a test tube instead of a rifle and finds more opportunities than his predecessor of a century or two ago.

Just what does research mean to North Dakota? First, much research is done on products which directly affect you—insecticides that control infestation, kill worms in elevators, flour mills, and greenhouses.

Research on housing facilities, such as is being carried on at Purdue University—which leads to better ways of keeping houses cool in summer and warm in winter; chemicals that make better refrigerators, bath tubs and automobiles, and thousands of other things. But more than that, every dollar spent on research in the United States directly or indirectly benefits residents of this state.

*LIGNITE IN INDUSTRY*

Within the next twenty-five years North Dakota will be better known for its lignite products than for its agriculture.

In making this prediction I am merely repeating a statement made to me in Washington about twenty-five years ago by your late United States Senator A. J. Gronna. At that time the senator said that within fifty years North Dakota would be better known for its lignite and clay products than for its agriculture. Twenty-five years have passed and after much researching of researchers I am sure the senator's prophecy regarding lignite will come true, if researchers now being carried on here at North Dakota University and elsewhere in the United States can be continued and enlarged and enhanced. I can see no reason for failure!

North Dakota has approximately 600 billion tons of lignite which can be easily mined. When produced with the latest and best machinery, lignite can be sold for fifty cents a ton at the mines.

A commodity that costs so little and has so many potentialities as has lignite is bound to be the basis of many industries.

Here at North Dakota the United States Bureau of Mines and your university are carrying on experimentations and researches that sound minds believe will result in the production of cheap gases such as hydrogen, oxygen, carbon monoxide and carbon dioxide from lignite, all invaluable in present or forthcoming industry.

Scientists visualize whole trainloads of char, produced from lignite being shipped from North Dakota to Northern Minnesota to beneficiate or process the many kinds of taconite and low grade iron ores that abound there.

Researchers believe that with North Dakota's aid Minnesota may produce from its low grade iron ores and taconite from 50 billion to 250 billion tons of high grade iron ore which may sell for about $1.00 a ton higher than our present iron ore. Fifty billion tons of iron ore would last us 500 years, 250 billion tons, 2500 years—if used at the rate of 100,000,000 tons a year. We may use that much after war's end, as many industries will require more for commercial production than for war munitions. It will take 50,000 men to produce 100,000,000 tons of iron ore from taconite whereas it takes 18,000 to mine the same amount of high grade ore—result more jobs for Northern Minnesota. The Minnesota legislature in 1941 wisely reduced the tax on mining taconite to about 6c from the 50c charged on high grade iron ore. This lower tax will no doubt encourage even more extensive research on taconite than is being carried on at present.

And hundreds, perhaps thousands will be employed in North Dakota producing char and by-products from lignite for this iron ore operation and other purposes.

Dr. L. H. Reyerson of Northwest Research Foundation who has been doing research on lignite for many years believes that many new industries will arise from your cheap hard fuels.

In addition to providing char to produce hydrogen for beneficiating Minnesota low grade ores, the Doctor thinks that hydrogen produced from lignite, processed into char, will be used in the manufacture of high octane gasoline. He believes this will occur when shortages of hydrogen develop in refineries making high octane gasoline.

It is also likely according to good authority that much of our present petroleum supply may soon be used entirely for making high octane gasoline, largely for the government, and for making other chemical products. In such case we will have to rely on North Dakota's lignite for the production of motor fuel for our automobiles and domestic uses; for heating oils and for diesel engine fuel.

My information is that researches now being carried on indicate that we can make all of these products from lignite, and that they may be sold at prices not much higher

than present costs of the same, when made from petroleum. Researches being carried on here at North Dakota University may decide these problems. The possibilities for new industries to be created from lignite are beyond one's imagination.

Coal tar has been the source of thousands of chemical products during the past 25 years—such as medicines, perfumes, plastics materials and dyes. Coal tar may well be a lignite by-product.

In addition to the necessary funds for continuing research, that is long term research than for short terms, we need pilot plants and factories to produce these materials and pioneers who will invest their funds in research, and in the production of all these materials from lignite. But more important than all, we must draft for the Universities and industry an army of chemical engineers, engineers of all kinds and researchers with imagination and initiative not only to carry on applied research, but equally important—fundamental research. Yes, in 25 years North Dakota will be better known for its lignite than for its agriculture.

*NOTED NORTH DAKOTA ALUMNI*

Most of the graduates of North Dakota University have been pioneers, sons or grandsons of pioneers, and thus have a keen sense of the value of education. The same is true of North Dakota University women.

Many of these men and women have had to work their way through the university and I believe that is another reason they achieved success. Some of them are here in this audience this morning.

Recently I was taken to and through the great laboratory of American Cyanamid Company at Stamford, Connecticut. The man whom I accompanied was your noted son, Howard Huston, Assistant to the president of American Cyanamid and an important and successful officer of that great concern. Mr. Huston came to North Dakota as a small boy with his father from Missouri, and thus he was a pioneer. You know of his work with the League of Nations and his interesting career.

American Cyanamid was not founded until 1907. It is a creature, pure and simple, of research and it is proud to

admit that fact. It's war record is one of amazement, as in fact has been its whole history. Before the war Cyanamid had over 10,000 employes and it has one of the finest laboratories in the world. In addition to Mr. Huston, one of the men I met at American Cyanamid is S. J. Swainson, a graduate of North Dakota School of Mines and who is now head of American Cyanamid's research division which deals with minerals and ores.

J. F. Gates, another North Dakota School of Mines graduate, is head of American Cyanamid's activities in Europe, with headquarters in London. Messrs. Huston, Swainson, and Gates helped Cyanamid to become successful.

The late A. V. Ritchie was Superintendent of Beacon Laboratories of the Texas Company and was a North Dakota University graduate. Mr. Ritchie did outstanding research in the field of petroleum chemicals.

Before the war Bell Laboratories was the largest individual laboratory in the world located at one place. It spent 18 million dollars a year for research which was about three times the amount we were spending in the United States to find a cure for cancer which is untimely taking away so many of our people.

Since the war began Bell's efforts in research and design have been voluntarily devoted to the war needs of the nation.

One of Bell Telephone System's greatest achievements was th development of the Electrical Gun Director known as the M9.

Major General Levin H. Campbell, Chief of Ordnance of the United States Army stated recently: "The M9 director electrically operated is, we feel in Ordnance, one of the greatest advances in fire control made during this war and we anticipate from the M9 director very great things as the war goes on."

General Campbell said there was an incident that happened the other day in the South Pacific when 16 Japanese bombers flying 14,600 feet high, everything riding fine, no trouble and all at once the 90 millimeter anti-aircraft gun (which I have mentioned) in the hands of our

great artillery men went to work and with 88 shots knocked down 12 out of the 16 bombers. Some fighter airplanes got the other four. General Vandercliff told General Campbell that he knocked down planes as high as 27,000 feet with these 90 millimeter guns. In World War I we used to hit a plane, not knock it down, once for every 17,000 rounds.

Bel now employs about 8000 persons in its Research Laboratories and has nearly 500 active military projects. About 55 per cent of its war work has been for the Army, 35 per cent for the Navy, and 10 per cent for the Office of Scientific Research and Development.

Not only has the Laboratories developed war communication equipment, both wire and radio, but it has made notable contributions in radar, submarine warfare, rocket design, electrical computers, electronic tube development and in other fields which cannot be divulged at present.

With the aid of electrical devices our bombers attack their targets with precision and guns are accurately aimed at fast moving enemy planes which may travel two miles while a shell is on the way.

One reason Bell is so successful is that it has researchers in its "Laboratories" such as that well-known University of North Dakota alumnus Ray Heising, who has done significant research work for Bell. Mr. Heising did much to develop, plane-to-ground, ship-to-shore and walkie-talkie methods of communication which have proved so valuable in the war. Mr. Heising is also probably more responsible than any one else for the modern transmitter used in loud speakers and radios. Some six or eight years ago the National Association of Manufacturers presented Mr. Heising with a medal as one of "America's Modern Pioneers".

Another reason for Bell's success is J. B. Johnson, North Dakota University alumnus who was cited in a recent publication by Westinghouse Electric, (although associated with Bell) as one of the four outstanding men in the world in the field of electronics. He discovered the "Johnson effect" in physics. He is an outstanding authority on the oscillograph tube. Mr. Johnson synchronized the sound in talking movies by developing a photoelectric process

which enables the sound strip to be placed on the celluloid with the picture. The recording and the picture formerly were separate units.

And Harry Nyquist, B. S. in Engineering, North Dakota University, is an expert researcher and mathematician at Bell Laboratories.

Another well-known North Dakota "boy" is Charles Boise, one of the most prominent engineers in the British Empire. Mr. Boise is now living in London and has custody of all diamonds used in drills and other instrument work by the allied nations.

Then there is Dr. John Lundy, North Dakota University alumnus, who is Chief Anaesthetist at Mayo Clinic, Rochester.

And John Hutchinson, Associate Director of Research at Westinghouse Electric.

And Franzo H. Crawford, prominent scientist and Rhodes scholar and head of the Physics Department at Williams College.

And to show that women are successful too when they graduate from North Dakota University, there is Miss Pearl I. Young, Bachelor of Science of this University, who majored in physics and mathematics. Miss Young is now chief editor at Langley Field Publications.

And again in the field of medicine, Dr. Cushman Haagensen, Chief Investigator of Cancer at Medical Center, Columbia University.

And Archie Baggenstoss, researcher and first assistant to the chief pathologist at Mayo Clinic.

In the field of exploration are Richard Black, Antarctic explorer and the great Rilhjalmer Stefansson, internationally known and beloved Arctic explorer.

And Charles Clapp, late great president of the University of Montana, and Oxford graduate.

## *THE PLACE OF UNIVERSITIES IN INDUSTRIAL RESEARCH*

There is only one way in which men can be trained for the research phases of industry. After they have received their broad technical training, they must be taught the research technique by being given research to do, and in

the early phases of that training that research work can be done in the university to the best advantage. In the conduct of that research results are sure to accrue. And that is the field which the university should occupy in the conduct of industrial research. Progress has already been made. Large numbers of great institutions have successfully undertaken work in that field, says Warren K. Lewis, professor of chemical engineering, Massachusetts Institute of Technology.

*WOMEN AS RESEARCHERS*

On the inside cover of North Dakota Engineer for May, 1945, is a statement over the name of Dean L. C. Harrington, College of Engineering, which says among other things:

"Young women should consider the opportunities that an engineering education offers them. Not only are many technical posts open in the women's branches of the service, but industry is turning to trained women more than ever before."

When I read the report of Mellon Institute for Industrial Research, University of Pittsburgh, for the fiscal year March 1, 1944, to March 1, 1945, I noticed there had been engaged 474 senior and junior scientists and engineers and that "134 women chemists and biologists have participated invaluably in research of the organization".

I was interested in noting that in the department of Tar Synthetics there were engaged during the period mentioned 25 men and 25 women—and that in the Shaving Research division there were twice as many women as men —yes—two women and one man, proving probably that women prefer men with smooth faces.

In most of the divisions at Mellon are a fair proportion of women. And we find this to be true in many of the country's great industries. So I wrote my friend, Dr. W. A. Hamor, Assistant Director of Mellon Institute, for a statement I might use here today regarding the importance of women in research. He replied on July 16, 1945, that I had asked a question that is very difficult to answer in a compact way, but after citing a number of articles telling of the importance of women in various lines of research the doctor said regarding Mellon's experience:

"In general we have a high opinion of the young women chemists who are serving as aids in our wartime research programs. For the most part these girls have come to us fresh from college and have had to undergo laboratory indoctrination. In addition, we have on our investigatory staff a number of women who have earned the right to professional classification and some of them have their doctorates. These latter chemists are real scientists, capable of independent research."

Dr. Hamor continued: "As to the future, we can predict that the management will continue to employ well qualified women if there is a busy postwar nation. The chemical world, after the readvent of peace will have opportunities for women chemists, but they must realize that in competing with men they must have comparable training and skill. Moreover, they must be plainly imbued with the ambition to progress professionally, in stature as well as status."

Recently I visited a number of laboratories including American Cyanamid, Dow Chemical, Du Pont, Monsanto, General Electric, Durez Plastics and Chemicals, Minnesota Mining and Manufacturing and many others. One of these was Alexander Smith & Sons Carpet Company at Yonkers, New York. Here I noticed there were more women than men in the research department, and while many were aids and assistants, the laboratory chief was high in his praise of the work of these women researchers. With their fingers they were more apt than men in many researches. Generally, I am told that in industry, in all departments, women have a better aptitude and attitude than men. They join a union because they have to and then forget about it as well as they are able.

We have been spending about two billion dollars a week to win the war. To date the cost of our part in World War II besides the loss of hundreds of thousands of men and a total of about one million one hundred thousand casualties, has been some 300 billion dollars.

Would two billion dollars a year be too much for the United States Government to spend for research when the

war ends—or as soon as is practical thereafter? With such an expendiutre for research we may prevent a future war.

Under the Agricultural Adjustment Act the United States Government built four so-called regional research laboratories to study the problem of the farmer. These laboratories have been engaged largely in war research. Each cost one million dollars to build and one million a year to operate. Why not build and operate one such laboratory in connection with each state university, one in Hawaii and one in Alaska—the total cost, 50 million dollars and fifty million dollars a year to operate. This is but a drop in the bucket compared with what we have spent for relief and is equal to the cost of only a few battleships. But we must have the battleships too.

*IN TIME FOR PEACE PREPARE FOR WAR*

As a victorious nation we must not again think there is no danger of another war as we did after 1918. But we *must* through research be so far ahead of those nations who are war-like—ahead in industry—ahead in instruments of war—that they will not dare attack us. This will be the price of peace and it will be a low price.

What we teach in our schools, universities and research laboratories in the next 10 years may be more important to the future peace of the world than any agreement, treaty, charter or pact that may have been or may be entered into as a result of World War II.

When nations signatory to a peace treaty no longer wish to be bound by its covenants, that treaty or agreement becomes merely a scrap of paper.

Likewise nations parties to leagues or allied groups abandon the same when it seems desirable.

If you doubt this, look at history: There have been signed 8,000 treaties in the 3,521 years of recorded history, all of which were broken. Only 8 per cent of all that time has the world spent entirely at peace—286 warless years out of 3,521. Why then do we think that the present agreement or pact of the United Nations or any treaty signed at the end of this war will not be broken? I realize we have had many prominent men from all over the world preparing the San Francisco Charter and placing around it every

safeguard the dictionary provides. But mere words, high ideals and good wishes will not make treaty number 8,000 any better than its 8,000 predecessors were.

What is the answer then? Research of course and the products of science.

For what do nations go to war?

Generally for more territory or for raw material, which amounts to the same.

Through education, especially research, we can largely create materials. Paradoxically, Germany which has gone to war twice in a quarter of a century, fought for territory —for raw material—yet Germany before World War I was in many respects the world's greatest industrial nation. If Germany had spent, since 1914, one half as much for research and building up its industry as it spent for war, it would today be far ahead of the rest of the world in research and, consequently, in those lines of industry in which it sought to excel. If we could educate the world to show that research and not wars pays dividends, then we may prevent wars. It is worth trying. In fact, the United States might encourage other nations to carry on research and help them in research where it may be advisable.

What we need in the world today is more molecular manipulation and less political manipulation. That is more chemistry and less power politics.

Moleculars and atoms offer the opportunity for great expenditure of energy and money in research. In a drop of water it is said there are so many atoms that all of the people in the world counting continuously every hour of the day could not count them all in ten thousand years.

In a spoonful of water are 500 sextrillion molecules and in a glassful of water some 25 nonillion molecules, enough to move a train from Grand Forks to the Twin Cities if the atoms or molecules could be converted into all the power conceivable.

And perhaps we need more international research and fewer international cartels.

*THE FUTURE OF RESEARCH*

The war has brought to light the close relationship that should exist between the workers in fundamental

science and the technologists who direct industries and protect our armed forces. Since the war started nearly all research has been of an applied nature. We have been drawing upon the stored information accumulated through the years in the fields of pure science. Had we not possessed this scientific information and trained personnel at the outbreak of war, our plight would have been hopeless, states George A. Sloan, Industrial Executive of New York City.

Mr. Sloan is also authority for the statement that restoring this reservoir of research upon which we have so freely drawn and the level of which has been steadily dropping will be more difficult because of the acute shortage of personnel particularly as the result of the loss of college trained scientists (who have been inducted into the army, and many of whom are doing work entirely foreign to science.)

"Industry must do everything it can when the war ends to stimulate fundamental research. Industries will be coming to the universities to solve specific problems, and government, it is becoming increasingly obvious will finance applied research on a scale never before known in this country. Government and industry will make a mistake if they divert too much of our scientific personnel and facilities toward this kind of research at the expense of creative investigation. For the same reason industry will injure itself if it takes away from the universities too many leaders in fundamental research. In the scramble for men after the war the universities cannot compete with industry in the salaries paid to research people. They are at a distinct disadvantage in any such competitive bidding. Industry should encourage good minds to stay in education if it expects to receive a steady flow of adequately trained men and new ideas from research laboratories. Our universities, on the other hand, must show increasing consideration of the capacity of individual faculty members and provide the facilities and recognition which will hold outstanding men" said Mr. Sloan.

*WE NEED RESEARCHERS*

The United States before the present war undoubtedly was the world's greatest research nation. We hope we are still. But we cannot for long remain so unless we use our efforts to train chemists and engineers and other scientists to carry on our research.

The American Chemical Society warns that the refusal of Selective Service to defer advanced scientific students already has cost the United States "one generation of future scientists, and may cost another".

Meanwhile, foreign student enrollment in American colleges has doubled over 1920-40 averages; and applications pending would make over 400 per cent increase in foreign students, many maintained and sustained by United States scholarship funds.

American manufacturers of scientific apparatus and technical equipment are deluged with lend-lease orders "which any ten-year old child would recognize are to be employed post-war for equipping plants and laboratories". Conclusion of American Chemical Society: "WITH RECKLESS ABANDON, OUR GOVERNMENT IS SELLING AMERICA SHORT TECHNOLOGICALLY".

A Purdue University survey of "a very small percentage" of American industries revealed an urgent need for 5,806 engineers. This would indicate that the total need by American industry of fully trained engineers is certainly many time 5,806. This is particularly serious since the output of civilian engineers from all engineering colleges of the United States during the present war will be less than 2,000 made up largely of the physically incapacitated.

This survey showed the long-range need for researchers after the war ends to be 3,996 or 36 engineers for each company of the 111 industries surveyed. These totals do not include present needs nor do they become affected by the return of veterans, since the companies took this into consideration when reporting.

The survey states: "The ending of the war will find this nation with many of its natural resources greatly depleted and facing from other lands the keenest competition ever conceived. To keep full employment in industry in the

years of reconstruction, adequate engineering and scientific staffs must be made available to develop new materials and better articles of commerce, and to manufacture them in large quantities at low cost to meet world competition.

It is said that Russia deferred at least 50,000 young engineers and chemists and researchers for its industries and war research; that Britain and even France deferred thousands for the same purpose and likewise Germany according to the best available information.

The Massachusetts Institute of Technology reports that in 1939 it had a total of 2,883 students both graduate and undergraduate studying scientific subjects and a total of 217 foreign students and those figures were about the same for 1940, 1941, and 1942, but in 1945 its total United States students is 871 or about 30% of 1939, while foreign students were 302 or 140% of 1939, and there are applications on hand for the admission of 667 foreign students.

Is it any wonder therefore that American business men fear a United States facing the keenest world competition in its history with a great shortage of technologists, for as they very well realize "PRODUCTION IS AFTER ALL, MERELY OUTWARD EXPRESSION OF SCIENCE AND TECHNOLOGY".

We along with our allies defeated Germany because we were able to make as good or better weapons and munitions than the Nazis, but particularly because our technology enabled us to produce them in larger quantities.

The American Chemical Society further warns us that it is evident that unless an aroused public demands an immediate investigation and congressional action such as is necessary to remedy the unfortunate situation in which we find ourselves, the United States is headed for a second —and third-rate role in the postwar period. God help us if we become engaged in a third World War in the next 25 years. Because of this growing lack of scientists and researchers, we have probably lost the next war already. That is all the more reason why we must obtain Congressional action now. By replacing, restoring and introducing 70,000 technologists, engineers, and scientists, including a suit-

able number of students into our industries, laboratories, and universities, we may yet avoid a catastrophe, BUT CONGRESS MUST ACT NOW!

The late Thomas Midgley, Jr., President and Chairman of the Board of American Chemical Society says: "Accelerating expansion of potential fundamental knowledge constitutes an ever-growing stockpile of raw material ready for fabrication by industrial research. And Mr. Midgley should know. He is responsible for perfecting high test or anti-knock gasoline. He performed 15,000 experimentations before his formula proved successful. Along with associates he sailed on the ship Ethyl along the coast of North Carolina near Kure Beach at Wilmington and there discovered that the ocean contained billions of bromine which was necessary to use in producing his anti-knock gasoline. In this latter work he was associated with scientists from Dow Chemical Company who take bromine and magnesium from the ocean with motors made by Electric Machinery Company of Minneapolis.

And Under Secretary of War Robert P. Patterson, who has done a praiseworthy job during this war, states: "There is no four-lane highway to scientific achievement; a bulldozer is needed every inch of the way."

What can we do to provide additional chemists, chemical engineers and scientists? Well, if a bill is introduced in Congress to carry out Dr. Bush's plan, which I outlined, we should support that bill; otherwise, we should back the McDonough Bill, which would get back into industry and our universities 70,000 students and researchers. You can create public opinion to aid in the passage of this needed legislation, and public opinion as voiced by the people and disseminated by the press is the supreme court of the world and generally writes the last decision.

We have great natural resources still left in this country, though we have dissipated much of them in this war; we have the greatest industrial resources in the world, and far above and transcending these we have the greatest supply of human resources. We need strong men to finish with the task of winning the present war, and then through research to provide jobs for everyone and to prevent further wars.

May I quote Edgar Guest's "A Prayer"?

God grant to us the strength of men,
The patience to be brave,
The wisdom to be silent when
The days with doubt are grave.
When troubles come as come they must
Throughout the trying hours
Let us continue still to trust
That triumph shall be ours.

---

We have foresworn our days of ease
To battle for the right,
To venture over troubled seas
Oppressions wrongs to fight,
And we have pledged ourselves to grief,
To bitter hurt and pain,
Then let us cling to this belief
We suffer not in vain,

---

God grant to us the strength of men
God help us to be true,
Until that glorious morning when
The world shall shine anew,
We shall be tested, sore and tried,
And flayed by many fears,
Yet let us in this trust abide,
That right shall rule the years.

I thank you.