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PEACETIME VALUES FROM A WAR TECHNOLOGY[1]

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Introduction

In a world at war one gets the impression that all forces are solely for destruction. When war ends, the new technology will more quickly, efficiently and effectively convert the war effort to the pursuits of peace with an amazing speed. With the tremendous increase in research and development, the commercialization of processes has occurred which would have taken years under normal conditions to reach fruition. Out of the welter of the war effort, values will flow that will increase man's effective span of life with greater satisfaction for living.

Science has already prolonged and saved man's life through germ-killing chemicals, new anesthetics and synthetic vitamins. Through scientific and technical research our food supply has increased in quantity and quality. Synthetic textiles have provided us with more beautiful, durable and sanitary clothing. Plastics will revolutionize the building arts, for the trend is to supplant many house-building and house-furnishing materials with plastics as soon as they can be released for civilian use. Plastics together with new and more efficient fuels will also play a dominant part in our transportation systems.

Let us look at the transportation situation first. The petroleum industry will play a controlling part in this. Airplanes hurtling through the air at over five hundred miles an hour carrying a thousand or more passengers will make all parts of the world less than twenty-four

[1] Presented at the Wartime Marketing Conference, American Management Association, Drake Hotel, Chicago, January 14, 1943.

hours away from Chicago. Luxurious as the *Normandie* and *Queen Mary* were for ocean travel, airships yet to come will operate with a smoothness and comfort unknown to-day. Low cost air travel and jitney planes should be within the pocketbook of every American. The competitive impact of the new airplane industry on all other forms of transportation may be quite serious.

Increase in air travel will be made possible primarily by the capacity of the oil industry, increased by wartime demands to produce 100 and higher octane gasoline, and by the amazing developments in airplane design, material and construction that have been forced by the hard hand of war necessity.

The same technique and the same processes that produce 100-octane gasoline in almost unlimited quantities for airplane use will also mean greatly improved fuel for automobiles; in fact, at least 50 per cent. more miles per gallon. We may hazard a guess that the automobiles to come after the war will give new pleasure to driving because of their improved design, speed, safety and beauty.

In the short span of twenty-five years, man has entirely revolutionized transportation through the design and construction of the automobile and airplane and petroleum products. By careful study and experimentation, it is certain we can produce from petroleum better rubber than was ever obtained from trees or plants, and tires which will give 100,000 miles or more of trouble-free service are a reasonable expectation of the future.

For years we have been led to believe that world leadership in research and development rested squarely on Germany and that the United States was laggard. Even now statements are made from time to time to the effect that we are still behind Germany in research, development and commercialization. This is not so to-day with the facts. There was an element of truth in such a statement during World War I when the United States was short of many necessary materials due to its reliance on Germany for pharmaceuticals, dyes, fine chemicals, potash, lenses, chemical glassware, instruments, etc. We are now completely independent of any country for these and other materials.

Prior to the previous war it was thought that if one wanted to study chemistry, physics, mathematics or medicine, one had to go to Germany, but that day is also gone forever. In less than twenty-five years the United States has reached world leadership in research and has awakened to a miracle of scientific and technological development under our system of free enterprise.

Private initiative is responsible for America's world leadership in science and industry. The tremendous effort that is being put forth in the United States, the effort that will win the war, is the work of private initiative.

The impact of researches, carried on by private corporations and speeded up enormously by the war, will bring vast changes in our peacetime economy. Their research departments were the organizations upon which many companies relied to bring them out of the depression. Their results are the backbone of the country's mobilization for total war.

Obviously, in the time allotted this evening one can but show a few highlights in the accomplishments of research.

The fact that many of nature's products have been unsatisfactory has stimulated man's inventive faculty fortified by the vision prevailing in our industries. The tremendous cooperation of industry in the United States is responsible for the spending of millions of dollars to develop a basic idea for the welfare of mankind. No industry stands alone in achievement, as they are all interrelated through research.

The destructive nations' efforts to rule the world must be wiped out as surely as we must defeat the insect and bacterial hordes that prey upon us.

HEALTH ENGINEERING

Man's struggle to survive is ever present. He has either vanquished or domesticated large animal life. Our present battle is to overcome the ravages of rats, insect life and bacteria; it would seem that the smaller the scale of life the more difficult is the problem of its extermination or control. Even the very nature of some of the smallest forms has presented man with some of his greatest difficulties of discovery and eradication by chemical or physical means. Great strides in this direction have been made, but the ultimate solution is still far off. Increased tempo in research and experimentation along many fronts will ultimately present the remedy, but with the vastly improved tools man is constantly providing for himself, the end is certain to be on the favorable side for mankind.

From the necessities that war has forced upon man have grown the scientific principles of health engineering so vitally necessary to man's well-being as a fighting force. Accurate knowledge of vast areas hitherto seldom visited by dwellers in temperate regions have been the motive force behind a medical exploration of tropical territories that may well be carried over in the future development of our own hemisphere.

When it became necessary to provide troops with anaphylactic measures against tropical and sub-tropical diseases, it was the problem of the medical force to provide accurate knowledge of the type of health dangers encountered and to provide prevention and cure of malaria, cholera, typhus, hookworm, bubonic plague, sleeping sickness, dysentery and typhoid. Mosquitoes, rats, leeches, fleas, flukes, bats and a host of other disease-bearing or spreading agents had to be studied and their control and extermination planned. Drugs of all types had to be ready for disease combat and the checking of infection.

In the Far Eastern and African campaigns insects and infections have beset our armies. Our men went down with malaria and other diseases. Among these are dengue fever, dysentery, tropical ulcers and sores, as well as the bites of malarial mosquitoes and tropical spiders, some as large as crabs. There is a drainage of the soldier's vigor in this pestilential atmosphere wherein he fights, eats and sleeps but a few hundred miles from the Equator. As one eyewitness expressed it about the Buna campaign:

> . . . that every ounce seems to grow to 10 pounds when carried through a jungle through knee-deep mud. That means giving soldiers jungle equipment, including the lightest kinds of carbines, tropical uniforms, waterproof shoes, more efficient and lighter packs, as well as smaller mosquito nets.

What has research done to modify this type of torture and death to which our fighting forces are subjected? The methods of attack are chemical, physical, medical and engineering.

An indispensable tool in the study of man's health for many years has been the microscope, discovered over three hundred years ago. Slow improvements had been made in this instrument until a few years ago when a revolutionary principle was discovered through the use of the electron. This made possible a magnification of over 200,000 times compared to the 3,000 from the best previous microscope.

Anti-insect sprays, delousing, swamp drainage, felling of certain trees, sanitation, oil and chemical dust spreading and other methods are used to keep our troops in fighting condition and will have great value industrially and agriculturally during peace.

A number of synthetic chemicals, such as the sulfa drugs, synthetic quinine and synthetic vitamins are finding amazing uses on the fighting fronts. Where the World War I record was four deaths out of five due to germ infection of abdominal wounds, the present record is one out of five. Quoting Howard Blakeslee:[2]

> On the 2,000-mile front, in all the war, only 1.5 per cent. of the Russian wounded have died. That is slightly higher than the remarkable recovery rate at Pearl Harbor, 96 out of each 100. The report says the Russian recovery rate is 98.5 per cent. of all wounded. The Russian rate is one-half of 1 per cent. worse than the Guadalcanal miracle of 1 per cent. of wounded dying. . . .
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> The Russians claim some new medical advances of their own. When plasma is made in America, the red blood cells are thrown away. The Russians report that they have made a process to use these cells to manufacture blood. Nerve sections taken from the dead have been successfully grafted into the wounded. The peritonea of animals, the inner linings of visceral cavities, have been used as living bandages for gaping wounds. It is claimed that cure is facilitated and that the scars are not so heavy. . . .
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> A compound that is not a vitamin, yet has the blood-clotting effects of Vitamin K, is in use. The Russians say they have found a method to obtain thrombin in thousands of quarts volume. Thrombin is a natural clotting substance in blood.

[2] *New York Times*, January 10, 1943.

The latest sulfa drugs which are working wonders against infection and disease are sulfathiazole, sulfapyridine, sulfaguanidine and succinyl sulfathiazole which have been synthesized for specific diseases. Each soldier's kit contains first aid doses of sulfanilamide for the purpose of checking infection at the time a wound is received.

Pentothal, which is injected intravenously, is one of the very best of the newer anesthetics, having no explosive hazards such as ether and the hydrocarbon gases. In addition, the equipment necessary for its administration is simple. A shot in the arm is all it takes to put one asleep.

Bacteria, soil molds and molds found in the intestines of animals or insects create chemicals that are highly useful in destroying infection. Penicillin, a new drug produced in soil mold, is about 100 times as effective as sulfanilamide for combating infection and far less toxic. Gramacidin from soil bacteria has been found to be a powerful germicide for both pneumococci and streptococci, two extremely dangerous germs to man.

One can not pass public health without mention of the vitamins. Many diseases of baffling nature have been due to dietary deficiencies and upon treatment with the proper vitamins have been cured. New methods of production, mainly chemical synthesis, have made vitamins available. Vitamin C (ascorbic acid) and Vitamin B_1 (thiamin chloride) are probably the most outstanding examples. In 1933 the cost of Vitamin C was $213. per ounce; in June, 1942, the price had been reduced to $1.65 per ounce. Vitamin B_1 was sold for $8,000 per ounce in 1935 and is now marketed at $15.00 per ounce. Because of the huge reductions in price, these vitamins as well as several others can be added to fortify various foods, giving them protective factors for health never before included in their manufacture.

FOOD

Food plays the dominating role in all nations. Rationing has hit all of us, hence our keener interest in this subject. Research has made available foods relatively new to our civilization, not alone from the standpoint of new varieties but chemicals used for treatment increasing their quality, size and vitamin content.

Petroleum plays a role in the newer methods of increasing food supply. When oil is cracked to produce motor fuel, olefinic gases are by-products. These gases, such as ethylene, propylene and butylenes, hasten fruit ripening and growth. Ethylene was first used for the purpose of ripening oranges rapidly, by putting a tent over each tree or storing the unripe fruit in a room and adding small percentages of ethylene. By using this method of ripening, the fruit could be shipped without loss due to rotting. The growth of potatoes has been stimulated by ethylene and propylene. It has been reported that the speed of growth of potatoes has been increased 100 per cent. when the seedlings have been treated with ethylene. The growth time to maturity was shortened, while at the same time the potatoes were more numerous and larger and contained higher percentages of Vitamin C.

The Russians have studied the use of butylene gas, showing that it has a stimulating effect on the speed of growth of trees, such as the apple, apricot, pear, cherry, plum, peach and walnut, bringing them to fruition far faster than without its use. Where the growth season is too short to allow the full maturing of trees due to the inclement weather in parts of Russia, so that flower formation and fruit setting are delayed, butylene has been used to hasten the growth period. The method of treating a tree is to enclose it in a tent for two weeks before the normal or desired leafing, *i.e.,* start of the growth cycle. Butylene is passed into the tent in concentrations of one part in a hundred thousand parts of air at temperatures between 69 and 100° F. for a period of one to two hours. Small heaters are probably used to raise and maintain the temperature of the air around the tree so as to obtain maximum effects of the growth-inducing hydrocarbon, butylene.

Acetylene, so important in the production of synthetic rubber, plastics and other materials, is being used in Australia to increase the growth of pineapple plants. Calcium carbide, derived from coal and limestone, is placed in the heart of the plant, and rain or dew reacts with it to produce acetylene in sufficient quantities to increase the growth of the pineapples.

In California, fruit orchards are fertilized by ammonia added to the irrigation water, which has markedly improved productivity. It may be of interest to point out that this ammonia is produced from the nitrogen in the air and the hydrogen from cracking of petroleum.

The autumn crocus contains a yellow powder called colchicine, which is extracted from the plant. This powder when applied to seeds, leaves or buds of a plant increases growth of fruits and vegetables to double their normal size. Colchicine also gives rise to new varieties of fruits and vegetables never known before. The colchicine acts at a very critical point in the germination of the seeds. When cell division is ready to take place, the cell does not divide, which is usual in nature, and the specie-bearing chromosomes remain in the seed in double the number, giving rise to new species of fruits and vegetables.

Shipping of food supplies to the United States fighting men abroad is in a critical situation because of lack of transportation. To overcome this obstacle a number of processes have been developed to dehydrate foods in order to cut down their bulk and weight.

"Quick freezing" of fruits, vegetables and meat has added materially to food supply, particularly in decentralized communities, and also conserves steel and tin in the form of cans. This development has great economic value for peace and war.

The impact of these researches on the food economy of the world will develop enormously in that one may work out new hormones and chemical stimulators which will give rise to new plant life.

Developments already achieved present an almost incredible picture of our food supplies of the future. Obviously these developments will make it possible to raise more food of higher nutritive quality on less acreage, with far less labor compared to present methods.

Textiles and Clothing

For years the silkworm was the sole producer of the raw material used in weaving fine silk fabrics symbolic of richness and luxury. Marco Polo in the fourteenth century introduced these fabrics into Europe. The products from the silkworm held leadership for centuries as a symbol of wealth. The silkworm's job is well-nigh finished, although silk will probably find a number of special uses. The research chemists have developed synthetic silks far superior to the best that the silkworm can do. Rayon is one of the earliest of the silk substitutes and was produced primarily from wood and cotton linters.

The most striking development in the textile and plastics industries in the past few years is the commercial production of Nylon. One of the main uses of Nylon was for hosiery that has at least ten times the wear quality of the best silk from the worm. Nylon is now used largely in parachutes and for ammunition bags, in which it replaces natural silk.

Structural Materials

After World War I a great impetus was given to the building arts. Structural steels, alloys, aluminum, concrete, synthetic stones, plywoods, insulators, plastics and a host of other materials were generally made available. A new era in design, building, housing and transportation will be the aftermath of the present war with the many new materials now produced which will be diverted from the war to peace. A tremendous business potential is ahead of all of us, which will strain us to the limit to fulfill the demands of building, furnishings, automobiles, trains, etc.

GLASS

For thousands of years almost no progress was made in the glass industries of the world. The only researches of moment were through the addition of minerals to give beautiful colors to the windows of the world's cathedrals. Researches in the glass industry of the United States since World War I have made amazing strides in the materials that can be produced from sand. In World War I this country was cut off from the chemical glassware and lenses of Germany, which held leadership at that time. We are now entirely independent of any foreign country, for we have developed new products from sand that are leaving their impact upon other industries in a competitive way that will be intensified in the peace period to come. Mass production of hard glass for laboratory use has found its way into everyday life in its use for baking and other heat-resisting utensils. In addition to this development, the present war is bringing out the utility of glass in jobs which were previously taken care of by steel, silk and cork. Glass fiber boards for heat insulation in fighting planes have saved five and one-half million pounds of aluminum and other scarce lightweight metals which can be used in building 250 Flying Fortresses. For electrical insulation, glass filaments are spun which make a flameproof wire coating for use in heavy bombers. Glass foam has found use in displacing cork in life preservers and life boats. Unlike air-filled rubber floats, a puncture is not vitally destructive, since, when a bullet passes through, only the cells in the immediate vicinity are destroyed. One of the outstanding uses of spun glass in the present war is as a replacement for silk and gut in surgical sutures. Spun glass is also widely used as a fireproof textile. Some of the newer optical glasses use no sand at all, but depend upon the rare earth elements such as tantalum, tungsten and lanthanum. The glass made from these materials is highly satisfactory for use in aerial photography lenses, since it gives more sharply defined images at higher altitudes than ever before possible.

PLASTICS

The plastics industry was founded years ago by Hyatt, an American. He was the first to work with cellulose nitrates and camphor as a plastic mass in an effort to find a substitute for the ivory in billiard balls. In general, however, the founding of the modern plastics industry occurred in 1907 when Dr. Leo H. Baekeland produced in his laboratory in Yonkers, N. Y., the first phenol-formaldehyde products, commercially known as Bakelite. This American research was the stimulating force that has brought the plastics industry to the important position it now holds in our war effort. World leadership in the plastics field is without question in the United States. One can be clothed from head to toe by plastics that are now available. One may live in a plastic house and be transported in vehicles largely made of these materials. There is no end to the variety of plastics that are potentially available and in the making.

These remarkable plastics have at least 100,000 uses. Perhaps one of the most important at the moment is for the production of hoods for pilots and gun turrets on airplanes, where prolonged high visibility is so essential. One of the most important plastics is Plexiglass, made of methylmethacrylate. The flexibility of this material lends itself to forming any shape desired by molding. In addition to clarity of vision, which these plastic windows give for a long time, they are practically shatter-proof.

It is to be expected that in the automobile to come plastics will play a great part in its structure. One may expect practically 100 per cent. visibility in the new type car based on plastics. For these uses it will be highly competitive with other types of structural materials.

Much has been accomplished in the United States in brightening life, housing and transportation by the use of plastics of every color. One may say that the period in which we are living is the renaissance of color. This reawakening to color values was apparent before the global blackout. Many plastic products form excellent media in which the commercial artists and designers have expressed their art in home and business interiors. Current United States magazines are full of beautiful illustrations of radios, electric irons, telephones, airplanes, milady's boudoir, many of which are made of plastics.

The color effect of these plastics plays a definite role in the well-being of humanity and in our capacity for work. This industry of color effect from glasses and plastics has not been fully exploited. However, a number of manufacturing plants have worked out color schemes that raise the tempo of production and ease fatigue at the same time. Eyestrain particularly is in general an overlooked factor in well-being and productivity. Walls of dull gray, brilliant white and black machines in many cases contribute to accidents. The fatigue factor also holds for office work and study should be given to the relation of color to accuracy and output of those engaged primarily in mental activity.

In general, the architect in planning buildings has limited himself as regards color to a comparatively narrow range, gray portland cement, red sandstone and gray, red, and yellow bricks, etc. Newer building plastics are available in colors as beautiful and far more practical than precious stones whose colors they imitate. The architect could well use plastics in slabs that would give us colorful buildings at low cost.

One may expect that the new plastics will play a competitive role with building and window glasses. Both the plastic and glass industries will also be highly competitive with the paint and varnish industries.

SYNTHETIC RUBBER

We were caught with our natural rubber supplies shut off by the devastating attacks of the Japanese, who now control over 95 per cent. of the world's rubber supplies. In normal times the United States requires about 600,000 tons for its peacetime pursuits. Fortunately science and research in the United States were not caught napping in the knowledge and technique for the production of synthetic rubber. For a matter of twenty years or so, long before the fall of the Far East, processes were available to produce synthetic rubber. The production schedule is for 1,100,000 tons of synthetic rubber for the war effort. The synthetic rubbers, Neoprene, Thiokol and Ameripol, were in commercial production prior to the fall of the East Indies. The "know how" of producing other rubbers, such as Buna-S and the butyl type rubbers, was also available. The United States has all the raw material necessary to produce any quantity. It is now a question of materials and their fabrication to equipment in order to construct the plants already O.K.'d by the government.

Neoprene rubber is based upon acetylene—the same acetylene that induces plant growth and is the basis of a whole host of other products.

Acetylene is one of the most important of all the hydrocarbons, and has been produced through the years almost entirely from coal and limestone in electrical furnaces. One of its primary uses for years has been in acetylene welding and now in synthetic rubber. Researches have been going on for years in an endeavor to use our vast natural gas and petroleum resources for the production of acetylene. There are a number of commercial units now under construction, one of which will produce at the rate of 75 tons a day of acetylene, or 27,000 tons a year. It is believed that acetylene will be produced at a lower cost from processing our natural hydrocarbons than by the high temperature electric furnace method. The natural gas industry of the United States produced in 1942 about 3,000,000,000,000 cubic feet of gaseous hydrocarbons, part of which could supply the whole world with acetylene and its derivatives.

Thiokol is manufactured from ethylene derived from the cracking of oil, chlorine and sulfur, whereas the Buna-S rubber is produced from styrene from coal and petroleum, and butadiene derived from grain alcohol and petroleum.

Butyl rubber is based upon the chemical reaction of isobutylene, butadiene or isoprene.

We are being geared to produce synthetic rubbers in the following tonnages:

	Tons per year
Buna-S	845,000
Butyl	132,000
Neoprene	69,000
Thiokol	60,000

The world's natural rubber production for 1941 was 1,675,000 long tons, of which the United States imported 820,000 tons. With the tremendous number of airplanes, tanks, motor trucks, ships, trains, gun mountings, etc., the rubber demands are ever increasing, not alone for the fighting forces on the far-flung fronts, but for the necessary war work behind the lines. A statement appeared a few days ago that ground tanks were passé due to the fact that the heavy guns of the United States were able to smash them. If this be so, then airplane tanks heavily armored for low altitude flying should be the answer, and this will call for increased quantities of rubber. Medium size tanks require 500 pounds of rubber and pontoon bridges over 1,000 pounds. The gasoline tank alone of a Flying Fortress uses 500 pounds of bullet-sealing rubber, while large bombers require over 1,200 pounds. Gas masks use three fourths of a pound, while battleships use between 75,000 and 150,000 pounds. Excavation trucks used by the Army with tire diameters of nine and one half feet require about 3,500 pounds. There are many hundred more products requiring rubber that are vital in the war effort, such as blimps and barrage balloons. The latter have not been used in the United States to any extent. However, if the war reaches our shores tremendous quantities of rubber will be needed for this purpose. Rubber boats, rafts, safety vests and suits for flyers, hospital rubber requirements, etc., are also some of the products demanded from the rubber industry.

Ironically, press dispatches from the Far East indicate that the Japanese are cracking rubber to produce gasoline and other oils, which is an indication that they have a shortage of oil despite the fact that they have taken over the Far Eastern oil fields of the Netherlands and the British. As a contrast, in the United States we crack petroleum to produce synthetic rubber and gasoline.

You may well ask the question: Is synthetic rubber equal to the natural? One may say, the synthetic product is at least equivalent to the natural, but as of to-day it does not duplicate it, nor is it essential to duplicate nature's product, for the chemist's goal is to produce rubber with far superior properties to the natural. It has already shown far superior properties from the standpoint of gasoline, oil and chemical resistance. The synthetic product has greater wearing properties, and does not deteriorate readily in sunlight and air.

A number of trucks and motor cars using synthetic rubber have gone over 35,000 miles, and one may reasonably expect at least 100,000 miles with the amount of research going on in the laboratories of the United States. The greater general strength of a synthetic tire means less driving hazards and far better road gripping. The latter property has been thoroughly tested on wet and muddy roads. Hill tests made with a number of trucks on a muddy road showed that the synthetic-tired vehicle had very little side-slipping, while the natural-tired vehicle slipped all over the road. Taxicab drivers advise that they all feel far safer in driving in mud or on wet city streets when their cabs are tired with synthetic rubber.

The research laboratories of the United States have discovered at least three thousand synthetic rubbers of varying properties. Some of them are exceedingly expensive to produce and others relatively low priced. One may state that synthetic rubber for tires will be highly competitive with the natural rubber, and in mass production synthetic should be less than 15 cents a pound. Natural rubber has sold through the years at prices varying from 3 cents to $3.00 per pound.

We are in a rubber crisis which may mean that all motor vehicles not used in the war effort will cease operating in order to be sure that all our fighting fronts will have sufficient rubber for ultimate victory.

Synthetic rubber must be provided at the rate of at least 1,100,000 tons a year called for by the Baruch Committee. Never again should the United States be caught short of rubber, whether in war or peacetime.

Aviation Developments

Scientific, technical and industrial miracles are taking place throughout the United States, not the least of which is in the airplane industry. In a few years production of airplanes has stepped up from less than 1,000 per year to over 48,000 in 1942, with 100,000 projected for 1943. It is not solely a question of the number of planes but their design, quality and size based on incorporating the knowledge gained on the fighting and research fronts.

Extraordinary strides have been made in the fabrication of airplane engines, propellers and bodies. The materials of construction are now of aluminum, magnesium and their alloys, stainless steel, plywood and plastics. These will be highly competitive after the war. Aluminum alloy forgings for cylinder heads stepped up the horsepower of the engines 15 per cent. as well as decreasing its weight. Seversky reported that a 32,000 horsepowered airplane was in the making, using four 8,000 horsepower engines. A Flying Fortress, the U. S. Army B–19, is an 8,800 horsepower airplane, with a 36,000 pound high explosive carrying capacity. In contrast, "Air Jeeps" of 65 to 100 horsepower are in our fighting forces on the Pacific and African fronts. They are used for fighting since they carry Stokes mortars and heavy machine guns, as well as 100-pound bombs, and have a range up to 500 miles with an altitude averaging about 1,000 feet. They are also used for observation in place of the old-type balloons, for courier duty, auxiliary scouts and as advanced guards by the striking forces. In peacetime these planes were the well-known Piper Cubs, Aeroncas, Taylor Crafts, Fairchilds and Stinsons.

The giant strides made by the airplane industry are at least matched by the oil industry in producing the 100 and higher octane gasoline and the necessary lubricants to operate the hundreds of thousands of aviation engines.

There are many chemical processes involved in the production of our aviation gasoline. The 100-octane gasoline is a 100 per cent. development of the oil industry of the United States. We have far superior aviation gasoline and lubricating oils than the Axis powers have available. The octane ratings of aviation gasoline which were collected from shot-down German planes averaged about 87. It has been reported that the German invasion of England in September, 1940, was stopped by the R.A.F. because their fighting planes were powered with 100-octane fuel, while the German planes were fueled with 87-octane.

The importance of high octane ratings in gasoline for airplanes is strikingly shown in the performance of 87-octane compared to 100 in a bombing plane, particularly as to speed, rate and time of climbing to maximum ceilings and maneuverability of the plane. Comparative tests of 87- versus 100-octane in a bombing plane showed that it took nineteen minutes to reach an altitude of 26,000 feet for 87-octane, whereas the 100 required only twelve minutes. The absolute ceiling of the plane in round numbers was 37,000 versus 33,000 feet for the lower octane-fueled plane.

The newest transport plane, called the Constellation, just tested, will carry fifty-two passengers with a speed greater than the Japanese Zeros. The plane can fly at about a seven-mile ceiling far above storm conditions, while ordinary cruising altitudes are about four miles. The Constellation can cross our continent in one eight-hour hop using more than 8,000 horsepower with the remarkably low fuel consumption of one gallon of gasoline per mile.

CONCLUSION

World War II may not be a total loss for humanity. A tempo never before attained in the United States has been reached with a collaboration and exchange of knowledge between heretofore highly competitive groups. New materials now in war production will have great peacetime values. We will also have access to a vast amount of knowledge and experience which has been accumulated as the result of hectic years of war. Man's life will be prolonged, his health, mentality, imagination, and productivity increased, and the pain and irritations of life will be reduced to a minimum.

OBITUARY

OSKAR BOLZA

NEWS has recently reached mathematicians in America through the American Red Cross that Oskar Bolza passed away peacefully in Germany on July 5, 1942, at the age of eighty-five years. He emigrated to this country in 1888, was one of the founders of the Chicago Section of the American Mathematical Society and a member of the National Academy of Sciences, and had great influence on the development of mathematics in America during his residence here from 1888 to 1910.

He was born on May 12, 1857, in Bergzabern in the Palatinate of the Rhine. The fortunes of his family were considerable, due to the exploitation in 1817 of an invention of a rapid printing press by his maternal great-great-grandfather, Friedrich Koenig. So far as is known he was free throughout his life from financial worries. In 1873 his father, who had retired from his position in judicial service, moved his family to Freiburg-im-Breisgau, and from that time this city was Professor Bolza's German home city to which he returned for a part of almost every year.

As a young student Bolza was interested primarily in languages and comparative philology. But in an academy at Neuchatel under a Frenchman named Terrier, and in the Gymnasium at Freiburg under a professor named Koch, he studied what we would call college mathematics. Both of these men were inspiring teachers, and Bolza's experience with them became decisive for his whole life. His enthusiasm for mathematics grew to be a dominant one, while his interest in languages took a secondary position.

At the University of Berlin, which Bolza entered in 1875 at the age of eighteen, it soon became evident that he would be much more interested in a scientific career than in the family printing press factory which had long been managed by two of his uncles. After some hesitation over theoretical physics he decided in 1878 to devote himself to pure mathematics. Due to his own conscientiousness, and probably partly to his financial independence, his university student career was a long one. He studied at the University of Berlin under Kummer, Kronecker and Fuchs, and notably under Weierstrass in the famous course on the calculus of variations which Weierstrass gave in 1879. This course proved to be perhaps the most potent influence in forming Bolza's mathematical interests, though his doctor's dissertation was written in a different field. In other years he studied at Göttingen under Schwarz and Klein, and his dissertation on the reduction of hyperelliptic to elliptic integrals was finally approved by Klein in 1888. His examination for the Ph.D. was successfully passed in the same year when Bolza was twenty-nine years old.

The problem of a profession was a serious one for Bolza. Two of his intimate student friends, the mathematician Heinrich Maschke and the physicist Franz Schulze-Berge, had both reluctantly taken positions as gymnasium instructors. There did not seem to be opportunities in Germany for the three friends as lecturers in a university. Bolza had been rejected for military service because of his rather delicate physique and he dreaded the twenty hours a week of teaching required in a gymnasium. Fortunately at this stage, in 1887, Schulze-Berge came to the United States and promptly secured a position as an assistant in Thomas Edison's experimental laboratory. His enthusiastic recommendations and the persuasiveness of two American professors, M. W. Haskell and F. N. Cole, who were then students in Göttingen, decided Bolza to take a chance in the New World. In April, 1888, he joined his friend Schulze-Berge in New Jersey, and shortly thereafter he was appointed reader in mathematics at the then youthful Johns Hopkins University. A year later he was appointed "associate" at Clark University, which opened its doors for the first time on October 1, 1889.

Clark University had been founded as a graduate school. In a few years it had financial difficulties which led to unhappiness and dissension in the faculty, as a result of which a number of them were quite ready to accept positions at the still newer University of Chicago which opened on October 1, 1892. Bolza was invited to join this group and he persuaded President Harper of the new university and Professor E. H. Moore, the head of the department of mathematics, to appoint both himself and Maschke as associate professors, Maschke having meanwhile also come to the United States. Bolza took up his new duties on January 1, 1893, and after one year was made a