papers by eminent specialists will be presented The titles have been assembled under four headings: I. The Biology of the Gonococcus. II. The Diagnosis of Gonococcal Infection. III. Sulfanilamide and Related Compounds. IV. Therapy and Control. The title of the introductory paper is: "The Problem of Gonococcal Infection," by G. W. Anderson. In the final paper, R. A. Vonderlehr will consider "The Public Health Aspects of Gonococcal Infection."

The Sub-section on Pharmacy. On Tuesday, June 20, the sub-section will present a symposium on vitamins, with special reference to their standardization. In the morning session Aaron Arnold will present a paper on "Vitamin B, Thiamin"; P. H. Phillips, a paper on "Riboflavin"; and C. A. Elvehjem, a paper on "Nicotinic Acid." In the afternoon session W. D. Woolley will read a paper on "Chick Antidermatitis Factor and Vitamin B_6"; A. Black, a paper on "Vitamin A"; and Mrs. F. P. Dann, a paper on Vitamin E.

The Society of American Foresters. The society will hold sessions for the presentation of papers on Monday afternoon, Tuesday morning and afternoon, and Wednesday morning and afternoon. On Thursday the society will take a field trip to Forest Products Laboratory, Madison, and from Friday, June 23, to Sunday, June 25, it will take a field trip to Goodman operations, the Menomonie Indian Reservation and the Nicolet National Forest. An address will be delivered by Robert Goodman.

The program on Monday afternoon, under the chairmanship of C. P. Winslow, consists of an address of welcome by Clarence F. Korstian, president of the society, and four papers by Thomas R. Truax, Mark W. Bray, Arnold O. Benson and Arthur Koehler.

The program on Tuesday morning, under the chairmanship of T. Schantz-Hansen, is on the general topic, "Forest Rehabilitation in the Lake States." Addresses will be delivered by Ray Bassett, H. Basil Wales, Russell N. Cunningham and George Banzhaf. The program on Tuesday afternoon, under the chairmanship of Henry Schmitz, will consist of papers by O. W. Swan, William Heritage, F. H. Eyre and D. M. Matthews. On Tuesday evening the society will hold a banquet, Stanley Wilson, toastmaster.

On Wednesday morning the society will hold a joint symposium with the Ecological Society of America on "Land Use." The four speakers are Aldo Leopold, K. C. McMurry, George S. Wehrwein and Raphael Zon. On Wednesday afternoon the society holds a session, under the chairmanship of W. F. Ramsdell, the speakers on which are Clarence E. Knutson, L. E. Sawyer, J. Alfred Mitchell and P. A. Herbert.

Section on Education (Q). The Section on Education will hold three sessions, Friday morning, June 23, Friday afternoon and Saturday morning, on the general subject, "The Education of the Emotions." At the session on Friday morning, under the chairmanship of A. S. Barr, papers will be presented by Margaret Joseph (Milwaukee), W. Clark Trow (Ann Arbor), H. Meltzer (St. Louis), Robert S. Drews (Detroit), J. L. Kaukonen (Washington) and Benjamin C. Gruenberg (New York City), and Roy C. Bryan (Kalamazoo).

At the Friday afternoon session H. Meltzer will act as chairman and the papers presented will be by O. Irving Jacobson (Alton, Ill.), Kenneth Holland (Washington), Stanford C. Ericksen (University of Arkansas), E. F. Van Buskirk (Stephens College, Columbia, Mo.), Sister Mary Berenice Rice (Catholic University of America, Washington) and Arthur H. Moehlman (Columbus, Ohio).

At the final session on Saturday morning, under the chairmanship of H. H. Remmers, papers will be presented by J. H. Farley (Lawrence College, Appleton, Wis.), E. I. F. Williams (Heidelberg College, Tiffin, Ohio), Leo P. Clements (Creighton University, Omaha, Neb.), Mildred B. Mitchell (Psychopathic Hospital, University of Iowa), F. C. Dana (Iowa State College, Ames, Iowa) and M. Kendig (University of Chicago, Chicago).

SCIENCE VERSUS UNEMPLOYMENT[1]

By Dr. ROBERT I. ALLEN
STETSON UNIVERSITY

SOME months ago, President Roosevelt addressed an open letter to Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and to the heads of other schools of applied science in the United States, the spirit and purpose of which is shown in the following sentences:

Events of recent years have brought into clearer perspective the social responsibility of engineering. In respect of the impact of science and engineering upon human life—social and economic dislocations as well as advance in productive power—the facts are revealed with distressing clearness in public records of unemployment, bankruptcies and relief.

The design and construction of specific civil engineering works or of instruments for production represent only one part of the responsibility of engineering. It must also consider social processes and problems, and modes of more

[1] Address of the president of the Florida Academy of Sciences, Rollins College, November 18, 1938.

perfect adjustment to environment, and must cooperate in designing accommodating mechanisms to absorb the shocks of the impact of science.

This raises the question whether the curricula of engineering schools are so balanced as to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility.

I am calling this matter to the attention of educators of high administrative authority in the hope that it may be thoroughly explored in faculty discussions and in meetings of engineering, educational and other pertinent professional associations.

To this communication President Compton made the following reply:

In response to your challenge to educators. . . . I am sure you will be pleased to know that these are already matters to which progressive educators and engineers have been giving most earnest and constructive attention through their schools and professional organizations. To this end, for example, increasing emphasis is being placed upon fundamentals rather than specialties in undergraduate engineering education, and there has been a notable increase in attention to the study of economics and social science.

I can not but wonder why your exhortation has been directed specifically toward engineers, for surely we would agree that similar breadth of knowledge and training is also urgently desirable among business leaders, economists and politicians—as is also thorough training in fundamentals. For example, there is a tendency in some quarters to make science the major scapegoat of our social ills, from which social planners will rescue us. What are the facts?

Just before the advent of the machine age, social planners were devising resettlement projects and model industrial communities based upon a scheme to employ labor of all children above the age of four years. This was their best solution of the desperate struggle of the masses of the people for the bare necessities of life. Since that time science and engineering have so increased productive power that it has been possible for enlightened public leaders to inaugurate a great program of social security, including child labor laws, universal education, moderate hours of labor, pensions, insurance and unemployment relief on a large scale. These are superimposed on an enormously improved general standard of comfort, health and interest in living. Such achievements of science dwarf into insignificance the "social and economic dislocations" to which you refer, unfortunate as these are and much as these merit the attention which you recommend.

So vital to the interests and welfare of all scientists do I consider the issues raised in these two letters that I am taking advantage of this occasion to pass along for your consideration certain data and conclusions that have come to me during the past several years as a result of a study of the very closely related problem—"The Influence of Science upon Employment."

Time was when there was no such thing as "unemployment." In those pre-scientific days each member of the family shared in the task of defending the home against the ravages of nature, beast and man. Even women and children toiled from dawn to sunset to eke out the bare necessities of existence. Those were also the days when human slavery was prevalent throughout the world; when human suffering was almost universal; when the death rate was frightful and entire families were wiped out by horrible epidemics of disease; when famine and pestilence were considered inevitable; when constant warfare was fierce and cruel in the extreme; when social conditions were at their worst! Go back to 1600 and read Lord Bacon's description of the serious economic and social conflicts of his day; or further back to the days of ancient Egypt and Babylonia and read of the labor unions struggling with hours, wages and "sit-down" strikes, and a social order that reeked with economic and social distress. Such were the conditions of mankind in those "good old days" of employment before modern science stepped in to commence its role of "creating unemployment."

To-day, certain enthusiastic and presumably sincere well-wishers of society are proclaiming that modern science has gone too far in its work; that "technological unemployment" is the direct and immediate cause of the economic, social and moral "muddle" in which the world apparently admits itself to be; and that politics, economics and sociology are at present unable to cope with the problems which technology has presented. The more rabid of these critics would have us believe that scientists have created a new world for which man is at present unadapted, and unless science enters upon an indefinite *moratorium* civilization may be destroyed. They cite example after example where some machine like the cotton-gin has "displaced" human labor, thus "creating unemployment," with its attendant ills, among a group of people who formerly were trained in a particular type of service.

If the figures of Mr. Harry G. Davis, director of research of the Farm Equipment Institution, are correct, we must agree that the cotton-gin is indeed a monstrous culprit in this regard, for says Mr. Davis:

> If the cotton-gin were eliminated, and the production of cotton maintained at the average of the past 10 years, 37,000,000 people (or ¼ of our entire population) working 8 hours per day for 300 days per year would be required to separate by hand the seed from the cotton lint.

In this connection, we wonder why some one has not proposed the abolition of the steam shovel or even the pick, spade and wheelbarrow in building roads, as the substitution of teaspoons and buckets or even the bare

hands would require a vastly greater number of laborers per cubic yard of dirt moved.

But seriously, no intelligent person can deny that science, during the past 150 years, in its innumerable ramifications, has had an effect upon human living second only to religion. Furthermore, no one will deny that frequently the introduction of some scientific principle or application into an established industry brings about a temporary, and sometimes a permanent, displacement of human labor in that particular field. Hence if one, in making his observations, selects a *"microscope"* and focuses it upon these immediate and transitory results, he may get the impression that "the normal effect of applying science to industry was to throw people out of work and impair standards of living." Basically, the fallacy of such arguments and conclusions, as has been suggested by President Frank B. Jewett, of the Bell Telephone Laboratories, "resides in the narrow angle of the lens through which the problem is viewed. It is an angle too narrow both in the *abscissa* of the population as a whole and in the *ordinate* of time."

Since no close-up or "microscopic" view of existing conditions can afford a true picture or fair perspective, let us adopt the *"telescopic"* (*i.e.,* long-range, wide-angle) point of view and thereby try to appraise the whole field of scientific application since the date of James Watt and his steam engine.

During the past 150 years, as a result of fundamental scientific discoveries, numerous new and vast industries and services have been established. Consider a few: automobile, aviation, radio, motion-picture, telephone, electric lighting and power, metallurgy, rayon, textile and refrigeration. Have these in any sense tended to diminish employment? One wonders what the millions of employees in these science-born industries would find to do if they should suddenly be abolished. Where would be the demand for all those bales of cotton, for instance, which the cotton-gin is now helping to provide, or the other raw materials now pouring into these new industries?

The actual results are to be found in the recently published Report of the National Industrial Conference Board, which featured a study of 18 industries which were entirely unknown 50 years ago. Some of their specific findings will be incorporated later in this paper, but let us note, at this point, several general conclusions regarding the entire national employment situation during this 50-year period:

(1) Jobs have multiplied much faster than people. While the population was increasing 118 per cent., the proportion of employed persons in the population increased 191 per cent. (*Note:* the earlier lower figure included a great amount of child labor from which the latter figure is free; furthermore, as Roger Babson recalls, "25 years ago women in homes and boys on farms or in schools were not reported as jobless; whereas to-day they are put down as 'unemployed' and possibly are 'on relief'.")

(2) In 1870 it required only 324 persons out of every 1,000 of population to produce what consumers demanded; in 1930, with the machine predominant, it required 400 persons out of every 1,000.

(3) National income increased from 1899 to 1929 by 423 per cent., and purchasing power rose 140 per cent. in this period. During the period between 1850 and 1933, the per capita wealth of the U. S. jumped from $308 to $3,500; meanwhile the annual earnings per worker were multiplied nearly 5 times, and the working hours per week cut almost in half. Wage rates, annual earnings and purchasing power have steadily increased with the increased use of machinery and the increased energy which machines have made available.

An interesting side-light on the situation is to be found in a (1937) survey of gainful occupations in the Borough of Manhattan, which shows that there are now 4 times as many ways of earning a living as existed a quarter of a century ago. In 1911 there were only 1,800 vocations listed in the city directory, whereas to-day there are nearly 7,500.

Not only has the introduction of technological development almost invariably resulted in a substantial increase in the total number of persons directly or indirectly employed, but also the standard of living has been greatly raised, because of the resulting lowering of costs of production and sale, and the enlargement of demand and consumption. To-day, living conditions for the average citizen are far more luxurious than existed in the household of kings before the advent of the machine age. These improvements have doubtless, in a large measure, been responsible for the extraordinary fact that the total world population has more than doubled during the past 150 years.

Continuing our "telescopic" survey, let us now proceed to analyze the relation between scientific advancement and industrial employment in several typical fields.

AUTOMOBILE

In selecting the automobile we consider it an outstanding example of pure scientific research—a veritable "child of the fundamental and applied science laboratory." It is also noteworthy as a scientific contribution which practically destroyed an old-established (carriage and wagon) industry. Before 1900 less than 1,000,000 individuals were employed in the manufacture and operation of horse-drawn vehicles; including blacksmiths, stable operators, teamsters, harness workers and wagon and buggy builders. A (1936) report places the total number of persons who are dependent directly or indirectly upon the automobile for their

livelihood at about 10,000,000—or approximately one person out of every seven now gainfully employed in the United States. A brief contemplation of the numerous allied industries which the development of the automobile has fostered (such as petroleum, rubber, cotton, glass, steel, trucking, repairing and servicing) is sufficient to convince one that these figures are not exaggerated.

Some idea of the enormous demand for raw products by the automobile industry can be gained by reference to the following partial list of requirements by the Ford Motor Company (during 1935):

69,000,000 pounds of cotton.
500,000 bushels of corn.
2,400,000 pounds of linseed oil.
2,500,000 gallons of molasses.
3,200,000 pounds of wool.
1,500,000 square feet of leather.
20,000 hogs for lard oil.
350,000 pounds of mohair.
2,000,000 pounds of soybean oil.

Additional data from the Ford Motor Company show that during this same depression year (1935) four times as many men were employed and five times more wages paid than during prosperity twenty-odd years ago, when machinery was comparatively crude and more hand work was required. In recounting the experience of the Ford Motor Company in judging the effect of machinery on employment, its spokesman, Mr. W. J. Cameron, states:

> It always surprises people to learn that most of the machinery in use is not labor-saving machinery at all. Most of it is labor-creating or labor-serving; it enables men to work at tasks that never would have been attempted otherwise.
>
> One year when the Company spent $4,000,000 for machinery, its employees increased by 20,000 men, and the pay roll by $48,000,000. Another year when the Company spent $9,000,000 for machinery, its employees increased by 40,000 men, and its pay roll by $88,000,000. In another year when the Company invested $10,000,000 in machinery, employment increased by 37,000 men, and the pay roll by $76,000,000. That was the invariable experience—the more machinery, the more men.

Another quotation seems appropriate here—this time from pen of the columnist, John Temple Graves, II:

> The automobile is the machine-age's best answer to those who say that machinery causes unemployment, for it has created infinitely more employment than ever it destroyed. It is the economist's best example of what the principle of competition means, for the competition of motor companies has produced in the modern low-priced automobile the greatest value in all history. It is the philosopher's best bet for that enlargement of individual life which he prescribes, for it has made possible to the average man, through mere pressure of foot against pedal, such commands of space and time as were never his before.

Dare we conjecture for one moment the present-day consequences which might have resulted if, 30 years ago, legal or other forceful steps had been taken to restrain technological development of the automobile on the ground that the carriage and wagon industry might be interfered with?

Electricity

Sweeping our "wide-angle telescope" toward the second largest new industry created by science—the *electrical*—we find a similar record of achievement in increasing employment and raising standards of living. Time does not permit detailed reference to its many specialized fields (such as: illumination, ignition, power transmission and conversion, television, telegraphy, telephony and radio), so I have selected for a brief consideration two rather restricted applications—the dial telephone and electrical refrigeration—as typical examples in electricity.

Dial Telephone

Between 1921 and 1930 dial-telephone installations increased from less than 3 per cent. to more than 30 per cent., while the number of operators, which it was feared might eventually disappear, rose from 190,000 to 249,000. Meanwhile, telephone calls had increased more than 100 per cent. and the number of linesmen had practically doubled. Dr. Frank B. Jewett, president of the Bell Telephone Laboratories and vice-president of the American Telegraph and Telephone Company, recently said: "Of my thirty years of industrial research activities I can not find a single instance where a scientific achievement has resulted in a reduction in employment. In nearly every case more work has resulted and there has been a betterment of living conditions to all classes of society."

Electrical Refrigeration

Another by-product of the "electrical-age" is electrical refrigeration. Fifty years ago the manufacture of ice had not attained the status of an industry. About 15 years ago, when the electrical refrigerator began to bar the ice man from America's kitchens, many critics of technological advancement bemoaned his apparent exit from the ranks of the employed. They overlooked the advent of a new industry which was destined to create not only new employment and new purchasing power but also to actually stimulate the demand for ice by influencing the public in becoming "ice conscious." By 1930 the number of ice dealers had increased 237 per cent. over the census of a decade before, and the sales of ice had reached the highest level in history. To date it is estimated that nearly

10,000,000 electric refrigerators have been manufactured. In a recent (1937) *Bulletin* of the National Resources Committee we read: "A comparison of the sales of electric refrigerators since the beginning of the industry in 1920 with the sales of ice boxes over the same period clearly demonstrates that even if the same number of man-hours were necessary to produce each, no technological unemployment could have resulted from the introduction of this development."

PRINTING

Although not classed as a new industry, printing has during the past 40 years become highly mechanized. This has greatly reduced the cost of printing, thereby stimulating an increased demand for books, magazines and newspapers. Despite the vastly increased output per laborer made possible by machinery, the total number of workers in the printing industry has quintupled, and the average annual earnings per person has increased four-fold. This does not include corresponding expansions in related industries and activities, such as lumber, paper, ink, writing, publishing, editing, news and book dealing, and machine manufacturing. The *Monthly Labor Review* cites a typical case, where "one daily journal published 26,000 copies of a 4-page, 6-column paper in 1852, with '40 compositors and a handful of pressmen, fly boys and other labor.' In 1926 the mechanical staff (of the same newspaper) numbered 1,700 of whom 325 were compositors." If the scribes of Paris could have foreseen such possibilities, they would doubtless have been less vigilant in keeping the printing press out of that city so long.

CLERICAL WORK

Even modern business offices have been electrified and mechanized. These mechanical devices, instead of reducing employment among clerical workers, have made possible such large-scale clerical methods that the total number of secretaries, copyists and accountants increased by nearly 400,000 during the past decade. The invasion of the typewriter has not even injured the pen and pencil trade—witness the new business in fountain pens and patent pencils that has arisen. It is doubtful if modern "big business" could continue to function without the aid of such physical equipment as dictaphones, typewriters and adding machines.

STEAM SHOVEL

A "microscopic" appraisal of the influence upon employment of the steam shovel might suggest that thousands of men who formerly dug for a living have now been displaced. But the "telescopic" view will readily reveal the tremendous program of public works, highways and skyscrapers which this iron monster and its twin brother, the crane, have made possible. How many more riveters, steel workers, masons, carpenters, truckers and other laborers this program has required; and how much greater demand for raw materials and other products—since the power shovel opened the way!

TEXTILE

In the days of the spinning wheel and the hand loom, clothing was scarce and expensive. The perfection of power machinery in the textile industry has made possible greater production at lower cost, which in turn so increased the demand that 30 per cent. more workers are making women's clothes to-day than a decade ago, while 15 per cent. more are making men's furnishings. The whole textile industry provided more employment per unit output in January, 1936, than in the same month of 1929, according to the National Industrial Conference Board.

SHOEMAKING

The census of 1900 lists the number of workers in shoe factories of the United States at slightly more than 150,000, with average earnings of about $415 per year. Despite the fact that during the ensuing quarter of a century the shoemaking industry became almost completely mechanized, the number of workers rose to over 200,000, with average earnings of over $1,000 per person. These figures do not take into account the great expansion in the leather and rubber industries resulting from corresponding increase in the sale of shoes. It should also be noted that the 1900 census included nearly 5,000 children under the age of 16 years, each earning about $175 per year. To-day such prostitution of child labor is intolerable.

Time forbids the further enumeration of the many ways in which science, during the past 150 years, has stimulated employment and otherwise promoted better living conditions for humanity.

What has been said is in no sense a contention that there are not problems of adjustment and distribution yet to be worked out. These are indeed serious problems—but they are *solvable*. The same spirit which enabled man to extract nature's secrets from her vast storehouse should likewise enable him to interpret and apply them to beneficent ends. The real need, humanly speaking, is for an extension of the methods of science into fields where it is not now applied. We agree with the eminent British scientist who said: "Modern society does not suffer too much from science—but from the *frustration of science* by the present social order."

In solving these problems the scientist should give greater attention to the social aspects of his work. No longer should we lay ourselves liable to the charge that the average scientist is too engrossed in the "pur-

suit of truth for truth's sake" to consider the impact of his work upon society. Dr. Einstein emphasizes this when he warns: "It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for the man himself and his fate must always form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations."

Thus it becomes the duty and privilege of the scientist of the future, because of his vantage point in viewing and understanding the significance of his own research, to take the initiative in pointing the way to a better social control and distribution of the "gifts of science." The challenge to follow up his work *socially* is a challenge which no progressive scientist can afford to ignore.

SCIENTIFIC EVENTS

THE DARWIN LIBRARY AT DOWN HOUSE

A PROPOSAL has been adopted by the Down House Committee of the British Association and endorsed by the council, to the effect that efforts should be made to accumulate a collection of books and papers relating to Darwin and his times, more representative than that which is at present housed in his former home. The major part of the existing collection consists of Darwin's own library, which belongs to the professor of botany in Cambridge for the time being, and was generously replaced in Down House by Sir Albert Seward during his tenure of that chair, an action confirmed by his successor, Professor F. T. Brooks. For the rest, the number of Darwinian books in the possession of the association is not large; whereas inquiries concerning such books are not infrequently made by visitors and others. It is felt that a collection such as it is now hoped to acquire will prove to be of real value to students and inquirers, as well as of interest to many who visit the house.

The committee's aim is to collect—(a) all biographies of Darwin; (b) contemporary works on Darwinian theories and kindred subjects; further, (c) the collection of Darwin's own publications (books and papers) is not complete, and (d) the committee would gladly receive and preserve contemporary reviews of Darwin's works.

It is believed that members of the association and others may be able and willing to add to the collection by gift. For any such help the committee and the council will be most grateful. Those who may be in a position to offer appropriate books or papers are asked, in the first instance, to communicate particulars thereof to The Secretary, British Association, Down House, Downe, Kent, in order that duplication may be avoided.

STANDARDS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

MODIFICATIONS are to be made by the American Society for Testing Materials in methods of publishing standard specifications and tests. These changes are to become effective next November.

All the 870 standards of the American Society for Testing Materials are in use in many branches of industry and commerce. Each is available, and will continue to be in separate pamphlet form, and the standards have been issued in triennially published books of standards with an annual volume giving the so-called tentative standards and tests.

The new method of publication will be to issue the standards and tentative standards collectively in one triennial publication, divided into three parts: Part I, Metals; Part II, Non-Metallic Materials—Constructional; and Part III, Non-Metallic Materials—General. Publication of new and revised tentative standards in the annual *Proceedings,* Part I, will be discontinued; the *Proceedings,* including both committee reports and papers (about 1,300 pages double-column format), will be bound in one volume. The publication of the annual "Book of Tentative Standards" will be discontinued entirely. (The November, 1938, edition is thus the last one to be issued.)

In the two years between the triennial publication of the new book, supplements to each of the three parts will be issued, containing revision and new or revised standards and tentative standards for that year. Since these books will be appreciably larger than the present supplements and will have permanent reference value, they will be bound in cloth. The volume on "Methods of Chemical Analysis of Metals" published in 1936 will be continued as a separate publication.

It is provided that the three parts of the triennial publication in 1939 shall be made up as follows:

Part I, Metals.—Ferrous and non-ferrous metals (all A and B and some E serial designations) except methods of chemical analysis. General testing methods (E serial designations).

Part II, Non-metallic Materials—Constructional.—Cementitious materials, concrete and aggregates, masonry building units, ceramics, pipe and tile, thermal insulating materials (all C serial designations). Timber and timber preservatives, paints, varnishes and lacquers, road materials, waterproofing and roofing materials, soils (certain D serial designations). General testing methods, thermometers (E serial designations).

Part III, Non-metallic Materials—General.—Fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water (remainder of D serial designations). General testing methods, thermometers (E serial designations).