TELEPHONE-VANDERBILT 6000

THE COMMODORE
FORTY-SECOND STREET AND LEXINGTON AVENUE
GRAND CENTRAL TERMINAL
PERSHING SQUARE
NEW YORK

JOHN MC E. BOWMAN, PRESIDENT
GEORGE W. SWEENEY, VICE PRES. & MGR.

April 19, 1919.

President Harry Pratt Judson,
University of Chicago,
Chicago, Ill.

My dear President Judson:

At the conference which you held with Professor Stieglitz, Professor Michelson, Professor Moore and myself, you asked us to formulate some specific recommendations for next year and for succeeding years. Inasmuch as the recommendations herewith submitted involve two of the members of this group, I am taking the liberty of sponsoring them myself. Apart, however, from the recommendations which relate to Professor Michelson and Professor Stieglitz themselves, I know that this plan meets with their approval. The first section is introduced on Professor Stieglitz's suggestion, because he felt that you might wish to have some statement of this sort with which to arouse the interest of prospective Donors. The last section is the only one in which you yourself would be interested, for it contains the specific suggestions which you asked to have made.

I have a feeling, from conversations which I had with Mr. Rosenwald, in Washington, last year, that he might be interested in this project, although I have not mentioned it to him, and should, of course, not do so without your permission. If it would

be proper, I should be glad to send him an address upon this general theme,which I am giving at Yale next Thursday night, but, of course, should do so only if you think it wise.

I am to be in attendance upon the meetings of the National Academy of Sciences, Phylosophical Society and the National Research Council during the whole of next week and part of the succeeding one. I am sending you this somewhat hastily formulated draft in case you may wish to take some steps in the immediate future.

Very respectfully yours,

R. A. Millikan

DEVELOPMENT OF THE DEPARTMENT OF CHEMISTRY,

UNIVERSITY OF CHICAGO

Introduction

The most important element in the development of the department of Chemistry rests obviously in the type of men it can hold on, and draw to, its staff. However, by the peculiar situation of the department in being housed in a laboratory altogether inadequate for its enrollment both of graduate and of undergraduate students, the question of enlarged quarters in a new laboratory designed exclusively for graduate and research work has become for the time being the paramount question, and this will be discussed briefly ffrst. Hand in hand with this goes the problem of new and up-to-date equipment, Kent being indeed so crowded - even its halls are used for a supply-room and for a balance-room - that we actually have not the space in which it would be possible to install new equipment of value.

This report will deal therefore with the problem presented, in the order:

I. Laboratory space
II. Equipment
III. Staff

Normally, from the point of view of relative importance, the order would be reversed.

I. Laboratory Space.

As a part of this report is appended the detailed report to President Judson on the plans for a new chemical laboratory to be located just west of Kent and connected with it. It is to be used exclusively for research and graduate work and the necessary general purposes of library, supply rooms, etc. The report may be summarized as follows:

1. Space Distribution:

For Research Work	15,500 sq.ft.
For Other Graduate Work	10,150 " "
For General Purposes	8,300 " "
For Hallways, Stair cases etc.	7,000 " "
Total	40,950 " "

2. Estimated Cost

The building - four stories and basement, covering 10,000 sq.ft.	$500,000
Endowment for maintenance	120,000
Changes in Kent Laboratory	20,000
	$640,000

II. Equipment

In the crowded condition of Kent there has been no room for the proper installation, proper care and protection of fine research and graduate equipment. This has been one of our most serious handicaps. Only the absolutely indispensable apparatus has been purchased because of the great risk of loss, injury and depreciation and much important work has been postponed on account of lack of the necessary appliances. It is therefore recommended that in the provision for the new laboratory we have:

Equipment, new	\$25,000 to \$40,000
Endowment for equipment	50,000

Even without a new laboratory for the needs of present research material and apparatus, the annual appropriation for supplies and expense should be increased by at least \$2,000. Our annual increases have almost exclusively represented re-appropriation of sums taken in for laboratory fees and breakage, largely from undergraduate sources. These sums are simply for re-purchase of stock and do not represent at all additional funds for research with growing numbers of staff men and research students (35 this year) and growing costs. An additional appropriation of \$2,000 represents a minimum for proper care of the department's needs.

III. Staff

1. Except for a chair in industrial chemistry (see below) and a new assistant professorship for undergraduate work recommended in the budget for 1920-21, the departmental staff as far as men are concerned, is now in a strong position. It is standing on the brink of instability, however, because of salaries and industrial competition (see 2 below). With the addition of Dr. Nicolet (Ph.D. of Yale) to the staff in organic Chemistry, the department, through the chairman and Dr. Nicolet should be able to maintain its leadership in the important field of organic Chemistry. In Dr. Harkins we have a first-class productive physical chemist, in Dr. Wendt (Ph.D., Harvard) likewise a first-class productive radio-active chemist. Dr. Schlesinger is doing good work in physical and inorganic research, Dr. Glattfeld in organic research and Dr. Terry in physico-organic work. The strength of the department is shown by the fact that it has some 35 Ph.D. candidates at work distributed among all the staff, the chairman, Dr. Harkins, Drs. Wendt and Nicolet carrying the main burden. The critical question is that of satisfying and keeping these men.

2. There are, namely, two alarming factors in the situation of Chemistry in this country, which unless corrected, will prove disastrous and destroy for many years any chance for America to compete with European nations in the proper development of Chemistry which is so vital to the nation's needs. The first of these two factors is that by very high salaries the industries are draining our universities of their best research men. The older men to a considerable extent are remaining

faithful to their university careers, but for the young men the parting of the ways meets much less stability in university adherence in the face of the much higher salaries combined with excellent research opportunities offered by the industries. The second factor is equally important and in my judgment like a malignant cancer, much more insidiously destructive - and that is that under pressure of circumstance, university men of highest research capacity, including the more faithful older men, are accepting appointments of one kind or another as research consultants of industrial firms. This means inevitably the gradual loss of the man to pure science and instruction of the highest type: the academic duties are not insistent, academic problems can be postponed, the industrial problem is insistent, has actually or morally an urgent time factor, and irresistibly the men's best hours of work and mind are used for applied science and not for pure science.

Now, the staff of Kent has for 28 years resolutely refused every kind of outside consulting work, however remunerative or tempting it might be. It has been the explicit rule of the department that except for the U.S. government, the State or City authorities, no outside work of any kind should be accepted! In the case of one professor who became interested in his own industrial applications, the department immediately felt the serious handicap of his reluctance to assume the fair share of administrative duties, of research direction of Ph. D. candidates, etc., the excess burden being thrown on the shoulders of the other staff members.

In view of these two dangers to university staffs in chemistry, the Chairman of the department as president of the American Chemical Society in 1917 urged upon university presidents and trustees the vital need of putting their chemistry departments on the same salary basis as their law or medical schools (the address forms appendix II and the relevant passages are marked). As a matter of fact, two of the most promising younger staff members (Wendt and Nicolet) have within the last few months received offers of $6,000 for industrial research positions. They are receiving $2,500 from the University. They were invited to join our staff as assistant professors as promising young men to strengthen our research work in radio-activity (Wendt) whichhad been crippled by the resignation of McCoy and in organic chemistry (Nicolet), handicapped by the loss of Professor Nef. The older men have been urging the chairman of the department to relax in the departmental tradition of full time service to pure science, , that is, now to permit consulting work. The staff consequently continues in a condition which does not make for the best results - it has no assured stability, content and freedom

from pressing financial cares. While this is true of all departments in a University, the intimate relation of chemistry to industry, like medicine to practise and law to practise, makes the situation in chemistry peculiarly acute and threatening. It does not seem quite wise or perhaps quite fair to put the whole burden of the financial sacrifice on the staff members: doing so is detrimental to the morale and stability of any department.

3. This situation has been presented at length because it forms the explanation of the recommendations concerning staff salaries, to remove existing defects and shortcomings in the department. Specifically, it is thought that if an endowment of $200,000 for a professorship (Princeton has recently received such an endowment for a chair of Organic Chemistry) could be secured, yielding say up to $8,000 for a professorship and $2,000 for technical assistants for a chairman of the department (who would be relieved of the greater part of administrative (clerical) duties by the development of an efficient departmental secretaryship), the salary funds released ($6,000) would make possible a scale of salaries, which would grant the more valuable men of the department salaries commensurate with their importance for the development of its full strength in research and instruction. The university now appropriates $24,750 ($27,250 if the new assistant professorship is granted) for staff appointments (Assistant professorships and higher). With the $8,000 from the proposed new endowed professorship, this would make $35,250. This amount would be exactly sufficient to put the department on a proper footing of stability and maximum efficiency (the specific salaries to be aimed at can be supplied if desired).

4. Aside from the salary question, the most insistent need for improvement in the situation lies, first, in the greater relief of the chairman of the department from administrative (clerical) duties by the further development of a departmental secretaryship and, second, in an increased appropriation for research assistants. At present, the University allows some $2,000 for research assistants to the chairman of the department and Dr. Harkins. The chairman should have at least $2,000 alone for an assistant, so as to be in a position to secure a fully trained man, a Ph.D. as research assistant (in place of Ph.D. candidates), who could carry out the ideas and plans without constant supervision. Dr. Harkins should have at least $1200 for the same purpose not being burdened by administrative duties. An increase of at least $1,500 in the

appropriation for research assistance would therefore be urbently needed for developing greater efficiency in the research work of the department. Two or three times this amount could very profitably be used to bring out the greatest field of productive research by highly trained helpers to the leading staff members.

A similar pressing need of the department (and of the whole university) is for a <u>glass-blower</u> at a salary of $1500-$1800. Such a man would be an invaluable addition and would also save the University considerable expense going to outside glass-blowing shops.

5. The establishment of a chair in industrial chemistry as described in the plans for a new laboratory would be very valuable for maintaining contact with the important applications of chemistry in industrial life, but it is thought that this item should be considered last in the development of the department to full strength. An endowment of $150,000 for the professorship and assistants would be needed.

IV. Summary

The following is a summary of the additional funds needed for the development of the department of Chemistry

1. For a new laboratory for graduate and research work:	$500,000
2. For endowment for maintenance:	120,000
3. For new equipment	30,000
4. For endowment for equipment	50,000
5. For an endowed professorship (primarily for research) ans assistants	200,000
6. For Research Assistants and Technicians, (glass-blower)($3000 per year)	60,000
7. Endowment for a Professorhip of Industrial Chemistry and Assistants	150,000
8. For changes in Kent Laboratory	20,000
	$1,130,000

Appendix I

REPORT ON THE PLANS FOR A NEW CHEMICAL LABORATORY

I. Discussion of the New Laboratory.

1. The new building is to be devoted exclusively to research and graduate work preparatory to research and may well be considered the first new unit (Ryerson and Kent Laboratories being the present units) in the building up of a Research Institute of Physics and Chemistry. It will provide for the research work of some 75 investigators (besides the staff), including candidates for the Ph.D. degree, post-doctorate Fellows, and adequately prepared independent research workers, to whom the University has always extended a hospitable welcome. We have now in Kent Laboratory already some 35 men and women (besides the staff) engaged in research work in crowded rooms and dark nooks with altogether inadequate facilities. It is anticipated that within ten or fifteen years the number of research workers will rise to the limits of the new building. In the interim, the courtesy of research space in the new building could with advantage to the University be tendered to the department of physics and particularly also to the department of physiological chemistry, whose research facilities are entirely inadequate.

2. It should be recalled here that Kent was planned and built before the era of physical chemistry, which has developed to one of the most important branches of the science, and before the day of radioactive chemistry, which has become both in its pure science relations and in medicine and applied science, another most important branch of chemistry. The new laboratory will for the first time afford proper facilities and equipment for instruction and research in these fundamental branches at the University which have developed heretofore under the most disadvantageous conditions and wholly through the exceptional devotion of the Chemistry staff.

3. Organic Chemistry has grown to be of increasing importance, both in wholly scientific lines and in applied chemistry. In very great measure the science of life itself, that is, all the biological sciences, including medicine, look to organic chemistry to solve such problems as heredity, health and the combatting of disease. In equal measure the security and industrial welfare of the nation rest in large measure on the foundations of organic chemistry, since this embraces in its applied branches the science of explosives, of gas warfare, of dyes, textiles and hundreds of other industrial applications. All of these vital applications, especially in medicine await in many directions the progress of the pure science of organic chemistry. As a result the demand for men thoroughly trained to do research in organic chemistry, pure and applied, has far outstripped the supply. In the new laboratory adequate space will be provided for graduate training and for research in organic chemistry.

4. The development of a complete course of training in chemical technology is not a part of the present program and is left to the institution of a School of Technology. It is thought, however, that forthe rounding out of the Ph.D. training in Chemistry itself, some instruction in the elements of industrial chemistry is desirable - instruction in the general principles of adapting laboratory methods to large scale production, in the elements of calculations of costs, and especially in the problems pressing in the world of to-day. All the better American and continental European universities have with a complete equipment for training in the pure science of chemistry some instruction in industrial chemistry which is intendedto broaden the outlook of the Ph.D. candidate. It is considered desirable to assign a small part of the new building to the possibilities of graduate instruction in the theoretical foundations of industrial chemistry.

II. Kent Chemical Laboratory.

1. According to the plans of the department, Kent Chemical Laboratory will be used to take care of the college work in chemistry, together with a part of the graduate work, and to provide space for the shops and over half of the storeroom and supply service. With the relief of the congestion afforded by the installation of the new laboratory and withcomparatively inexpensive changes in Kent Laboratory provision can be made to give instruction in Kent Laboratory in a single Quarter to the following numbers of students:

388 in General Chemistry (This could eventually be increased to 680. The present number is 280).

216 in Qualitative Analysis (This could eventually be increased to 378. The present number is somewhat over 100).

195 in Elementary Organic Chemistry (The largest number per Quarter thus far has been 140).

155 in Quantitative Analysis (This could eventually be increased to 208. The largest number per Quarter thus far has been about 110).

These represent a total of from 954 to 1461 students in these four branches of college chemistry alone. The present attendance is about 580 in these college courses. It is evident, therefore that the new building by relieving the congestion in the large laboratories of Kent, will provide through Kent for the unquestionably rapid increase that is to be foreseen in the students demanding chemistry. Provision for such an increase should be made because failure to doso would cripple all the sciences dependent on chemistry, namely geology, physiological chemistry, physiology, bacteriology, pathology and to some extent botany and zoology. The department has deemed it its

duty to provide for all students properly prepared who have applied for courses in chemistry, just because a refusal could well cripple a man's preparation for his life work!

2. The suggestion has occasionally been made to relieve the congestion in the demand for work in this science (and physics) by relegating the work in General Chemistry (and General Physics) completely to the secondary schools. Any such policy, it is believed, would be a disastrous one: disastrous to the cause of chemistry (and physics) in this country, which must look to chemistry (and physics) for much of its progress in indsutry, health and economics; disastrous to the development of the student himself; and disastrous to the departments concerned. Reasons for this unqualified judgment are:

(a) The Secondary Schools are drifting more and more rapidly from the thorough teaching of the <u>principles and theory</u> of chemistry to the teaching of some form or other <u>of applied chemistry</u> - food chemistry, agricultural chemistry, etc., teaching even in our Universith High School the subject "with a social background" rather than as a science of the first magnitude. Progress in chemistry and in all of its great applications to the biological sciences and industry will depend without question on the thoroughness with which the theory and principles of pure chemistry are brought home to the student. As a consequence, even when a student has had High School Chemistry from a half year to two Quarters of College Chemistry is considered absolutely essential by those intent in turning out <u>the best</u> quality of product. The very mingling with assistants who are Ph.D. candidates, with research professors is a source of inspiration to the beginner, whose value cannot be overestimated. This view has been amply confirmed by our own experience of 27 years! We have had the best results, the most reliable graduate students from our own undergraduate body and from graduates of universities giving the same type of training. The department is unanimous that it would risk disastrously the <u>prime quality</u> of its output if it abandoned this position.

(b) Our large undergraduate classes yield not only the best scientific material for the development of our final product, but they also strengthen in a very vital way the department's capacity to provide for graduate and research work. In the first place, the growing numbers are a positive source of revenue, the income now growing very much more rapidly than the actual cost of providing for further undergraduate students and constantly lowering the actual cost of the whole department to the University. In the second place, the large staff of associates and assistants required for the undergraduate classes form a large and vital part of our graduate student body and research workers. This is so well recognized that one might well say that with foresight and proper handling of the problem, the larger the undergraduate body, the stronger and better the staff can be made for research as well. Men strong in research, when they are good teachers

are pre-eminently good, they are men whose inspiring and broad treatment will produce immeasurably better results than the stereotyped methods of the sterile pedagogue whose productiveness in science has ceased. It is the duty of the guiding powers in a department of a University like this to find for the purposes of undergraduate instruction that type of man which has been described, who combines in himself the ability of a good teacher and of a good investigator. The more men of this type that we have, the stronger a department will be in research as well as in the results of its instruction. In our own chemistry department every single member of the staff of assistant professional rank or higher is engaged in research and guiding Ph.D. students, and every instructor, including the chairman of the department, at some time in the year takes a part in the undergraduate instruction.

In a word, with the urgent need of the country for research men in chemistry, the large bodies of undergraduates in the subject, wisely handled, become sources of greatest strength to the research staff, to the body of Ph.D. candidates (incipient investigators) and to the material resources of a laboratory. To remove the undergraduate work "would bleed a department white" both in strength of instruction and in strength of research.

III. Detailed Discussion of the Plans.

1. The Distribution of Space in the New Laboratory:

The following plan of the distribution of space in the new laboratory has been drawn up tentatively with the aid of the whole departmental staff. The distinction between the groups A, B and C is not a sharp one. For instance, the libarry, the service rooms and the offices and conveniences given under C are obviously necessary also for the proper organization of research work. The division has been made merely for the sake of a rapid survey of the general plans.

New Laboratory

A. Rooms for Research Work.

				Sq.Ft.
1.	24	research laboratories for individual students	10 x 18	4320
2.	18	" " " two students	15 x 18	4860
3.	6	" " " staff members	15 x 18	1620
4.	1	" laboratory for the Chairman	20 x 18	360
5.	1	general research laboratory for radioactivity	30 x 18	540
6.	1	chemical laboratory for radioactivity	10 x 18	180
7.	1	room for High Tension Electricity	30 x 18	540
8.	1	" " Transformer	10 x 18	180
9.	1	" " Calorimeter and Potentiometer	20 x 18	360
10.	1	" " Low Temperature work (in the basement)	20 x 18	360
11.	1	" " Constant Temperature	12 x 18	216
12.	1	Conductivity Room	12 x 18	216
13.	1	Spectroscopy "	15 x 18	270
14.	1	Dark Room	6 x 18	108
15.	1	Photochemistry Laboratory	15 x 18	270
16.	1	Microchemical Laboratory	15 x 18	270
17.	1	Organic Combustion Room	15 x 18	270
18.	2	Balance Rooms	6 x 18	108
19.	1	Seminar Room	25 x 18	450
				15,498

B. Rooms for Graduate work Preparatory to Research.

				Sq.Ft.
20.	1	Laboratory for General Physical Chemistry	60 x 32	1920
21.	1	Preparation Laboratory for Physical Chemistry	10 x 18	180
22.	1	Laboratory for Advanced " "	30 x 18	540
23.	1	" " General Radioactivity	30 x 18	540
24.	1	Chemical Laboratory for "	10 x 18	180
25.	1	Laboratory for Organic Preparations	60 x 32	1920
26.	1	" " Rough Organic Preparations	30 x 18	540
27.	1	" " Inorganic "	60 x 18	1080
28.	1	" " Special Industrial Chemistry	60 x 30	1920
29.	1	Small Lecture Room	40 x 18	720
30.	1	Balance Room for General Physical Chemistry	10 x 18	180
31.	1	Conductivity Room	12 x 18	216
32.	1	Combustion or Bomb Furnace Room	12 x 18	216
				10,152

C. For General Purposes

33.	Library		1800
34.	Main Store-room for Service(for both buildings, Kent & the new builing	32 x 18	576
35.	Solution-room	25 x 18	450
36.	Office for Curator	10 x 18	180
37.	Office for Students' Accounts	15 x 18	270
38.	6 offices for staff (connected with research laboratories)	8 x 18	720
39.	1 office for Chairman	12 x 18	216
40.	1 " " Secretary of Chairman	8 x 18	144
41.	1 Storage room for Physical Chemistry apparatus	10 x 18	180
42.	Storage Room for Special Fire Apparatus	8 x 18	144
43.	Supply Room on 3rd floor	14 x 18	252
44.	Vault	6 x 6	36
45.	1 Men's & 1 Women's washrooms (basement)	15 x 18	540
46.	1 " "" " " (second floor)	15 x 10	300
47.	1 Faculty (men) Washmoom	10 x 18	180
48.	1 " (women) "	6 x 18	108
49.	Surgical Office (couch, washbasin, etc.)	6 x 12	72
50.	Glass blower's shop	15 x 18	270
51.	Elevator	8 x 8	256
52.	Distilled Water Room (in Attic)	30 x 18	540
53.	2 Ventilation Rooms	30 x 18	1080
			8312
	Hallways	5 x 10 x 100	5000
	Stairways		2000

Summary

For Research Work	15,498
For Other Graduate Work	10,152
For General Purposes	8,312
For Hallways and Stairways	7,000
	40,962

For a four stories and basement laboratory on a ground area of 10,000 sq. ft., we would have available from 45,000 to 50,000 sq. ft., making ample provision for walls and other architectural features.

III. 2. <u>The Changes in Kent Chemical Laboratory.</u>
The following tentative plan of changes in Kent has been drawn up with the aid of the chemistry staff.

Third Floor.

1. Laboratories A & B. Change remaining lockers to 4 drawer system, making the total capacity for General Chemistry 388 per Quarter. This could be increased to about 680 eventually by converting the iron-ware lockers into drawers and having the iron stored under hoods in lockers.
   <u>Connect through laboratory A (west wall) with the new laboratory.</u>

2. Laboratory C: Present locker system would be changed to 4 drawer system with iron ware locker and provide room for 216 students, and ultimately if needed for 378.
   Build direct flues for improvement of the hoods.

3. Room 44 to be restored to its original purpose, for use for spectroscopic work (in Qualitative Analysis).

4. Rooms 40 and 43 to be used for chief assistants in General Chemistry and Qualitative Analysis, as offices and research laboratories.

5. Room 39 to be converted into a second balance room.

6. Room 41 to be converted into a class-room (laboratory quiz room).

7. Room 45 to be converted into a store-room serving laboratories A, B and C.

8. Room 24. Lockers changed to 3 or 4 broad drawers per double desk: One half desk removed to allow passage way to new building, leaving 100 desks, providing for 150 students. With space in room 25, would provide for 195 course 4 students.
   Connect through west wall with new laboratory. This laboratory is directly over lecture-room 14 and the floor should be deadened to improve the hearing qualities of the lecture-room.

9. Room 25 could be reconverted ultimately into an organic laboratory, hoods restored on East wall. Room for 45 students in course 4.

10. Present library converted into a study-room for undergraduates, with selected books.

11. Room 34 ultimately office and laboratory for course 4 chief assistant.

12. Rooms 31 and 32. One for a professor, the other for chief quantitative assistant.

13. Room 30 should have improved hood facilities. It is also directly over a lecture-room and the floor should be deadened to improve the hearing qualities of lecture-room 20.

14. Room 21 to be used for food analytical laboratory.

15. Room 15 used for electrolytic, electrometric and water analysis.

16. Room 19 to be used as a museum room, for storing specimens, etc.,or for a class-room quiz.

17. Room 22 reserved for overflow in courses 8 and 9.

Basement.

18. 2 B converted into a storage room for acids in bulk and for correspondence course outfits.

19. 3 B to be used as a janitor's room.

20. 1 B to be used for a students' shop room.

21. The west wall of 8B to be pierced to establish connection with the new laboratory.

22. From the stock-room 5 B under Kent Theatre a covered passage (semi-underground) should be constructed, leading to the new laboratory.

III. 3. The Estimate of Costs.

A. Immediately Necessary

1. A building, covering 10,000 sq.ft., with four stories and basement (like Rosenwald)	$400,000 to	$500,000
2. Equipment (aside from laboratory tables and other fixtures which are included in 1.)	25,000 to	40,000
3. Changes in Kent Laboratory	20,000	20,000
4. Endowment for Maintenance (Janitors, Laboratory Service, Repairs)	120,000	120,000
	$565,000	$680,000

B. Independent Needs

5. Endowment for Equipment	50,000
6. Endowment for a Research Professorship, with technical assistants	200,000
7. Endowment for a Professorship of Industrial Chemistry & assistants	150,000

4. Discussion

a) Harvard University is planning to build three new chemical laboratories, each of 12,000 sq. ft. floor space, 4 stories and a basement, at an estimated cost of $500,000 for each laboratory. Our proposed new laboratory would correspond approximately to such a Harvard unit. With our one new laboratory designed for graduate and research work and Kent used efficiently for undergraduate work as is proposed the needs of the University of Chicago should be met for the next twenty-five years (barring the development of engineering chemistry for which no provision is made) and allowance made for an expansion of over 100 per cent.

The following statistics show the rate of growth of the department:

A. Graduate Students

Autumn	Quarter	1916	69
"	"	1917	60
"	"	1918	43
"	"	1919	87

B. Total Registrations

1892-93	131
1895-96	303
1898-99	548
1901-02	1173
1904-05	945
1907-08	1149
1910-11	1310
1913-14	1739
1914-15	1810
1915-16	2169
1916-17	2245
1917-18	1883
1918-19	2435

While both tables are impressive attention is called particularly to the large and growing graduate registration. With this consideration should be given to the fact that we have 35 research men and women at work now, a number sufficient at once to fill half the research rooms provided for in the new laboratory.

b) The endowment for maintenance includes $2,000 for janitor service, $2,000 for laboratory service and $2,000 for annual repairs.

c) The special endowments for staff may of course be secured as special gifts - the
Research Professorship in Chemistry or the
Professorship of Industrial Chemistry. Such endowments would be the best means for strengthening and expanding the present staff of the department.

Respectfully submitted by

Chairman of the Department
of Chemistry.

December 15/19.

REPORT ON THE PLANS FOR A NEW CHEMICAL LABORATORY

I. Discussion of the New Laboratory:

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2. It should be recalled here that Kent was planned and built before the era of physical chemistry, which has developed to one of the most important branches of the science, and before the day of radioactive chemistry, which has become both in its pure science relations and in medicine and applied science, another most important branch of chemistry. The new laboratory will for the first time afford proper facilities and equipment for instruction and research in these fundamental branches at the University which have developed heretofore under the most disadvantageous conditions and wholly through the exceptional devotion of the Chemistry staff.

3. Organic Chemistry has grown to be of increasing importance, both in wholly scientific lines and in applied chemistry. In very great measure the science of life itself, that is, all the biological sciences, including medicine, look to organic chemistry to solve such problems as heredity, health and the combatting of disease. In equal measure the security and industrial welfare of the nation rest in large measure on the foundations of organic chemistry, since this embraces in its applied branches the science of explosives, of gas warfare, of dyes, textiles and hundreds of other industrial applications. All of these vital applications, especially in medicine await in many directions the progress of the pure science of organic chemistry. As a result, the demand for men thoroughly trained to do research in organic chemistry, pure and applied, has far outstripped the supply. In the new laboratory adequate space will be provided for graduate training and for research in organic chemistry.

4. The development of a complete course of training in chemical technology is not a part of the present program and is left to the institution of a School of Technology. It is thought, however, that for the rounding out of the Ph.D. training in Chemistry itself, some instruction in the elements of industrial chemistry is desirable - instruction in the general principles of adapting laboratory methods to large scale production, in the elements of calculations of costs, and especially in the problems pressing in the world of to-day. All the better American and continental European universities have with a complete equipment for training in the pure science of chemistry some instruction in industrial chemistry which is intended to broaden the outlook of the Ph.D. candidate. It is considered desirable to assign a small part of the new building to the possibilities of graduate instruction in the theoretical foundations of industrial chemistry.

II. Kent Chemical Laboratory.

1. According to the plans of the department, Kent Chemical Laboratory will be used to take care of the college work in chemistry, together with a part of the graduate work, and to provide space for the shops and over half of the storeroom and supply service. With the relief of the congestion afforded by the installation of the new laboratory and with comparatively inexpensive changes in Kent Laboratory provision can be made to give instruction in Kent Laboratory in a single Quarter to the following numbers of students:

388 in General Chemistry (This could eventually be increased to 680. The present number is 280).

216 in Qualitative Analysis (This could eventually be increased to 378. The present number is somewhat over 100).

195 in Elementary Organic Chemistry (The largest number per Quarter thus far has been 140).

155 in Quantitative Analysis (This could eventually be increased to 208. The largest number per Quarter thus far has been about 110).

These represent a total of from 954 to 1461 students in these four branches of college chemistry alone. The present attendance in these college courses is about 580. It is evident, therefore that the new building by relieving the congestion in the large laboratories of Kent, will provide through Kent for the unquestionably rapid increase that is to be foreseen in the students demanding chemistry. Provision for such an increase should be made because failure to do so would cripple all the sciences dependent on chemistry, namely geology, physiological chemistry, physiology, bacteriology, pathology and to some extent botany and zoology. The department has deemed it its

duty to provide for all students properly prepared who have applied for courses in chemistry, just because a refusal could well cripple a man's preparation for his life work!

2. The suggestion has occasionally been made to relieve the congestion in the demand for work in this science (and physics) by relegating the work in General Chemistry (and General Physics) completely to the secondary schools. Any such policy, it is believed, would be a disastrous one: disastrous to the cause of chemistry (and physics) in this country, which must look to chemistry (and physics) for much of its progress in industry, health and economics; disastrous to the development of the student himself; and disastrous to the departments concerned. Reasons for this unqualified judgment are:

(a) The Secondary Schools are drifting more and more rapidly from the thorough teaching of the principles and theory of chemistry to the teaching of some form or other of applied chemistry - food chemistry, agricultural chemistry, etc., teaching even in our University High School the subject "with a social background" rather than as a science of the first magnitude. Progress in chemistry and in all of its great applications to the biological sciences and industry will depend without question on the thoroughness with which the theory and principles of pure chemistry are brought home to the student. As a consequence, even when a student has had High School Chemistry from a half year to two Quarters of College Chemistry is considered absolutely essential by those intent in turning out the best quality of product. The very mingling with assistants who are Ph.D. candidates, with research professors, is a source of inspiration to the beginner, whose value cannot be overestimated. This view has been amply confirmed by our own experience of 27 years! We have had the best results, the most reliable graduate students from our own undergraduate body and from graduates of universities giving the same type of training. The department is unanimous that it would risk disastrously the prime quality of its output if it abandoned this position.

(b) Our large undergraduate classes yield not only the best scientific material for the development of our final product, but they also strengthen in a very vital way the department's capacity to provide for graduate and research work. In the first place, the growing numbers are a positive source of revenue, the income now growing very much more rapidly than the actual cost of providing for further undergraduate students and constantly lowering the actual cost of the whole department to the University. In the second place, the large staff of associates and assistants required for the undergraduate classes form a large and vital part of our graduate student body and research workers. This is so well recognized that one might well say that with foresight and proper handling of the problem, the larger the undergraduate body, the stronger and better the staff can be made for research as well. Men strong in research, when they are good teachers

are pre-eminently good, they are men whose inspiring and broad treatment will produce immeasurably better results than the stereotyped methods of the sterile pedagogue whose productiveness in science has ceased. It is the duty of the guiding powers in a department of a University like this to find for the purposes of undergraduate instruction that type of man which has been described, who combines in himself the ability of a good teacher and of a good investigator. The more men of this type that we have, the stronger a department will be in research as well as in the results of its instruction. In our own chemistry department every single member of the staff of assistant professional rank or higher is engaged in research and guiding Ph.D. students, and every instructor, including the chairman of the department, at some time in the year takes a part in the undergraduate instruction.

In a word, with the urgent need of the country for research men in chemistry, the large bodies of undergraduates in the subject, wisely handled, become sources of greatest strength to the research staff, to the body of Ph.D. candidates (incipient investigators) and to the material resources of a laboratory. To remove the undergraduate work "would bleed a department white" both in strength of instruction and in strength of research.

III Detailed Discussion of the Plans.

1. The Distribution of Space in the New Laboratory:
The following plan of the distribution of space in the new laboratory has been drawn up tentatively with the aid of the whole departmental staff. The distinction between the groups A, B and C is not a sharp one. For instance, the library, the service rooms and the offices and conveniences given under C are obviously necessary also for the proper organization of research work. The division has been made merely for the sake of a rapid survey of the general plans.

New Laboratory

A. Rooms for Research Work.

				Sq. Ft
1.	24	research laboratories for individual students	10 x 18	4320
2.	18	" " for two students	15 x 18	4860
3.	6	" " for staff members	15 x 18	1620
4.	1	" laboratory for the Chairman	20 x 18	360
5.	1	general research laboratory for radioactivity	30 x 18	540
6.	1	chemical laboratory for radioactivity	10 x 18	180
7.	1	room for High Tension Electricity	30 x 18	540
8.	1	" for Transformer	10 x 18	180
9.	1	" for Calorimeter and Potentiometer	20 x 18	360
10.	1	" for Low Temperature work(in the basement)	20 x 18	360
11.	1	" for Constant Temperature	12 x 18	216
12.	1	Conductivity Room	12 x 18	216
13.	1	Spectroscopy "	15 x 18	270
14.	1	Dark Room	6 x 18	108
15.	1	Photochemistry Laboratory	15 x 18	270
16.	1	Microchemical Laboratory	15 x 18	270
17.	1	Organic Combustion Room	15 x 18	270
18.	2	Balance Rooms	6 x 18	108
19.	1	Seminar Room	25 x 18	450
				15,498

B. Rooms for Graduate Work Preparatory to Research.

				Sq. Ft
20.	1	Laboratory for General Physical Chemistry	60 x 32	1920
21.	1	Preparation Laboratory for Physical Chemistry	10 x 18	180
22.	1	Laboratory for Advanced " "	30 x 18	540
23.	1	" for General Radioactivity	30 x 18	540
24.	1	Chemical Laboratory for "	10 x 18	180
25.	1	Laboratory for Organic Preparations	60 x 32	1920
26.	1	" for Rough Organic Preparations	30 x 18	540
27.	1	" for Inorganic "	60 x 18	1080
28.	1	" for Special Industrial Chemistry	60 x 30	1920
29.	1	Small Lecture Room	40 x 18	720
30.	1	Balance Room for General Physical Chemistry	10 x 18	180
31.	1	Conductivity Room	12 x 18	216
32.	1	Combustion or Bomb Furnace Room	12 x 18	216
				10,152

C. For General Purposes

33.	Library		1800
34.	Main Store-room for Service(for both buildings, Kent & the new building	32 x 18	576
35.	Solution-room	25 x 18	450
36.	Office for Curator	10 x 18	180
37.	Office for Students' Accounts	15 x 18	270
38.	6 offices for staff (connected with research laboratories)	8 x 18	720
39.	1 office for Chairman	12 x 18	216
40.	1 " for Secretary of Chairman	8 x 18	144
41.	1 Storage room for Physical Chemistry apparatus	10 x 18	180
42.	Storage Room for Special Fire Apparatus	8 x 18	144
43.	Supply Room on 3rd floor.	14 x 18	252
44.	Vault	6 x 6	36
45.	1 Men's & 1 Women's Washrooms (basement)	15 x 18	540
46.	1 " " " " " (second floor)	15 x 10	300
47.	1 Faculty (men) Washroom	10 x 18	180
48.	1 " (women) "	6 x 18	108
49.	Surgical Office (couch, washbasin, etc.)	6 x 12	72
50.	Glass blower's Shop	15 x 18	270
51.	Elevator	8 x 8	256
52.	Distilled Water Room (in Attic)	30 x 18	540
53.	2 Ventilation Rooms	30 x 18	1080
			8,312
	Hallways	5 x 10 x 100	5,000
	Stairways		2,000

Summary

For Research Work	15,498
For Other Graduate Work	10,152
For General Purposes	8,312
For Hallways and Stairways	7,000
	40,962

For a four stories and basement laboratory on a ground area of 10,000 sq. ft., we would have available from 45,000 to 50,000 sq. ft., making ample provision for walls and other architectural features.

III 2. The Changes in Kent Chemical Laboratory.
The following tentative plan of changes in Kent has been drawn up with the aid of the chemistry staff.

Third Floor.

1. Laboratories A & B. Change remaining lockers to 4 drawer system, making the total capacity for General Chemistry 388 per Quarter. This could be increased to about 680 eventually by converting the iron-ware lockers into drawers and having the iron stored under hoods in lockers.
Connect through laboratory A (west wall) with the new laboratory.

2. Laboratory C: Present locker system would be changed to 4 drawer system with iron ware locker and provide room for 216 students, and ultimately if needed for 378.
Build direct flues for improvement of the hoods.

3. Room 44 to be restored to its original purpose, for use for spectroscopic work (in Qualitative Analysis).

4. Rooms 40 and 43 to be used for chief assistants in General Chemistry and Qualitative Analysis, as offices and research laboratories.

5. Room 39 to be converted into a second balance room.

6. Room 41 to be converted into a class-room (laboratory quiz room)

7. Room 45 to be converted into a store-room serving laboratories A, B and C.

Second Floor

8. Room 24. Lockers changed to 3 or 4 broad drawers per double desk: One half desk removed to allow passage way to new building, leaving 100 desks, providing for 150 students.
With space in room 25, would provide for 195 course 4 students.
Connect through west wall with new laboratory.
This laboratory is directly over lecture-room 14 and the floor should be deadened to improve the hearing qualities of the lecture-room.

9. Room 25 could be reconverted ultimately into an organic laboratory, hoods restored on East wall. Room for 45 students in course 4.

10. Present library converted into a study-room for undergraduates, with selected books.

11. Room 34 ultimately office and laboratory for course 4 chief assistant.

12. Rooms 31 and 32. One for a professor, the other for chief quantitative assistant.

13. Room 30 should have improved hood facilities. It is also directly over a lecture-room and the floor should be deadened to improve the hearing qualities of lecture-room=20.

First Floor

14. Room 21 to be used for food analytical laboratory.

15. Room 15 used for electrolytic, electrometric and water analysis.

16. Room 19 to be used as a museum room, for storing specimens, etc. or for a class-room (quiz).

17. Room 22 reserved for overflow in courses 8 and 9.

Basement.

18. 2 B converted into a storage room for acids in bulk and for correspondence-course outfits.

19. 3 B to be used as a janitor's room.

20. 1 B to be used for a students' shop room.

21. The west wall of 8 B to be pierced to establish connection with the new laboratory.

22. From the stock-room 5 B under Kent Theatre a covered passage (semi-underground) should be constructed, leading to the new laboratory.

III 3. The Estimate of Costs.

A. Immediately Necessary.

1.	A building, covering 10,000 sq. ft., with four stories and basement (like Rosenwald)	$400,000	to $500,000
2.	Equipment (aside from laboratory tables and other fixtures (which are included in 1.)	25,000	to 40,000
3.	Changes in Kent Laboratory	20,000	20,000
4.	Endowment for Maintenance (Janitors, Laboratory Service, Repairs)	120,000	120,000
		$565,000	$680,000

B. Independent Needs

5.	Endowment for Equipment	50,000
6.	Endowment for a Research Professorship, with technical assistants	$200,000
7.	Endowment for a Professorship of Industrial Chemistry & assistants	150,000

4. Discussion

a) Harvard University is planning to build three new chemical laboratories, each of 12,000 sq. ft. floor space, 4 stories and a basement, at an estimated cost of $500,000 for each laboratory. Our proposed new laboratory would correspond approximately to such a Harvard unit. With our one new laboratory designed for graduate and research work and Kent used efficiently for undergraduate work as is proposed the needs of the University of Chicago should be met for the next twenty-five years (barring the development of engineering chemistry for which no provision is made) and allowance made for an expansion of over 100 per cent.

The following statistics show the rate of growth of the department:

A. Graduate Students.

Autumn Quarter	1916	69
" "	1917	60
" "	1918	43
" "	1919	87

B. Total Registrations (per year)

1892-93	131
1895-96	303
1898-99	548
1901-02	1173
1904-05	945
1907-08	1149
1910-11	1310
1913-14	1739
1914-15	1810
1915-16	2169
1916-17	2245
1917-18	1883
1918-19	2435

While both tables are impressive attention is called particularly to the large and growing graduate registration. With this, consideration should be given to the fact that we have 35 research men and women at work now, a number sufficient at once to fill half the research rooms provided for in the new laboratory.

b) The endowment for maintenance includes $2000 for janitor service, $2000 for laboratory service and $2000 for annual repairs.

c) The special endowments for staff may of course be secured as special gifts - the Research Professorship in Chemistry or the Professorship of Industrial Chemistry. Such endowments would be the best means for strengthening and expanding the present staff of the department.

Respectfully submitted by

Julius Stieglitz

Chairman of the Department
of Chemistry

December 15/19.

The University of Chicago

Department of Chemistry

January 5, 1920

Dear President Judson:

I am enclosing a list of people and firms who might be interested in the projected new chemical laboratory. I have limited the list to such firms as have had some connection or other with the Department. It could easily be expanded to include other prominent local firms which should be interested in the development of chemical research in this region.

I have never had any experience in the matter of solicitation of funds and I do not know whether it would be advisable to make it possible for individuals and firms to give endowments for specific purposes in connection with the new laboratory. I have thought it, however, possible to do this and am submitting an enclosed paper showing how endowments for specific purposes might well be distributed. Possibly such a plan would lead men who could give large amounts to be satisfied with smaller amounts. I am not at home in the psychology of such an undertaking. I have thought, however, that some of our alumni might be interested in giving the endowment for some of the research laboratories, the minimum for which would be $2500. A plan of this nature, according to which the individual laboratories would have the names of donors, has been used in connection with the Chemists' Club in New York. I do not know whether it has been used in any other undertaking of this kind and submit the idea for you to do with it as you see fit.

Yours sincerely,

Julius Stieglitz

JS/EL

Enc.

The University of Chicago

Department of Chemistry

January 5, 1920

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Yours sincerely,

Julius Stieglitz

JS/ML

Enc.

Distribution of Cost and Endowments.

1.	Research Library	$40,000
2.	General Laboratories for Organic Chemistry	60,000
3.	General Laboratories for Physical Chemistry	60,000
4.	General Laboratories for Inorganic Chemistry	25,000
5.	General Laboratories for Radioactivity	30,000
6.	General Laboratories for Industrial Chemistry	40,000
7.	24 Research Laboratories for individual students, at $2500 per room	60,000
8.	18 Research Laboratories for two students at $4000	72,000
9.	8 Research Laboratories and offices for staff members, at $8,500	68,000
10.	Research Laboratory for High Tension Electrical Work	15,000
11.	" " for Calorimetric Work	5,000
12.	" " for Low Temperature Work	7,500
13.	" " for Constant Temperature Work	7,500
14.	" " for Electrical Conductivity	10,000
15.	" " for Spectroscopy	5,000
16.	" " for Photochemistry	5,000
17.	" " for Microchemistry	5,000
18.	Seminar Room	10,000
19.	For service and General Purposes (General Fund).	100,000
		625,000

1. Mr. Ferdinand Schlesinger,
First National Bank Building, Milwaukee, Wis.
(Mr. Schlesinger might well be willing to interest some other gentlemen in the project. He is President of the Newport Chemical Company, Milwaukee, a leading dye and chemical manufacturing company, and has large steel, mining and similar chemical interests.

2. Mr. William Kent, San Francisco and Washington.
Mr. Kent might be interested in the remodeling of Kent Laboratory ($20,000) to meet the needw of the large numbers of students it is to provide for.

3. Mrs. Gustavus F. Swift, Mr. Loewenthal and Mr. William Hoskins (of Mariner & Hoskins) are Chicago donors of fellowships in Chemistry and have evinced a special interest in the department.

4. The following Chicago firms employing University of Chicago chemists might well be interested:
- Armour & Co.
- Swift & Co. (the chief chemist, Mr. W. D. Richardson, and other leading men of the chemistry staff, are U. of C. men).
- Morris & Co. (the chief chemist, Mr. John J. Vollertsen is a U. of C. man)
- Wilson & Co.
- The Lindsay Light Co. (The president, Dr. H. N. Mc Coy, the Secretary-Treasurer, Mr. O. W. Berndt, and practically the whole chemistry staff are U. of C. men).
- The Standard Oil Company of Indiana (Whiting). (Has often called upon us for their staff).
- The Illinois Steel Company, South Chicago.
- The Dearborn Chemical Company. (The chief chemist, Mr. D. K. French is a U. of C. man. The donor of the Willard Gibbs medal (Mr. W. A. Converse) is a director and a public spirited chemist.
- Special Chemicals Company, Highland Park, Illinois. (Mr. Carl Pfanstiehl, President, has often had the benefit of our advice - of course without remuneration.)
- Central Scientific Company.
- Jacques Manufacturing Company. (A baking powder concern).
- Sherwin-Williams Company (largest paint manufacturers in the world).
- American Cotton Oil Company.
- Sprague Warner & Company.
- Rueckheim Bros. & Eckstein (large chocolate & candy manufacturing house. The Chief Chemist, Mr. F. J. Seiter is a U. of C. man).
- The Western Electric Company.

William Wrigley Jr. Co. (Giom) Chief Chemist,
Mr. Parke H. Watkins, U. of C.

5. The following Chicago citizens, some of them chemists, might contribute or help interest others:

Mr. Stephen T. Mather, Assistant Secretary of the Interior, Washington, D. C.
(Mr. Mather a former resident of Hyde Park and a former Chairman of the Chicago Séction of the American Chemical Society, made his fortune as a chemist interested in the borax deposits of Southern California. He is a public spirited gentleman).

Mr. Lessing Rosenthal, Lawyer.
Mr. Tether, Past President, Chicago Association of Commerce.
Mr. Merrick, President of the Association.
Mr. Charles C. Kawin, Expert Steel Chemist.
Mr. William Redman, President, Redmanol Chemical Products Co.
Mr. Gustav Thurnauer, Aurora Metal Company, Aurora, Ill.

6. The following, resident outside of Chicago:
The E. I. du Pont de Nemours Co.
(address Mr. Irenee du Pont, Executive offices, E. I. du Pont de Nemours Company, Wilmington, Del.)
The National Aniline and Chemical Company, Buffalo, N. Y.
TheMallinckrodt Chemical Company, St. Louis, Mo.
The Goodrich ~~Rubber~~ Company, Akron, Ohio.
(We accorded the firm the countesy of a research laboratory and its facilities, April 1 to October 1, 1919.
Address: Dr. W. C. Geer, Second Vice-President, In charge of Development, B. F. Goodrich Co., Akron, Ohio.

7. The following alumni (in chemistry), could be interested either in direct contributions or in securing contributions:

Dr. R. F. Bacon, Ph.D. 1904, Director of the Mellon Institute of Industrial Research, Pittsburgh, Pa.
Dr. R. H. McKee, Ph.D. 1901, Professor of Chemical Engineering, Columbia University, New York, and Director of Research Laboratory, Tennessee Copper Company, Ridgewood, N. J.
Dr. Bernard C. Hesse, Ph.D. 1896, General Chemical Co., 25 Broad St. New York. (Dr. Hesse probably has an income of $20,000 to $50,000 a year and is childless).
Dr. H. N. Mc Coy, Ph.D., 1898, Vice-President of the Lindsay Light Co.

Dr. R. H. Brownless, Ph.D. 1906, Consulting Chemist, Pittsburgh, Pa.
Dr. Charles H. Viol, Standard Chemical Co., Pittsburgh, Pa.
Dr. Harry M. Paine, Ph.D. 1914, Research Chemist, Atlantic Dyestuff Co., Boston, Mass. New York City, N.Y.
Dr. Sidney M. Cadwell, Ph.D. 1917, Research Chemist, United States Rubber Company, (might interest the U. S. Rubber Company, which has a number of our men).
Mr. C. S. Miner, B.S. 1903, President of the Miner Laboratories, Chicago, Ill.
Mr. B. B. Freud, B.S. 1904, Professor of Chemistry, Armour Institute of Technology, Chicago.
Mr. Paul Van Cleef, B. S. 1905, M.S. 1906, Chicago.
Mr. W. D. Richardson, Chief Chemist, Swift & Company, Chicago.

AN EXHIBIT

Under the Auspices of
NATIONAL RESEARCH COUNCIL
Prepared by the
CHEMICAL WARFARE SERVICE
to Show the American People

WHAT THE CHEMIST HAS DONE

and

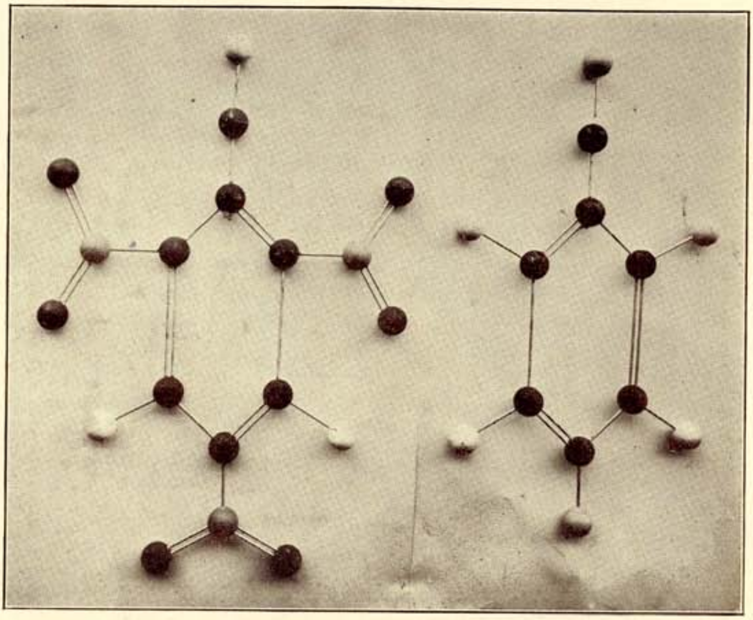
MAY DO FOR THEM

In War and Peace

THIS chemical exhibit is one in a series of popular scientific exhibits arranged under the auspices of the National Research Council, Washington, D. C., to emphasize the importance of fundamental research. It is the application of the results of such research by industry and the nation that leads to industrial progress and public welfare.

One of the greatest scientists has said:

"In our century science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring daily discussions of politics seem to be our guide. Empty appearances! What really leads us forward are a few scientific discoveries and their applications."



PICRIC ACID CARBOLIC ACID

To the chemist these models represent the molecules of two well known organic acids. Such models or diagrams are to the chemist what blue prints are to the builder. The balls stand for atoms, and if the arrangement of these atoms is changed the character of the molecule changes and with it that of the compound. In synthesizing a new compound the research chemist must first work out the design and then devise processes to turn out the desired molecule. In a pound of a certain dye there are estimated to be more than 40,000,000,000,000,000,000,000 complicated molecules and all built exactly alike—a feat seldom, if ever, accomplished outside of chemistry.

In the phenol or carbolic acid molecule there is a hexagonal ring composed of six carbon atoms and to all but one a hydrogen atom is attached. To that one there is a hydroxyl group consisting of an oxygen with a hydrogen atom. Besides being a disinfectant and medicinal, phenol is an intermediate product in making picric acid. Note that the difference is that every alternate hydrogen atom of the phenol molecule has been replaced by a nitrogen atom to each of which in turn are attached two oxygen atoms. Any other arrangement, no matter how slightly different, would not be picric acid.

Picric acid is used as a high explosive and as a dye. It is an intermediate in the manufacture of the war gas chlorpicrin.

There are about 250,000 known organic chemical compounds and two million theoretically possible.

WHAT THE CHEMIST HAS DONE AND MAY DO IN WAR AND PEACE

The Great War forced America into a new industrial field, the manufacture of organic chemicals. When our soldiers met the enemy on the battlefields of France they had to fight fire with fire and poison gas with poison gas. At the same time the home folks found themselves without the dyes and drugs that they had hitherto obtained from Germany. It became necessary then to create chemical industries of all sorts from optical glass to nitrates and this was done, but with haste and waste for enterprises which should have been a gradual growth had to be extemporized in a year. But by the time the fighting was over the gigantic task was accomplished and the United States was for the first time "free and independent" so far as most of the essential chemical products are concerned.

Now that we have got this chemical industry the question is, what shall we do with it? Shall we again place the weapons needed for self-defense in the hands of possible enemies and shall we once more turn over to our commercial rivals the keys to our most important manufacturers?

The answer to this vital question can only be given by the American people and they will only be qualified to decide when they know the extent and importance of the chemical industry and how it may be kept at home. If now it had been a piece of land that we had acquired through the war, say the little island of Yap, we could have kept it by a few forts and ships. But science is more slippery. It does not stand still but keeps moving —and in the case of chemistry moving very rapidly. The only way to keep it is to keep ahead in it. The American dye maker now has at his disposal all the German patents, but the German chemists have not stopped using their brains and unless we use ours we shall soon be left behind. Of what value was the best patent on a flint-lock the day after the percussion cap was invented? As soon as the Germans found out how to make artificial indigo, the indigo crop of India lost its value. The chemical industry is the offspring of science and dies if weaned from its mother.

We say "the chemical industry," not "industries," for although chemical products appear in the most various forms they are so closely related that they stand or fall together. From coal tar alone come thousands of compounds; dyestuffs of more shades and colors than can be found in nature, perfumes more pleasing than the flowers produce; medicines adapted to counteract the particular disease and modified to suit the idiosyncrasies of the patient; explosives of unprecedented potency.

The elements out of which these innumerable products are made are the commonest that the world contains; carbon from coal, oxygen and nitrogen from the air, hydrogen from water. The distillation of common coal in coke-ovens gives these four already combined in the compounds of coal tar. To the "Big Four" just mentioned may be added chlorine from the salt lakes and sulphur from the sulphur wells and such other elements as may be needed.

The model on the table shows the sort of a plant that any manufacturing chemist might envy but could not easily find, where the coal, sulphur and salt are on his own premises together with the water power necessary to run the establishment. In the middle of the table are the factories where these raw materials are combined; four groups of buildings looking much alike because they are much alike, yet, as the labels state, the first may be turning out "Explosives," the second "Pharmaceuticals," the third "War Gases" and the fourth "Dyes."

This correlation of the chemical manufacturers is a fortunate thing for it means that while we are developing one of our essential home industries we are at the same time making the most effective provision for national defense. A warship is of no use except for war. But a chemical plant producing dyes may readily turn out explosives in an emergency and the making of medicines must go on in peacetime and wartime. Young men drilled in the art of presenting arms and forming fours may never have occasion to use this knowledge, but young men trained as chemists may make the most effective combatants as well as the most useful of citizens. The development of American chemical industry is a policy that commands the support of pacifist and militarist as well as of all the rest of us who come somewhere in between.

The cost of a single battleship, some $30,000,000, would endow an establishment for chemical research such as the world has never yet seen, and the expense of keeping the battleship in commission, some $3,000,000 a year, allowing for depreciation, would pay for the education of all the chemists the country could need. The modern battleship is made as invulnerable as possible but the men on it are not invulnerable. No armor can keep out air and a ship does not have to be sunk if the crew is suffocated. A sharpshooter wastes no more ammunition on a riderless horse. A single airplane with a couple of men may sail over a warship at an unassailable height and besprinkle its decks with a liquid so corrosive that three drops of it touching a man's skin at any part will kill him and so persistent that such little of it as may be caught in crevices will render the ship uninhabitable for days. A 14-inch shell pursues a single course and when it explodes that is the end of it. An ounce of diphenyl-chlor-arsine, an innocent looking white powder, will keep up its bombardment for weeks and its molecular projectiles will fly around corners and into the smallest cracks.

Armored with such liquids and solids the airman of the next war will not need a machine gun or even bombs to attack the enemy underneath. He does not have to take accurate aim and calculate the allowance for wind, height and velocity. All he need do is to attach a sprayer to the tail of his machine and rain down poison on the earth beneath as the farmer kills the bugs on his potato field. Mr. Bradner, Chief of Research of the Chemical Warfare Service, stated in a hearing before the House Army Appropriations Committee on February 1, 1921:

> One plane carrying two tons of the liquid could cover an area 100 feet wide by 7 miles long and could deposit enough material to kill every man in that area by action on his skin.
>
> It would be entirely possible for this country to manufacture several thousand tons a day, provided the necessary plants had been built.
>
> If Germany had had 4,000 tons of this material and 300 or 400 planes equipped in this way for its distribution the entire first American army would have been annihilated in 10 or 12 hours.

Evidently we are in the midst of a revolution in warfare as great as that when guns and cannon supplanted the bow and spear. War has been a branch of applied chemistry ever since the invention of gunpowder. The recent and rapid development of this branch during the Great War, the use of noxious gases, is merely the introduction of a new weapon, more effective and no more cruel than the use of explosive gases. The German poison gas caused fifty times as many casualties among the American soldiers as the pistol, saber, bayonet, hand grenade and aviation bomb, all combined. But of the soldiers admitted to the hospital from gas injuries only 1.7 per cent died, while of the soldiers admitted to the hospital from other wounds 7.8 per cent died. The percentage of complete recovery is also in favor of gas. Of the gas cases 3.62 per cent were given disability on leaving hospital, while of the other wounded 13 per cent were discharged as disabled. Last December there were still some 5,000 soldiers remaining in the hospital from other injuries but only 4 gas cases. The experience of the Great War has demonstrated that Captain Mahan, representing the United States at The Hague Conference in 1899, was right when he protested against the proposed rule against the use of asphyxiating gases in war and argued that gas shells would be no worse than torpedoes and firearms. The only effect of the rule, which was adopted in spite of the opposition of the British and American delegations, was that when the Germans first sent a cloud of chlorine into the allied trenches at Ypres on the fatal morning of April 22, 1915, it found the British totally unprepared and all that the poor soldiers could do was to hold handkerchiefs over their noses. Some regiments were wiped out and if the Germans had pushed the attack they might have reached the sea.

Before the war all countries were largely dependent upon the nitrate beds of Chile for the nitric acid necessary for the munitions, fertilizers and various other industries. But in 1913 Professor Haber developed a process for fixing the nitrogen of the air in the form of ammonia and nitric acid. This made Germany independent of external sources for all nitrogeneous compounds for she had in the home atmosphere an unlimited supply of the free gas. If this process had not been known Germany would hardly have dared to challenge the world to combat, or if she had been so rash she could probably not have held out more than two years after the coast had been blockaded by the British navy.

The situation with reference to many pharmaceutical preparations at the outset of the war was such that America was dependent exclusively on manufacturers in enemy countries. The emergency, of course, required prompt and effective work on the part of American chemical manufacturers and as a result of this the market was soon supplied with the needed useful remedies. The first example of this is arsphenamine, more widely known as salvarsan. This preparation is one of the most difficult to produce in the whole range of pharmaceuticals, and the Germans fully appreciated that we could not produce it. But in spite of real difficulties involving much experimental work no less than four American firms were producing the drug before the end of the war. Also America is now making her own aspirin, acetanilide, atophan, and other synthetic drugs for which we were formerly dependent upon Germany.

The lesson of it is that any country that hopes to hold its own in peace or war must have an active chemical industry guided by scientific research and backed by patriotic public opinion. The chemist is by profession a futurist. He is more an inventor than a discoverer. He foresees what no one has yet seen. He constructs in advance a diagram picturing the structure of the molecule that he proposes to make just as a builder prepares a blueprint of the house to be erected. A period of investigation and experimentation often extending over years must precede the commercial development of a new process or product. Commercial chemistry is an applied science and a science must exist before it can be applied. That is why the countries that have made greatest progress in the chemical industries, such as Germany, have spent most money on research and that is why America must have similar research establishments if she is to keep up with the procession.

EDWIN E. SLOSSON.

Science Service,
Washington

THE CHEMICAL EXHIBIT

The main feature of the exhibit is a topographic model, 7 feet by 12 feet, of an idealized group of chemical industries whose development and maintenance are essential for adequate national defense. The outer portion of the model shows the plants and equipment required for the production of some of the more important crude materials which are required by the chemical industries. This includes models of sulphur wells; a sulphuric acid plant; a coal mine with the usual equipment for sorting and handling coal; a by-product coke oven with stills and storage tanks for the various crude products obtained from coal tar; a hydroelectric power plant which supplies electric power to a plant for the production of nitric acid from atmospheric nitrogen and also to an electrolytic chlorine plant from which caustic soda and chlorine are produced by the electrolytic decomposition of salt; and salt wells which provide the salt for the chlorine plant.

The above group of plants surrounds what may be called the heart of the chemical industry; that is, the plants which produce the intermediate and finished chemical products. The group of buildings representing the production of the intermediate chemicals are situated near the center of the model. Radiating from the intermediate chemical plant are four separate groups of factory buildings. One group represents an industry for the manufacture of dyes; another for explosives; another for pharmaceuticals and medicinals; and another for war gases. All of these four industries use the same chemical intermediates for the production of their finished products.

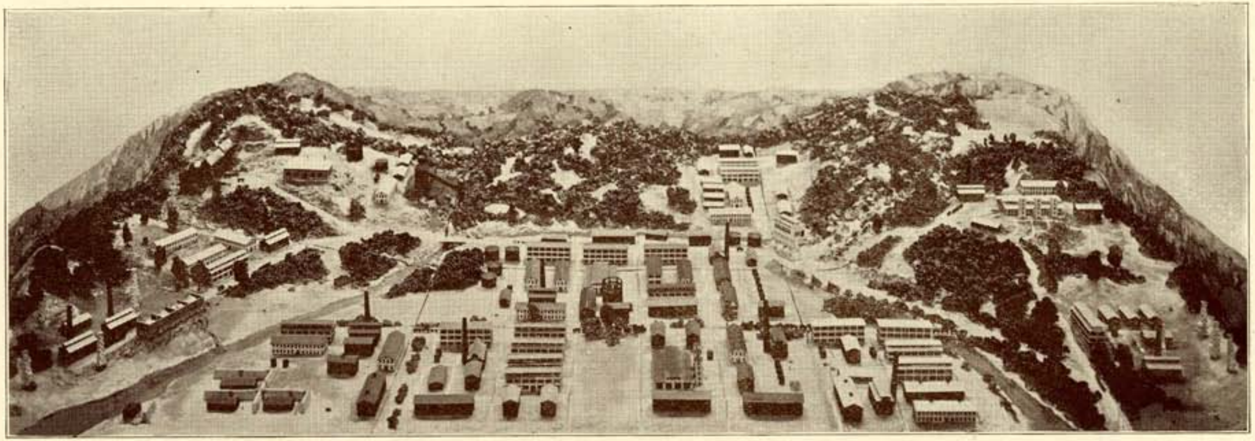
Back of this model are four charts showing some of the intermediates and finished products obtained from each of the four crude chemical materials—sulphur, salt, coal, and atmospheric air. On these charts actual samples of the chemical substances are attached.

Other features of the exhibit are: a group of the various appliances used in offense and defense chemical warfare; collections of some of the more important dyes; war gases; explosives, and pharmaceuticals derived from coal intermediates, and models to show the molecular structure of these chemicals. These models are the "blue prints" from which the research chemist works in so changing the molecules as to develop new dyes, war gases, medicinals, or explosives.

It may not be generally known that even our Government had to go begging to Germany for dyes following the outbreak of the European War so as to be able to continue the printing of its postage stamps. You remember how the shop men informed you that they would not guarantee the fastness of certain colors. Even today our textile trade is suffering because of the bad impression which it made in South America by exporting poorly dyed materials. But the American dye manufacturers have made wonderful progress, as the complete range of colors of American made dyes in this exhibit indicates. Dye patterns are also shown. The economic importance of the dye industry and its close relationship to many other industries have made the dyestuff industry a pivotal one whose reasonable safeguarding should have the assurance of the American people.

The Genealogical Table of the Chemical Industry

The following diagrams have been prepared to show how closely related are the various branches of chemical industries and how a few fundamental raw materials may be made into many useful products. The arrows indicate the order of synthesis, or the development that comes from special treatment or combinations. For example, from nitrogen, which comes from air, we get later by different processes an anaesthetic, an explosive, a war gas and a smokeles powder. Thus, by various reactions, thousands of products come from a few simple ones.



Topographic Model showing the Intimate Relation between the Coal Tar and other Industries.

PLAN OF BUILDINGS

Coal Mine By-Product Coke Ovens Nitric-Acid Plant Hydro-Electric Power Plant Chlorine Plant

Sulphuric Acid Plant Intermediates Plant Salt Wells

Sulphur Wells Explosives Pharmaceuticals War Gases Dyes

WHAT COMES FROM COAL, SULPHUR, SALT AND AIR

The photograph represents an idealized group of chemical industries such as are required in the production of dyes, war gases, pharmaceuticals and explosives. The model plants which produce the crude chemicals required are located on the outer portion of the topographic model, at the back and on the two sides, while the plants for the production of intermediates and finished products are in the center extending to the front of the model.

At the left hand lower corner of the model is represented a group of sulphur wells with the accompanying power houses and storage bins such as are found in Louisiana and Texas where native sulphur is pumped to the surface from deposits hundreds of feet under ground.

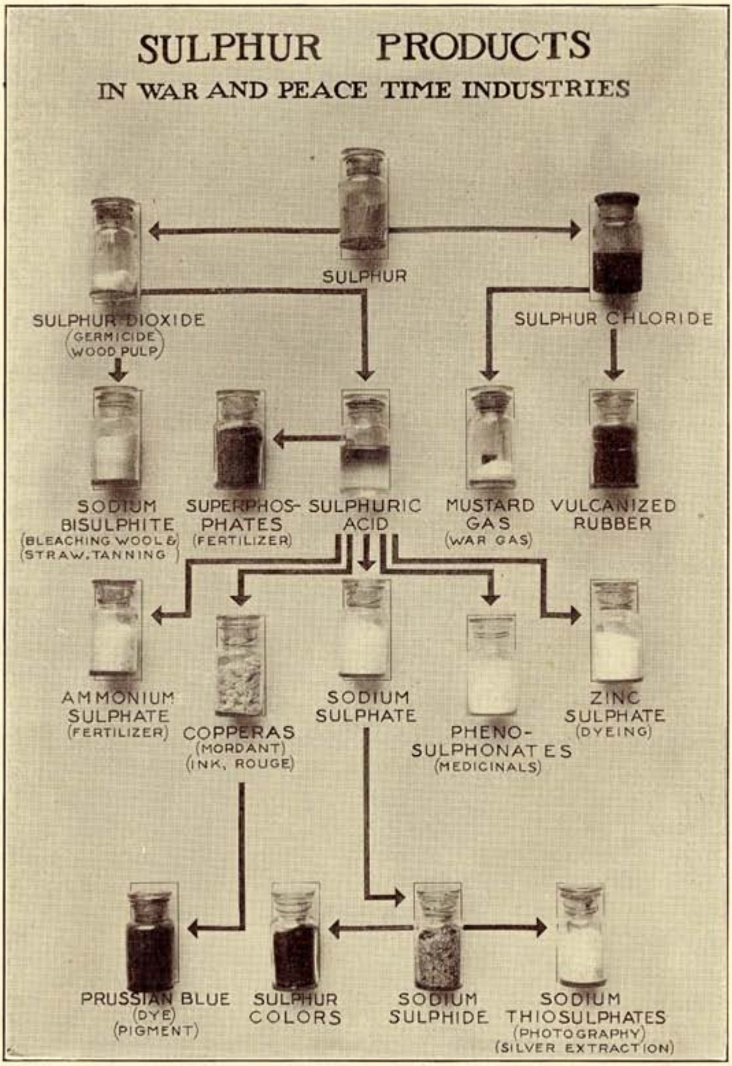
Adjoining the sulphur wells is a sulphuric acid plant where sulphur is burned to sulphur dioxide which in turn is oxidized in the presence of catalytic platinum to form sulphuric acid.

Back of the sulphuric acid plant in the far left hand corner of the photograph is a coal mine with a tipple and accessories which is the original source of coal tar crudes, the coal being distilled in the by-product coke ovens, located in the model at the right of the coal mine. The chief crudes obtained from the coal are xylene, benzine, toluene, napthalene, carbolic acid and anthracene.

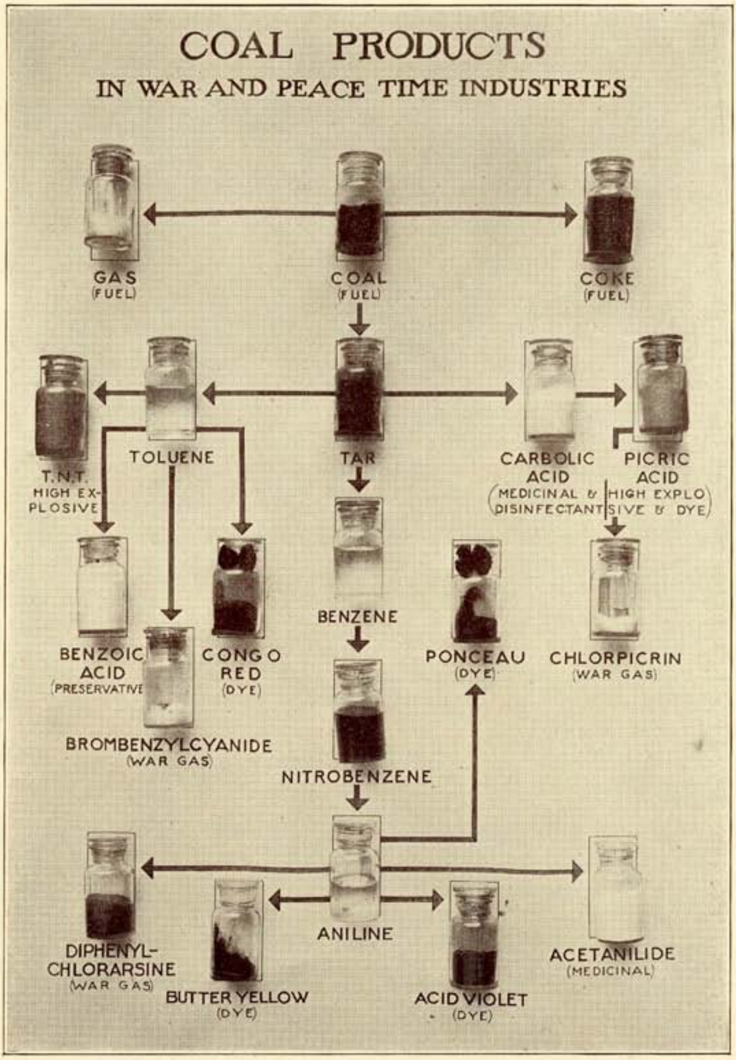
At the right of the coke oven is the fixed nitrogen plant where atmospheric nitrogen is converted into ammonia, nitric acid and ammonium nitrate. The electric power for this plant is supplied by the hydroelectric power plant located on the river below the falls. Power from this plant is also supplied to the electrolytic chlorine and caustic soda plant located on the hill to the right. The salt for the chlorine plant is obtained from the salt wells situated at the right hand lower corner of the model.

All of the crudes mentioned above are carried by miniature railways and boats to a large group of factory buildings in the center of the model where they are subjected to various chemical processes and thus transformed into the different intermediates.

Radiating from the intermediate plant are four smaller plants (in the front portion of the model) one for the production of explosives, another for pharmaceuticals and medicinals, a third for making war gases and the fourth for the production of dyes. All of these four plants use the same intermediate chemicals, but by using suitable combinations of the chemicals and subjecting them to the required processes, the four different types of finished products mentioned are obtained.

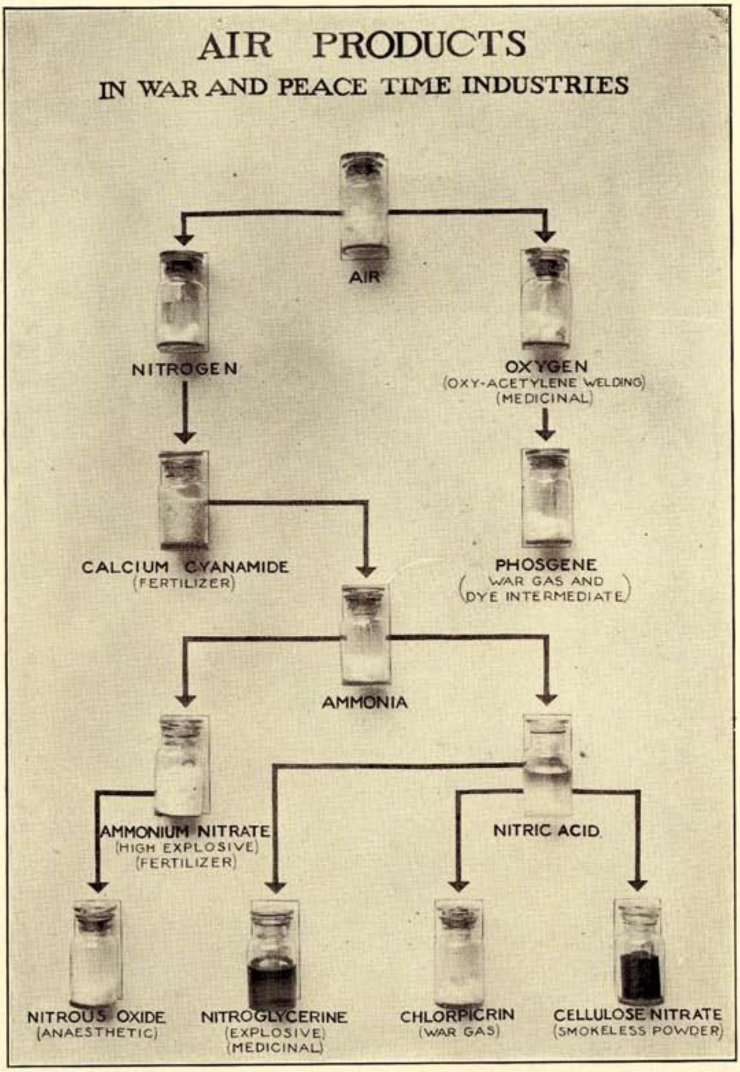


Sulphur enters into a large number of intermediates and finished products employed in the arts. By treating sulphur with chlorine we get a liquid, sulphur chloride, which is used in making the war gas, "mustard gas," and also in the vulcanization of rubber. Then, by burning sulphur in air sulphur dioxide is formed, useful as a germicide and employed in the manufacture of paper from wood pulp. By other chemical reactions we get products that are used in bleaching, tanning, photography, and in the manufacture of fertilizers, medicines, dyes, inks, etc. The chart indicates merely a few of these.



Thousands of products are obtained from coal. By distillation comes coke, illuminating gas, and tar. The latter gives us a large number of what are called "crudes." By nitration we obtain from one of these, toluene, the high explosive trinitrotoluene (T. N. T.), by oxidation the preservative benzoic acid, and by other treatment the dyes, Congo Red and Patent Blue, or the war gas, brom-benzylcyanide. Benzene, by nitration, gives nitrobenzene and from that we get aniline, the base of various dyes, such as Butter Yellow and Acid Violet, the war gas diphenylchlorarsine and the medicinal acetanilide.

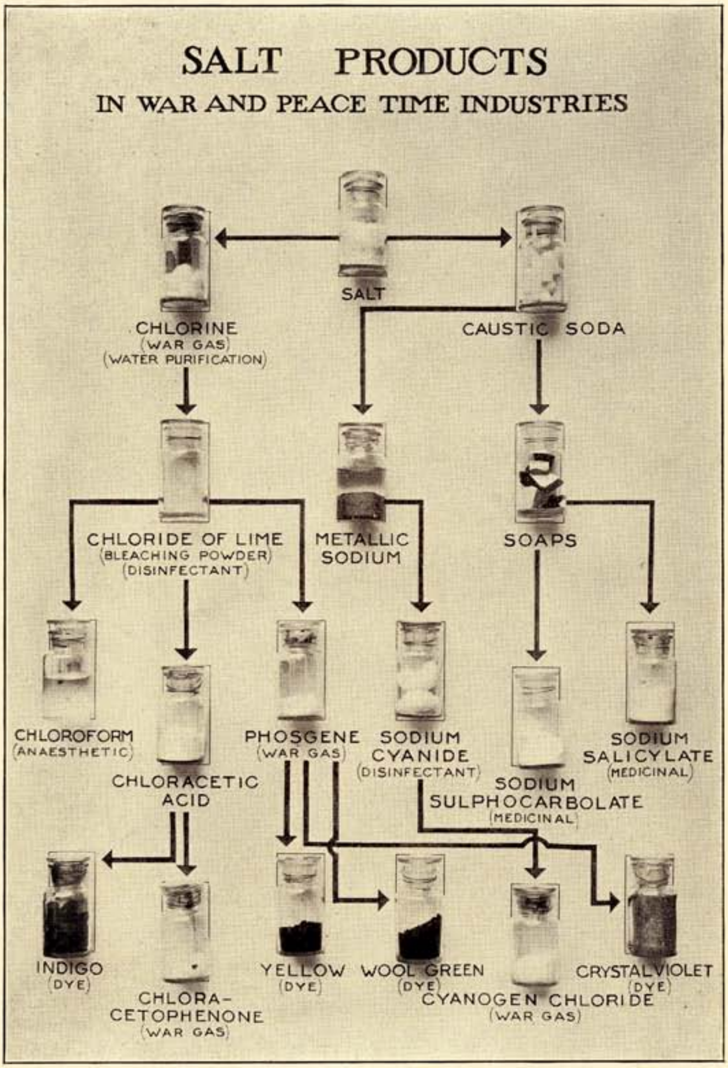
A large number of other products are obtained from the crudes shown on the chart, and an equally large number can be obtained from the other crudes, such as xylene, napthalene, etc.



When air is liquified it is readily separated into its two main constituents, oxygen and nitrogen. The accompanying chart illustrates a few of the uses for which these elements and their products are employed.

Oxygen is used in the oxyacetylene welding of metals, as a medicinal, and in the synthesis of phosgene, a war gas and dye intermediate.

Nitrogen combines with calcium carbide to form the fertilizer, calcium cyanamide, from which the important chemical, ammonia, is obtained. Ammonia in turn is used for the production of ammonium nitrate, a high explosive and fertilizer, from which the anaesthetic, nitrous oxide, is obtained, and nitric acid which is used for making explosives such as nitroglycerine and cellulose nitrate, the war gas, chlorpicrin, and in the synthesis of dye intermediates such as aniline.



The two main products of salt are chlorine and caustic soda, which are obtained by the electrolytic decomposition of brine (salt solution). Just a few of the products obtained from these and their use are indicated on the chart. One does not always associate the production of a deadly war gas with the extraction of gold or the manufacture of soap, but the arrows show the relation. Then, too, few people may think that the same chlorine which was one of the principle materials required in the war gas program has also wide use in drinking water purification and by various treatments gives us such important products as chloroform and synthetic indigo.

From

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What a Chemist Ought to Know

Compliments of
The author

Lecture delivered
by
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Director of Laboratory of
Toch Brothers
Etc., etc.

Cooper Union, February 20, 1920

What a Chemist Ought to Know

By

MAXIMILIAN TOCH

Cooper Union, February 20, 1920

Twenty-five or thirty years ago the four year course in chemistry in the United States contained a number of irrelevant subjects, and the actual time Chemistry was taught in the four years was probably not more than a year and a half. Subjects like French, German, Higher Mathematics and Drawing from Casts were included, and some of the subjects took up many more hours than the actual study of Chemistry itself; with the result, that when a man was graduated he had a fair knowledge of Analytical Chemistry, and that was all.

I recall a case where a young man went to the President of a University, and explained that he spoke French and German fluently and that he was more than an ordinary draughtsman, having earned a considerable salary during his Summer vacations at that trade, and he wanted to be excused from these subjects so that he would have more time to devote in the Laboratory; but the President told him that the curriculum was mandatory and that if the student did not like it, he could go elsewhere.

My own case was quite similar. After frittering away a great many hours during the day in subjects which I now know, and which I then thought, were irrelevant, I spent my evenings at Cooper Institute, and during the five years that I went steadily to the Night Classes, after working at the University all day, I learned more and was better fitted for my future career than had I spent my time in the pursuit of subjects which have little or nothing to do with Chemistry.

The bane of most students is the study of Higher Mathematics, and the reason always given is that it develops the intellect more than any other subject. I never could see this, and I have not found any chemist—and I know a great many of them—who, in purely industrial pursuits, has found Higher Mathematics essential.

One of the principal troubles, and the reason why students dislike Higher Mathematics so much, is that unless they are born mathematicians they cannot understand the problems at the age at which they are supposed to recite them.

The same statement applies to the study of Grammar; for, in the American schools, Grammar is taught at such an early age it is utterly impossible for scholars to correlate the rules of Grammar with rapid speech; and the worst of these subjects is that any scholar who possesses what is known as a stage memory shows up so brilliantly at examinations that he or she will graduate with honors when, as matter of fact the subject under examination is not understood.

The professional man whose mind is developed the most is probably the lawyer. A lawyer of middle age and vast experience has a mind so thoroughly trained that he becomes, probably, fitted for any position, whether it be the head of a corporation; the adviser to great business interests; or the defender or prosecutor in court of cases involving vast fortunes; and yet, in the curriculum of the study of law neither languages nor Mathematics enter, although the knowledge of both may be useful.

Among my acquaintances are several actors, and I have always taken a great deal of interest in speaking with them in order to find out whether their mentality is of a high order of development, or whether their art of mimicry is a matter of birth, and I am forced to the conclusion that many an actor who can study two hundred pages of manuscript by heart in a few weeks can study plane and solid geometry, without having the slightest notion of what the problems mean, walk up to a blackboard and recite orally and graphically one theorem after another, and pass a brilliant examination.

Mental development goes with age, just the same as physical development does. You could not train a ten-year-old boy to drive spikes on a railroad with a twenty-pound sledge hammer; but, analogous, mental acrobatics are attempted in schools where subjects are taught that are not understood.

I remember some years ago a very interesting case of where two men were shooting at long range across a lake. They did not know the range, and one of them stated that he was going to measure the distance accurately, and the other one said it would be a most difficult thing to do; that it would take a very long time; because they would have to get a thousand yards of cord, or more, and then row across the lake to the target. The other man explained that it would not be done that way at all—it was simply a question of drawing the base of a triangle on the ground and having the right angle line and the acute angle line converge accurately to the target, and then if a simple calculation were made, by the well-known method of triangulation, the distance to the target was easily figured, and when the base of the triangle was plotted on the ground the other man "saw" exactly how it was accomplished.

This, as you will remember, is a well-known theorem in geometry, which students learn by rote, and not until the mind properly develops is it understood. So that, I believe much of the time that is spent in Mathematics is wasted and can do the chemist no good in future life, and from my experience I must conclude that the study of Chemistry itself, particularly Analytical Chemistry, is the greatest intellectual developer for the chemist.

Do not misunderstand me that I am against the teaching of Mathematics, or any other subject which will develop a man's intellect; for, to paraphrase a Mohammedan saying, "No man carries a heavy burden who has knowledge." But—the point I wish to make clear is, that subjects like Algebra and Geometry, Ornamental Drawing, Grammar, Rhetoric, Composition and Languages should be studied before the student enters upon his practical course.

I feel as if I am particularly qualified to say what a chemist ought to know. Twelve or thirteen years ago it appeared that many unemployed chemists came to me, or to my friend, the late Professor Morris Loeb, of New York University, and we got into the habit of conferring frequently on what to do for these men who were looking for positions, because some of them were equipped for industrial work and others were not; and at last we decided to establish a Bureau of Employment at the Chemists Club, and we instituted a card system, and every man who came to us for employment had to tell us something about himself. In that way, men from Europe, and men from almost every institution of learning in this country came under our observation, and both of us were very much astonished at how little Chemistry some of them knew and how many nearly related subjects they were proficient in.

In passing this subject I must say that the Bureau of Employment of the Chemists Club finally grew into an institution with a Director and a staff of employes, and during the war, when the Government needed chemists, and since the war, that Employment Bureau was one of the important factors in placing the chemists where they belonged.

I have also employed a great many chemists in my time in my own business, both in the Laboratory and in the Works, and it struck me most forcibly that the men who had a good ground work in theory and were handy with tools, and who knew the value of time, made the best industrial chemists.

Speaking of knowing the value of time, that is one of the most important things that a chemist ought to know. There are many cases in Industrial Chemistry where a quantitative analysis cannot take more than ten minutes. I refer to reduction work, where, say a Sulphate is reduced into a Sulphide by means of coal and heat. You may suddenly find a drop, in the reaction, to 50% which ought to be 65% or 70%. The chemist has to analyze a batch between the time of loading one furnace and emptying it, and he must be able to put his finger on the sore spot, or else hundreds of dollars go to waste within the next three hours; and it is a very good plan for a man to train himself so that he works rapidly and accurately, and that he knows the difference between two kinds of accurate work. You could spend one whole day making an analysis of an iron ore, and the result, say, will be 76.4625, and you can do the same thing in twenty minutes and get a result of 76.5, and you will find that the approximate result of 76½% will be accurate enough for all purposes, whereas the one brought out to the fourth decimal is of no greater value, and has the additional feature of the waste of time against it.

A practical education is necessary in the preparation for practical life. Before the war, when I was more conversant with German affairs than I am to-day, I always understood that a Doctor of Medicine in Germany and Austria started his career at sixteen and studied twelve years until his final graduation. A lawyer in Germany did practically the same. In the curriculum of the physician four years were spent in the study of Latin and Greek, Latin particularly, and several reasons were given—first, because the prescription should be written so that the layman could not understand; and secondly, that the physician, in quoting Latin impressed those around him with his profound learning; and yet, I need not waste any argument in trying to convince you that the knowledge of Latin and Greek, or any other language, has never aided in a single cure of a human ill.

The German barrister is really a highly educated man, taken from the standpoint of knowledge of History, Economics, Jurisprudence and the decisions of learned Judges in noted cases; but, with all this profound learning of twelve years, the German barrister is no better than the American lawyer, and the German has the handicap of having wasted many years. The American has to spend a certain number of years at college, if he so elects, and a certain number of years in actual practical procedure, and arrives at the same goal.

We have in the State of New York a Code of Civil Procedure, which contains over thirty-three hundred sections, giving methods of procedure in every possible case that may be brought before the law, and it is utterly impossible for any student to master any great number of these; and yet, a student with the so-called Stage Memory could pass a better examination on the Code of Civil Procedure than the man with brains who has the practical experience of knowing the details in a general way.

The same token applies to Chemistry, and it is utterly useless at a year end examination to determine the ability of a man simply because he is able to recite the atomic and molecular weights, which he has studied by heart.

Thirty-five or forty years ago there were only two kinds of chemists—one the Professor of Chemistry and the other the Analytical Chemist. There were few if any factories controlled by chemists. I have recited the case elsewhere where in the manufacture of pigments all the work was done by rule of thumb, and manufacturers or foremen purchased formulas, and as long as things went along well the horizon was clear, but when batches were ruined there was nobody to correct them, and, as an example, I will only relate one of a friend of mine, who was a competitor and a large manufacturer of dry colors. He explained to me that he made over a million pounds of Chrome Yellow, which, as you know, is a Chromate of Lead, and he did not make any money, because when the year was around he found that his raw materials cost him as much as he had to sell his finished product for, and he asked me to investigate to see whether there was something wrong. He had no chemist other than a man who did routine analytical work and whom the foreman would not allow in the factory proper. But it did not take very long to find that the two solutions which he used for making Lead Chromate were not properly balanced, and that his profits were running into the sewer every year in the form of unused Acetate of Lead. Before this man died he had a first-class chemist installed, who not only stopped that leak, but discovered many others, and to-day this concern is a growing money making firm.

As a matter of fact, when I was a student the pigment industry was empirical from start to finish, and many of the older men looked at me askance, and to this day they probably feel that I have given away sacred secrets in publishing chemical facts with relation to the manufacture of pigments, but which every chemist ought to know, as a matter of course.

The Rubber Industry is one of the enormous industries of the United States, and Analytical Chemistry plays an important part in the purchase of raw materials. There are very few of the large rubber concerns which maintain research laboratories, but the belief in the scientific management of the Rubber Industry is growing fast, and when I enter upon my career here as Professor of Industrial Chemistry, that will be one of the subjects which I will outline to you, for I am sure that every rubber factory, no matter how small, will welcome more scientific control than they at present have.

The Motion Picture Industry in the United States is, I understand, the third or fourth industry, and I am reliably informed that in 1919 $850,000,000 were paid in admissions alone to the motion picture theatres. The motion picture producers are already looking around for men who understand Photographic Chemistry, in order to eliminate waste and prevent failures, for there is no industry in the world in which money is lavished to such an extent as in the motion picture field. Nor is there an industry, not excepting the Automobile Industry, which has grown as fast as that has. Most everyone to-day is familiar with photographic developers, and some of us even go so far as to make up two or three litres of stock developer. The amount of motion picture film developer used is so great that there are many concerns who use up thousands of gallons of developer a week, and a number of them still do it empirically. Here is a great opportunity for chemists to put this industry on a scientific basis, and a chemist who is worth $5,000 a year can save many times his salary in the scientific control of the materials used in the motion picture laboratory.

A chemical student should be so educated that he may be an analyst, if he wants to, or he may be an instructor, if he so elects; but, he should also realize that to-day many large establishments have chemists as salesmen; Presidents of big corporations have chemists as Assistants; Purchasing Agents are either chemists or have chemists associated with them; and all big buinesses, excepting the purely mechanical, have chemists in a managerial capacity, whether as Foremen, Superintendents or Managers, but they all need at least analysts to control the quality of purchase and sale.

Mr. Ellwood Hendrick, President of the Chemists Club, wrote a very delightful little book called the "Percolator Papers," and one of the essays is on the "Sense of Smell." Mr. Hendricks says, among other things, "that the sense of smell in the human being is not thoroughly developed, for every human being has a distinctive odor, just as distinctive as his finger-prints, and if you don't believe it, ask any dog." This, of course, is perfectly obvious, and our sense of smell is not highly developed. In fact, nearly every animal has a keener sense of smell than the human being. Yet, it is of paramount importance for the chemist to familiarize himself with the odor of any chemical that is distinctive, as far as that is possible.

You will find out before you are much older that there are many things that you cannot analyze by routine methods, and you will also find out that many things have to be synthesized in order to get at their approximate composition. This is particularly true in Organic Chemistry, where materials like the Resins change their composition, upon being heated do not crystallize, become insoluble and are generally refractory in every sense of the word, but many have distinctive odors —and sometimes after you do analyze a material and want to prove it up by making the synthesis, you find that you strike most alarming difficulties, just like every one of us has taken a watch apart at some time or other, but how many of us were able to put the watch together again? We always had two or three wheels left over. It happened that during the war the Navy Department took over the City of Norfolk and started to build a large encampment adjacent to a cotton oil mill, and they found to their dismay that on certain days when the wind blew in a given direction the air over the encampment was intolerable, and it was impossible, as far as they had gone, to trace the cause and eliminate the defect. So they sent for a chemist and asked that he make an investigation, and as soon as the chemist arrived on the scene and had a whiff of the odor, he said at once, "I have not smelled this odor for many years, but this certainly is not from a cotton oil mill. This is a material called Mercaptan."

Now, Mercaptan is an organic sulphur compound, which is rather rare, but once you have smelled it, your olfactory memory becomes infallible. In fact, it is such a disagreeable odor that you want to run away from it. It did not take this chemist long to find out that there was a pulp paper mill, where Sodium Sulphide became impregnated with some of the organic materials, that produced the odor in question, and it was not very difficult to devise a plan to stop the nuisance.

Every sense activates a corresponding memory, but the sense of smell, sense of sight and sense of hearing are the strongest exciters of memory. You may forget what you hear; you seldom forget what you see; you never forget what you smell. That the sense of sight is coupled with memory is one of the real reasons why chemistry is so largely taught through experiments, but I am for encouraging the training of the sense of smell as an additional factor in knowledge.

There are many sciences which a chemist ought to know, and Microscopy is one of the most important. Even though Prohibition has come to stay, the Fermentation Chemist has not lost his usefulness by any means, for there are other very important branches of Fermentation Chemistry besides that of making strong drink. The baking of bread and the making of cheese, two important industries in any country, are now no longer empirical, but successfully handled by the chemist.

Bacteriology is a branch of Chemistry, and every chemist ought to have at least three months' training in that science, for some time or other he will find it will come in handy.

Photography, Spectroscopy, and Pathological Chemistry, such as the analysis of urine, blood, etc., are all subjects which are of great use to the chemist, and elementary instruction in these branches does not consume a great amount of time.

There is a popular impression that Photography is one of the simplest arts in existence, and it is quite true that it has been simplified, owing to the wonderful initiative of some large and enterprising manufacturers of photographic films and accessories. Yet, when the chemist comes to photograph with a microscope, he has to know quite a little more than a push-the-buttonist, for, as has developed in later years, great detective work goes to the chemist practically before it goes to anyone else. It is quite up to the chemist to be able to differentiate on account of his superior knowledge.

I was told of a very interesting case of where two exceedingly expensive and rare postage stamps were in dispute. It appeared that only one of them could be genuine, and, by what is known as the very simple method of orthochromatic photography, it was quite easy to establish that the two stamps were not alike, because, under similar conditions and with similar screens the results were dissimilar.

So, summing up, what a chemist ought to know, my first impression is that he ought to have excellent ground work and what might be called a classical education—History, Rhetoric, Composition, Languages, Mathematics—in fact, he ought to be able to pass an examination such as the Regents impose on every University entrant and then, as soon as he is admitted to a School of Chemistry, his entire time should be taken up with Chemistry and related subjects—Electricity, Physics, Microscopy, Photography, etc., for he should be made to know that after he has been graduated he may become a salesman, a manufacturer, an assistant manager, a purchasing agent—in fact, he may occupy any one of a dozen positions other than that of a pure analyst in a Chemical Laboratory.

So, let his education be such that it will comprise as many subjects as he can possibly absorb during his college career, and if he has any spare time, let him take up subjects like Literature and Art, so that when he comes in contact with cultured people he may know things besides Chemistry, for he at all times should strive, in addition to his science, to be and maintain himself, a polished gentleman.

From
CHEMICAL
FOUNDATION
81 Fulton St.
New York City

"Shall America Remain the Only Important Country at the Mercy of the German Chemists?" Address by Joseph H. Choate, Jr., Counsel, The Chemical Foundation, at 21st Annual Meeting of the National Civic Federation.

The first question the subject allotted to me today probably suggests to you is whether we are in fact at the mercy of the German chemists. There is no doubt, unfortunately, that we are, and the first thing I must do is to make clear to you why I think so.

In the work of the Alien Property Custodian, it fell to me to investigate the German control and ownership in the American chemical industry, and there I discovered an extraordinary situation of affairs. In the simpler forms of the chemical industry, the manufacture of heavy chemicals, of the acids which are at the root of most of our manufacture, of such bulk products as soda, in the electro-chemical industries, in the manufacture of liquid chlorine, in the electro-metallurgical industries, even in the manufacture of wood alcohol, we could hold our own with any one. But beyond the point where those comparatively simple industries ended, there began the great and extraordinary world of organic chemistry, in which our industry was absolutely in its infancy. Organic chemistry is primarily the chemistry of hydrogen and carbon, and of one or two other elements with which those two combine in infinite variety. Almost every substance which forms a part of any living being has its origin primarily in some combination of those substances. They combine with each other, and with other elements in such infinite permutations and combinations, that in the old days it used to be supposed that the extraordinary results which are produced by the chemical factories of our bodies could only be accounted for by some magic of the life principle. Thus the branch of chemistry which studies

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The single industry which brings into play all the resources of this extraordinary world of science is the dye industry. In that industry, out of that unpromising material, coal tar, that sticky residue left after the distillation of gas from coal, are produced all the dyes which go to the coloring of all the substances we use in this world. The commercial complexity of the industry is almost beyond belief. Before the war one German factory manufactured habitually 11,000 different colors, most of which were different and definite chemical substances; not mere mixtures of shades such as an artist makes, by mixing various colors, upon his pallet, but different chemical materials, each distinct from the rest. Each of those substances was the result of a different process of manufacture. Starting from the ten so-called crude substances, naturally contained in coal tar, these substances are built up by a series of consecutive reactions. As a consequence, the complexity of the industry as a form of manufacture is, again, beyond belief. To produce each of these 11,000 different substances, that German factory had probably to produce several by-products, which at the start nobody wanted. Uses had to be found for these innumerable by-products. Methods of avoiding waste in their production had to be found. The problems thus presented offered by far the greatest field the world has ever known for the services of the research chemist; and the result of that was that in the German dye industry probably a hundred research chemists were employed for one employed in any other single industry in the world. These chemists are constantly at work obtaining, maintaining and correlating a mass of scientific

information such as the world has never known before, information which was capable of making, and which did make, every German industry more efficient than it had been before and which, so far as it was allowed to leak out, furnished the world with a mass of scientific material on which half of our industries are based today.

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That was the extraordinary situation of the German industry. It had, in the field of dyes, a world monopoly. It furnished dyes for all mankind. We had a little industry that put together German materials that were already, when imported, almost finished products. The Swiss had a little industry, and outside of that everything that had to be colored in the world had to be supplied with color by the Germans. Now, see what that meant. In the first place, industries of ours which use coal tar colors produce each year about three billion dollars' worth of goods. Unless they can get the colors, those industries cannot go on. When we went into the war, and when the Germans purposely withdrew their supplies of dyes from us, admittedly in order to try and force the hand of our State Department into bringing pressure on the British to break down the blockade, our entire textile industry, our leather industry, our paint industry, our ink industry, and all the other industries which make up this three billion dollars' worth of products a year, were helpless, and had it not been for the fact that the war itself and the British Navy shut out the importation of competing German products in these lines, we should have had either to give up the use of colors, or surrender without discretion to the Germans.

Now, the Germans had been practicing this extraordinary industry for forty years. They had acquired a fund of experience in addition to their extraordinary mass of scientific knowledge, which rendered them absolutely and beyond competition, first in the industry.

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I think I must illustrate at some length to you what information such as the world has never known before, information which was capable of utility, and which did make every German industry more efficient than it had been before and which, so far as it was allowed to leak out, furnished the world with a mass of scientific material on which half of our industries are based today.

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That was the extraordinary situation of the German industry. It had, in the field of dyes, a world monopoly. It furnished dyes for all countries. We had a little industry here and there, putting together German products that were already, when imported, almost finished products. The Swiss had a little industry, but outside of that everything that had to be colored in the world had to be supplied with colors made by the Germans. Now, we must bear that in mind. In the first place, something of what that means. In this country each year about three billion dollars' worth of goods which they can not get unless they can get the colors, these colors imported or not. When we went into the war, and when the Germans practically withdrew their supplies of dyes from us, absolutely in order to try and force the hand of our State Department into bringing pressure on the British to break down the blockade, our entire textile industry, our leather industry, our paint industry, our ink industry, and all the other industries which make up this three billion dollars' worth of products a year, were helpless, and had it not been for the fact that the war itself and the British Navy shut out the importation of competing German products in these lines, we should have had either to give up the use of colors, or surrender without discretion to the Germans.

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I think I must illustrate at some length to you what that experience means, and why it means what it does, why it gives the Germans an advantage which cannot possibly be compensated by anything except like experience. When you set out to make a dye, you have to carry out eight or possibly ten or twelve consecutive reactions. You take two or three comparatively simple substances and stir them in a vat, and apply certain conditions of temperature and pressure. A reaction takes place, the original substances are destroyed, and you get two or three new substances. Perhaps only one of those is what you want. You mix that one with other substances, and start a new reaction, and you get a new lot of substances, of which perhaps, again, only one is what you want. By the time you get through with your eight reactions, you have only a fraction of your original material left. But the difficulty is that each of these reactions can by skill be controlled so as to produce much or little of the desired product. The atoms of carbon and the other elements which go to make up these various substances have an extraordinary affinity for each other. Given the proper propinquity, each of them will marry the right mate. But they resemble human beings, our daughters and sons, in that propinquity is not enough. The other conditions must be right. If you bring your atoms together at the right place and time, but at the wrong temperature nothing will happen. Vary the temperature in the wrong direction and instead of making the right marriages, the atoms will rush in and marry the wrong fellow, and you will get a new family of substances that you don't want. Instead of getting 100 per cent. of what you should get in your reactions, you will get perhaps 10 per cent., with 90 per cent. of undesirable citizens.

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The minuteness of the variations in the processes which make these enormous differences is again almost incredible. In the testimony before the Senate Committee, Mr. Klipstein brought out the fact that, after struggling for a year with a difficult dye and getting only 10 per cent.

yields, when he should have got 90 per cent., his yields were in a single day brought up from 10 to 90 per cent. by one change in his method of manufacture, and that change you could not guess in a thousand years. It consisted in the decrease of the speed of the paddles which stirred materials in his vats, in one stage of the process, 5 revolutions a minute. At 65 revolutions a minute he had 10 per cent.; at 60 he got 90. That kind of knowledge is not in the books and cannot get into the books. It is in the minds of the foremen who have stayed in the same place and watched the same reactions go on for years, and in some cases for generations; who know what it means when a particular sort of bubbling goes on in the vat, and how to stop reactions when they have gone far enough, and what all the symptoms that develop before their trained eyes mean, things that are utterly meaningless to a man who is a beginner in the industry. For that reason the American industry, although amply provided with the most skilled research chemists, cannot by any possibility hope to rival the Germans as a commercial matter, even if the cost of materials and labor were equal, or the exchange problem were out of the way, even if every other element that goes into the problem were favorable, until they have had time, and by time I mean years, in which to study the problems of practical manufacture.

We have innumerable chemists who can carry out in the laboratory every process which goes into this entire industry. But the manufacturer's difficulty is this: It is a simple matter to take a test tube and put small quantities of the various materials in it, and get them all in the right state of agitation at once by stirring with a glass rod. You can check that when it has gone far enough with a turn of the hand, pouring the stuff off or putting it into ice water. But in real manufacture you mix, not a gramme in a test tube, but a ton in a large vat, and to get results pounds when he should have got 90 per cent., his yields were in a single day brought up from 10 to 90 per cent. by one change in his method of manufacture, and that change you would not guess in a thousand years. It consisted in the decrease of the speed of the paddles which stirred materials in the vats, in one stage of the process, 5 revolutions a minute. At 25 revolutions a minute he had 10 per cent., at 20 he got 90. That kind of knowledge is not in the books and cannot get into the books. It is in the minds of the foremen who have stayed in the same place and watched the same reactions go on for years, and in some cases for generations, who know what it means when a particular sort of bubbling goes on in the vat, and how to stop reactions when they have gone far enough, and know all the symptoms that develop before their trained eyes, things that are utterly meaningless to a man who is a beginner in the industry. For that reason the American industry, although amply provided with the most skilled research chemists, cannot for any probability hope to rival the Germans as a commercial matter, even if the cost of materials and labor were equal or the exchange problem were out of the way, even if every other element that goes into the problem were favorable, until they have had time, and by time I mean years, in which to study the problems of practical manufacture.

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Now, why should it survive? It is important, of course, that our three billions of dollars' worth of products that depend on it should not any longer depend on the Germans. It is important that those products should not be placed at the mercy of an industry which is practically organized as a part of the German Government. I say to you, however, that that importance is not a fraction of the vital importance to the country of this industry. In the first place, I think you probably all know that the dye industry is interchangeable with the explosive industry. I won't go into that any further than to say that in the case of one important dye, sulphur black, with which most of our stockings are dyed, the whole process of its manufacture is the same, up to the last step, with the manufacture of picric acid, which is one of the two great shell-fillers used in the war. By varying the last process to a slight degree you can make the job result either in sulphur black to color your clothes, or in picric acid to blow up your enemies. In the same way, TNT is almost produced in the manufacture of a large number of different dyes. You can turn a large

dye-works, over night, into an explosive factory, and get all the explosives you can ever need; and so, if you have a full-grown dye industry in time of peace, you need never maintain any great supply of explosives, or special explosive factories, or bother about having a trained force of explosive chemists and employees and engineers who are especially experienced in that line. That, however, is a secondary matter. The Great War began as 100 per cent. an explosive war. It ended as a 55 per cent. chemical war. In the last fighting more than half the shells fired were filled with poisonous gases. The Germans made every pound of their poison gases in their dye-works without changing them in the least. They had the factories ready to their hand, they had the men and the materials; they had everything.

Chlorine and Phosgene, the two gases they began with, were normal materials of dye-making, and they had them in stock in quantity. They had men who knew how to make them, and men who knew how to use them. And, under cover in the dye laboratories, they had researches that resulted in all the rest of their poison materials, and which continued as the war went on to produce new and more deadly materials which, in one case at least that I know of, had they been able to develop a proper method of applying it, would probably have altered the outcome of the war.

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So much for the attack side of chemical warfare. How about the defense? Where did the Allies stand when the Germans made the first gas attack? They stood on the very edge of utter defeat. Had the Germans known the value of their new experiment, had they prepared it in advance on a large scale and driven it home ruthlessly, the defeat of the Allies would have been instant and irretrievable. But, by the grace of God, they did not know it.

Now, what saved the Allies? Improvised gas masks

were rushed over in 36 hours by the British chemists. But those gas masks were nothing, to all intents and purposes, but handkerchiefs steeped with sodium chemicals. Every new poison devised had to be met, on pain of instant and total defeat, by a gas mask capable of resisting it. How in heaven's name are we going to resist attack of that species unless we have instantly available the most highly trained chemists in the world in that field; and where are they to be found except in the dye industry? The answer is, nowhere. The Germans had them at all times, and had they realized it earlier, before we, by building plants costing tens of millions and placing in the works chemists who could be ill-spared from other things, had met the attack, they could have won the war hands down. The Allies, after the Germans introduced mustard gas, took eleven months, during which it accounted for 300,000 men, to get mustard gas of their own to use in reply. To get it we had to build our $35,000,000 Edgewater plant. If we had had 5,000—nay, 1,000—tons of this gas in April, 1918, the great German drive (according to Gen. Fries, our chemical warfare chief) could have been stopped in its tracks.

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A full-grown dye industry could have met such a demand instanter, in days or weeks instead of months. Behind the impenetrable wall of the bodies of our brave allies, and protected by the impregnable bulwark of the British Navy, we had the time to develop, by main force and with hideous waste, the manufacture on which the world's salvation depended. That manufacture, if we had then had the dye industry we have today, we could have had without delay, for nothing. Next time, that wall, and those bulwarks, may not be there.

Now, where are we at the present time? We have developed a dye industry which is far in advance of any other in the world outside of the German. We have made in actual manufacture, practically everything which is

needed in the country, and made them of the highest quality. There is really no question of quality in these things, because they are definite chemical substances, and if you get them, you get them, and they are just as good whether they are made in Germany or in Hindoostan. Now, we have got them. We have got practically all that are required. The few remaining exceptions are just on the point of being placed on the market. In other words, we have an industry today which can furnish us what the German dye industry furnished the Germans.

And the question is, are we going to keep it? I should like you to consider this question with reference to the great demand of the world today, the cry of the world for disarmament, for relief from those intolerable burdens, those burdens hardest of all to bear and the most dangerous to the bearer. How are we going to disarm under the present conditions? Clearly disarmament is limited by national defense. No nation worthy of the name will ever disarm beyond the point at which national defense is imperilled. But how can any of us disarm if Germany be left armed? As long as Germany maintains a dye monopoly or is in a position where she may regain it, she has an armament for chemical warfare superior to that of any other nation. As long as she retains it, in full activity as it was at the end of the war, she will remain dangerously armed, even if we destroy every gun, every tank, every plane, every rifle, and every ship in the German Empire.

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At the outset of the chemical warfare, the chemical attack was practiced without the use of any other weapon. The first gases were merely blown down upon the British by the force of the wind, after being released from compression cylinders. Later, most of the gas was distributed by shells from guns. Toward the end the development turned back again towards methods of application that had nothing to do with guns or any other weapons. Today projectors exist which can be made in any tube works in quantities at wanted in the country, and made them of the highest grade. There is really no question of quality in those things, because they are certain chemical substances, and if you get them, you get them, and they are just as good whether they are made in Germany or in Hindustan. Now, we have got them. We have got practically all that can be stored. The few remaining intermediates are just on the point of being placed on the market. In other words, we have an industry today which can turn out what the German dye industry furnished the Germans.

Now the question is, are we going to keep it? I should like you to consider this question with reference to the great demands of the world today, the cry of the world for disarmament, for relief from these tremendous burdens, these military burdens of which so much is heard and the more particularly in this country. Now are we going to disarm under the present world state? Clearly disarmament is limited by national defense. No nation, whether of the [illegible] will ever disarm beyond the point at which national defense is jeopardized. And here one comes to the menace of Germany; we have learned as long as Germany maintains a dye monopoly so as to be in a position where she can create at once an instrument for chemical warfare superior to that of any other nation, she is, as she retains it, as fully armed as she was at the end of the war, and will remain dangerously armed, even if we destroy every gun, every tank, every plane, every rifle, and every ship in the German Empire.

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Today we are in that same happy position, and so, too, to a certain extent, are the British. The French are approaching it. But our chemical industry is far the best of the lot. Today, if all our guns and planes and tanks and rifles were destroyed, we should also be able to carry on a chemical war as well as anybody else, or very nearly as well. But if we lose our organic chemical industry, we lose that advantage. The British do not mean to lose it. In spite of their universal adherence to Free Trade, and aversion to all forms of protection, they have passed an Act of Parliament totally excluding, for ten years, all German dyes, except such as may be licensed for importation, and they license only those which cannot be obtained of British make. The result is that any British dye user can get any dye he needs, because if it is not made in Great Britain he can import it. The French have adopted the same system as regards German dyes.

If we do not adopt some similar measure our industry is as certain to be destroyed as it is certain that the sun will rise tomorrow. The Germans are dealing with a cent-and-a-half mark. That mark, which buys only a cent and

a half in gold and foreign exchange, buys five or ten cents' worth of goods in Germany, particularly of labor. They have an industry there in Germany equipped to furnish the whole world, which cannot possibly be run at a profit unless it does furnish the whole world. They have invested in that industry $500,000,000 of real gold. That is what is at stake. They have the enormous advantage of the skill and experience that I have pointed out. They have not and they never had any more conscience than—I was going to say a tom-cat, but I don't want to insult the tom-cat. They have no more sense of right and wrong than a grafting policeman. All through the period before the war they bribed, as a matter of course, the dyers of every American textile works. They practiced every form of commercial corruption known to man. Do you think they are going to stop it now, when they have at stake the possibility of regaining the world monopoly that would put them back on the map as a world power, and when, if they do not regain it, they lose their most lucrative industry, sacrifice the $500,000,000 of real assets, lose their best exporting industry, and see grow up in the outside world two or three opposing chemical industries which automatically make one, two or three great opposing powers? I say here, ladies and gentlemen, with the utmost confidence and with sincere belief, that in a disarmed world the dye-making nations are, and must be, supreme, and unless you want the United States to revert to a condition of subserviency, to a condition where she will be at the mercy of any dye-making country, you have got to see to it that your representatives in Washington protect that industry. This cannot be done by the tariff, because the Germans have too much at stake, and can safely spend the money necessary to introduce through any tariff wall any quantity of dyestuffs which may be needed to kill a half to gold and foreign exchange, [illegible] as two weeks worth of goods in Germany, particularly of labor. They have no industry that in Germany compared to [illegible] the whole world, which cannot possibly be run at a profit unless it goes through the whole world. They have invested in that industry [illegible] of real gold. That is what is at stake. They have the enormous advantage of the skill and experience that I have pointed out. They have not had [illegible] they never had any great commercial desk—it was going to [illegible]. They [illegible] have been an important [illegible]. [illegible] number of reasons, the years of very American foreign goods. They [illegible] form of [illegible] known to man. Do you think they are going to stand idle when they have at stake the possibility of controlling the world monetary that would put them back at the top as a world power, and when, if they do not succeed, they may lose their great German industry, together the [illegible] of real wealth, into their [illegible] industry, and then prove up to the outside world [illegible] American machine [illegible] which automatically make one [illegible] great superior power? I say, keep [illegible] and [illegible], with the utmost confidence and with [illegible] that in a [illegible] world the [illegible]-making [illegible] are, and must be, supreme, and unless you want the United States to revert to a condition of [illegible] in a [illegible] where she will be at the mercy of any [illegible]-making country, you have [illegible] that your representatives in Washington pro[illegible] that [illegible]. This cannot be done by one hand, because the Germans have too much at stake, and can safely spend the money necessary to [illegible] through any [illegible] with any [illegible] of [illegible] which may be enacted to aid the American industry.

The reason for this lies in the complexity of the industry. One of the great American dye works, the largest, makes perhaps 250 different colors. It could easily make 2,500, but the effort has been to confine itself to necessary colors and not make things that are not really essential. Of these 250 colors I suppose the real profits of that company have been made on not more than ten. We will say that a hundred of the colors are made in small quantities, as incidental by-products, and are sold at small prices, because the demand is not great. We will say another hundred are also made by other people. There is tremendous competition, so that the prices on them are not high enough to be profitable. Twenty or thirty more are new dyes, on which costs run far above receipts. On the few products which the company makes, and which nobody else makes, or which it makes better than anybody else, the profits depend. Now, all the Germans have to do is to take some part of the surplus which they have of the particular colors which they know to be the basis of the profit of that particular company, send over a few thousand pounds of each of these, and sell them for less than our cost. No one knows what the German costs are. Probably low enough. But if, instead of charging low prices, they had to pay people to take such fighting shipments, and if in addition they paid a thousand per cent. duty, it would still be a matter of only hundreds of thousands of dollars, not millions, to put out of business by such a selective attack any one American company, even the greatest.

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Now, it would only take three shiploads to supply the entire American market with dyes for a year. The Germans made perhaps four times or five times the total American consumption each year. When I was in Paris in December,

there came from the German Dye Trust a bitter complaint that the Allies were not taking all the dyes which they were entitled to take under the treaty, and that as a result the storehouses of the German dye works were getting clogged, and they could not do business, and wouldn't we please take some more. Accordingly, it is perfectly apparent that the German dye houses are stocked up and that they cannot readily sell all they make even now, when they are working at half capacity. Their selective attacks would really cost them nothing beyond the tariff duties, since the dyes with which to make the onslaught are in hand as surplus stocks, valueless otherwise because unsaleable elsewhere. They stand ready there to launch a flood upon this country if we allow them to do so. Up to date we are protected by the continuance of the War Trade Board Section's licensing scheme, which is precisely like that under the British bill, but which lasts as long as the Trading with the Enemy Act lasts, and no longer.

As soon as you try to protect the industry by the tariff only, you will have the German trust fighting for its life, utterly desperate, caring nothing for morals or conscience, sending carefully selected consignments of goods into this country, designed to put out of business first one and then another of our manufacturers, and so destroying piecemeal, in a very few months, the industry, which only by a miracle of achievement has been created in the last five years. The dyes are too closely interrelated for you to sort them out and load an enormous duty on some and not on others, because their chemical connection is so close that it would be the easiest thing in the world for the Germans to evade such a law. Instead of sending in the things the high duty there came from the German Dye Trust a letter complaining that the Allies were not taking all the dyes which they were entitled to take under the treaty, and that as a result the storehouses of the German dye works were getting clogged, and they could not do business, and wouldn't we please take some more. Admittedly, it is perfectly apparent that the German dye houses are stocked up and that they cannot readily sell all they would make now, when they are working at half capacity. Their selective attacks would surely cost them nothing beyond the small outlay, since the dyes with which to make the campaign are on hand as surplus stocks, valueless otherwise because unsaleable elsewhere. They would surely desire to launch a drive upon this country if we allow them to do so. Up to date we are protected by the continuance of the War Trade Board Section's licensing scheme, which is precisely like that under the [illegible] bill, but which lasts so long as the Trading with the Enemy Act lasts, and no longer.

As soon as you try to protect the industry by the tariff only, you will have the German trust fighting for its life, literally desperate, making a drive for months or years, sending specially selected consignments of goods into this country, calculated to put out of business first one and then another of our manufacturers, and so checkmate progress in a very few months, the industry, which only by a miracle of achievement has been created in the last five years. The dyes are too closely interrelated for you to sort them out and just put an enormous duty on some and not on others, because their chemical connection is so close that it would be the easiest thing in the world for the Germans to evade such a law. Instead of sending in the things the high duty was levied on, they would send the same things almost completed, or slightly varied, in such a way that their original character could be easily restored after import. An instance will perhaps make clear to you what I mean.

* * *

In the elaborate and complicated process of making indigo, it arrives at last, after something like ten complex reactions, at a substance called indoxyl. Indoxyl is no more like indigo than I am like that chair. But it turns into indigo when you place it in a vat and blow air through it. Now, if a high duty were levied on indigo, the substance would be brought here as indoxyl. The air would be blown through it in this country and so the high tariff would be worthless. This is a mere instance, one of a thousand types of easy evasion, against which there is no other remedy than temporary exclusion.

The industry can be saved only by the immediate enactment of a law forbidding for a time the import of those dyes which, being well made and reasonably sold at home, we do not need to import. The measure could take the form either of a licensing law like the British, or of one forbidding import of such products as may be found by an impartial commission to be properly made and sold here, thus obviating the need of licenses. A licensing bill (the Longworth bill) passed the House of Representatives in September, 1919. It was reported in an improved form intended to bring about exclusion without the need of a license system, by the Senate Finance Committee. Its passage was prevented solely by a small filibuster. A new bill on simliar lines will be introduced as soon as possible.

There is no serious opposition to this necessary protection except among three classes. First, the outright pro-

Germans. We can disregard them. Second, a few textile manufacturers, some timid, some frankly selfish. Of these the former argue that a licensing system means higher dye costs, and that this would handicap them, particularly in export. These gentlemen forget that the cost of the dyes in finished goods is negligibly small, amounting in an average suit of clothes to perhaps 32 cents, and in a dozen pairs of fine socks to about 1¾ cents. They also forget that their chief competitors, the French and British, are already, under license laws, buying their dyes from less developed industries than ours, under the very price conditions they fear. The latter class, fortunately small, propose to get their dyes as cheaply as they can be got, no matter where they come from, or who makes them, and they do not mean to be told by anyone, on the plea of National Defense or for any other reason, that they shall not buy where they choose. One of the greatest manufacturers in New Hampshire said that to me himself. He is almost alone, however, among textile manufacturers in this position. The rest have mostly signed a petition for the enactment of a license law. The third class of opponents consist of the hide-bound protectionists who can see nothing but the tariff as a means of saving any American industry. Some of these actually want a high dye tariff, as an argument for future use in demanding high tariffs in their own industries.

The opposition of each of these classes is so clearly based on unsound reasoning, having no weight whatever as compared with the overwhelming argument in favor of the proposed measure, that even the opponents of the bill in the Senate admitted that if allowed to come to a vote it would instantly have passed. Unfortunately, under the Senate rule even a single obstructionist can prevent any

Germans. We can disregard them. Second, a few textile manufacturers, seven times, more frankly selfish. Of these the German argue that a licensing system would raise the costs, and that they would handicap them, particularly in export. These gentlemen forget that the cost of the dyes in finished goods is relatively small, amounting in an average suit of clothes to perhaps 20 cents, and in a dozen pairs of fine socks to about 2½ cents. They also forget that their other competitors, the French and British, are already under license laws, having their dyes from home-developed making from that time. Under the very same conditions they want. The other class, relatively small, propose to get their dyes as cheaply as they can be got, no matter where they come from or who makes them, and they do not mean to be told to refrain on the plea of National Defense or for any other reason that they shall not buy where they choose. One of the greatest manufacturers in New Hampshire said that to me himself. This almost alone [illegible] among textile manufacturers in this position. The rest have really signed a petition for the enactment of a license law. The third class of opponents consists of the importers, [illegible] who care for nothing but the tariff as a means of getting any [illegible]. Some of these contain what a high dye tariff, in an experiment for future use in demanding high tariffs in their own industries.

The opposition of each of these classes is so clearly based on selfish reasoning, having no weight whatever as compared with the overwhelming argument in favor of the proposed measure, that even the opponents of the bill in the Senate admitted that if allowed to come to a vote it would certainly have passed. Unfortunately, under the Senate rules even a single obstructionist can prevent any

[illegible]

such measure from coming to a vote. For this situation there is no remedy but pressure of public opinion. It is for you to bring that pressure to bear. If you believe, as I believe, in saving for our country its only possible shield against the warfare of the future, and in preserving for the world that counterbalance to the chemical military power of Germany without which disarmament is impossible, you must say so, to your servants in Washington, in language open to no dispute. Write to your Senators and Representatives, and show them, with emphasis such as will banish hesitation and doubt, that the intelligence and patriotism of the country demand the immediate enactment of an exclusion measure.

The University of Chicago
Department of Chemistry

REPORT OF THE COMMITTEE ON A NEW LABORATORY BUILDING FOR CHEMISTRY AND ON THE ESTABLISHMENT OF A CHAIR OF INDUSTRIAL CHEMISTRY

I. A NEW LABORATORY BUILDING.

1. The Need for a New Laboratory Building for Chemistry.

The Kent Chemical Laboratory was planned and constructed for housing college, graduate, and research work in inorganic, organic, and analytical chemistry. Since the time when those plans were made and carried into effect two great new fields of chemistry, physical chemistry and the chemistry of radio-active substances, have developed and taken a place in chemistry equally as great and fundamental as the three branches first mentioned. In addition, industrial chemistry, for which no provision was made in the early plans of the University, has now become a matter of such moment to the welfare of the country, industrially, commercially, and defensively, that the University ought not to remain inactive any longer in this direction in view of the fact that the most urgent demand in this field is for men trained to do research, the very type of men, whose development must be considered the most important mission of the University. A large part of the necessary equipment and organization for this work is already on the campus, and the new plans, in fact, call simply for the completion of the University's equipment to do its proper share in meeting the country's need for research chemistry.

Physical chemistry, to whose rapid development in the last twenty years most of the brilliant successes of chemistry in this

period are undoubtedly to be ascribed, has found in Kent only such room and facilities as could be spared in carrying out the original purposes of the building and equipment. Only the fact that perhaps two-thirds of the staff has taken a profound personal interest in the subject has made it possible to put it on anything like a respectable footing; but it has always been handicapped by the lack of space and of special facilities. The laboratories assigned to it cannot take care of all the students desiring work in the subject, with the result, for instance, that special lockers are placed in the hallways for the equipment of the excess of students and that the instructors are obliged to ask students the favor of compressing their work into as few weeks as possible, so as to make way for other students--an intolerable situation. Research in Physical Chemistry, one of the most important in point of view of actual productivity in the department, has so outgrown the small laboratory designated for it, that it has taken refuge in basement corners, side by side with laboratory courses whose fumes and motors are a heavy handicap for the research work.

Radio-active Chemistry, the newest branch of chemistry, fundamental in the study of matter as well as in its applications to medicine, is fortunately represented at the University by the work of Professor McCoy, but the facilities for the work are confined to a basement room, where the danger from flood and chemicals from overhead is a constantly recurring menace to the sensitive work and to the expensive apparatus. Dr. McCoy is one of the two leaders in America in this field, and the University under present conditions

is losing its opportunity to greatly enhance its services to the country by providing for the proper development of the work in suitable laboratories.

The need for the inauguration of work in industrial chemistry will be discussed further on in connection with the proposal to establish a chair of industrial chemistry.

Aside from the totally inadequate or wholly lacking space and facilities for these three branches of chemistry, for which the original plans of the Kent Chemical Laboratory made no provision whatsoever, the work of the department in the older branches, inorganic, organic, and analytical chemistry, has so far outgrown the capacity of the building that it is now being done under the greatest handicaps and with danger to the success of the work. A few illustrations of these difficulties are as follows: The research laboratory, intended to accommodate at most twenty students, candidates for the Ph. D. degree, is too small now to hold the present number of research students; but of even greater importance is the fact that it is again and again invaded by the overflow from lower graduate courses--organic and analytical--the last resort in attempts to fulfill our obligations to take care of all the graduate students in the department. The balance-room, intended to take care of thirty students, is continually congested as a result of being used by over a hundred students, and these are forced to lose valuable time in waiting for their turn to use a balance. Our store-room, intended to provide for at most 200 students, is now struggling to meet the demands of over 600. No provision was made in the original plans for elementary laboratory work in organic

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chemistry, courses in which were organized only in 1901. Students taking these courses, numbering as many as 140 in a single quarter, have been taken care of "provisionally" "for fifteen years" (!) in laboratories designed for, used by, and overcrowded with, students in general chemistry and qualitative analysis.

These few details are sufficiently illustrative of the whole situation in Kent: only constant, strenuous efforts on the part of the staff have saved the department from a breakdown under these conditions and enabled it to hold its standing in the country. Expansion of space and facilities is absolutely imperative if the University wishes to fulfill its obligations to the community in this important branch of science. The present tremendous growth of interest in chemistry is bound to justify such expansion even far beyond the present urgent plans. University after university has doubled, tripled and even quadrupled its chemical laboratory facilities in recent years: Harvard, Michigan, Minnesota, Illinois, California, Ohio, Cincinnati, the Massachusetts Institute of Technology are a few of the schools which very recently have built new, larger, and better equipped chemical laboratories.

2. The Site and Size of the Proposed Building.

It is recommended that the campus space to the West of Kent to Ellis Avenue and north on Ellis Avenue to Snell Hall be reserved for expansion in chemistry, immediate and future. The new laboratory, which it is now proposed to build, should be located immediately to the West of Kent Laboratory, extending to Ellis Avenue (and possibly turning north on that avenue to form the corner of the quadrangle). It should be connected with Kent, somewhat in the

way that Rosenwald Hall is connected with the Walker Museum. The connection with Kent will make possible an organization of instruction, service, and storeroom facilities which will be of permanent value from the point of view of economy of expense and of time on the part of the staff and the students. On the enclosed diagram, the shape and location of the new building are indicated which, it is thought, will most efficiently utilize the space in this location. It is thought that the shape of the building would make possible architectural adjustment to the present laboratory buildings; thus, the northern wing of the proposed building is supposed to correspond to Kent Theatre and the Ryerson Annex--but possibly other arrangements would be architecturally more desirable and could fulfill the same ends.

It is estimated on the basis of the growth of the demand for chemistry in this country and especially in the larger universities that the new laboratory, with the introduction of work in industrial chemistry, will provide for growth for some fifteen to twenty years, and that is why it is recommended that all the space on Ellis Avenue to Snell Hall should be reserved for chemistry.

The building should have four floors and a basement, with an area of some 10,000 square feet per floor. The Western wing would provide the best place for the housing of any heavy apparatus and machinery for industrial chemistry and for such work in industrial chemistry as might cause injury to the finer apparatus used in research in other parts of the new building. That location would also bring this branch of chemistry in the proper position for further development and possibly ultimate[illegible] transfer to its own building on Ellis

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Avenue up to Snell Hall.

It is estimated that $300,000 (to $350,000) should be provided for the building, besides at least $25,000 for its equipment (other than the ordinary desks, tables, plumbing, etc., which are included in the cost of construction).

It is proposed to house in the new building:

(1) All the research laboratories, including those for industrial research.

(2) The main laboratories of Physical Chemistry, including Electro-chemistry, and Photo-chemistry.

(3) Radio-activity Work.

(4) Quantitative Analysis.

(5) Such of the industrial work as would demand heavy apparatus, machinery, or larger appliances.

(6) Graduate Inorganic Chemistry.

(7) The library and some offices.

(8) Shops for a mechanic for industrial chemistry and for a glass-blower.

The space vacated in Kent will make possible:

(1) Expansion of the work in Elementary General Chemistry, at present congested, and growing.

(2) The installation of a laboratory for Elementary Organic Chemistry, which at present is crowded into laboratories which are used at the same time for General Chemistry and for Qualitative Analysis.

(3) The installation of a laboratory for graduate work in Organic Chemistry, which at present is housed in a room much too small for the purpose, with consequent overflow into the present research laboratory.

The University of Chicago

Department of Chemistry

Avenue up to Snell Hall.

It is estimated that $500,000 (to $350,000) should be provided for the building, besides at least $25,000 for its equipment (other than the ordinary desks, tables, plumbing, etc., which are included in the cost of construction).

It is proposed to house in the new building:

(1) All the research laboratories, including those for industrial research.

(2) The main laboratories of Physical Chemistry, including Electro-chemistry, and Photo-chemistry.

(3) Radio-activity Work.

(4) Quantitative Analysis.

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(4) The basement, vacated by research and graduate students, would be well suited for a part of the work which it is proposed to give in industrial chemistry.

(5) Private laboratories and offices for the younger members of the growing staff of the department, some of whom are without private rooms at present.

It is proposed to put the storeroom in such a way in the space connecting the two buildings that access from both sides will provide service for both buildings.

II. THE PLANS AND SCOPE OF THE WORK IN INDUSTRIAL CHEMISTRY.

1. The Need for Such Work.

The Doctors of Philosophy of the department of chemistry have made a record in industrial chemistry of which the University may well be proud. One of these Doctors is the present Director of the Mellon Institute for Industrial Research, the most important, perhaps, of all research laboratories in technical chemistry in the country, whose methods and organization have not only stimulated all the foremost technical schools of the country to improve their facilities for research in technical chemistry but have also led foreign governments to undertake the establishment of similar institutes. Others of our Doctors and graduates have become most successful consulting and directing chemists in the research laboratories and working plants of some of the largest industrial concerns in the country. The demand for our men is far greater than we can supply. There is no doubt, judged by this record, that the department was guided wisely when it develop

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oped early in its history the policy which it has annually announced in its departmental program:

"Preparation for Technical Work

Thorough scientific training in all branches of chemistry required for the Doctor's degree forms the best preparation for a career as a chemical expert in any branch of chemical industry. With this preparation, the principles and details of technical processes are quickly grasped, advances in industrial processes are intelligently followed, and newly discovered principles are readily applied.

All the more important requests received from technical establishments specify a doctorate of philosophy, with its training to do research work, as a fundamental requirement."

Successful as this policy has been and justified by the results it has produced, closer analysis shows that the department has simply supplied excellent material, but not men prepared in the very best way. Our men have had indeed to pick up information on matters of fundamental importance in industrial chemistry, such as the relations of large scale operation to laboratory experimentation, the relations of first cost and operating costs to output as a vital element of success, and the relations of chemistry to the possibilities of industrial research in meeting specific needs of industry. A measure of training in these fundamental elements, of men who are preparing to enter this field would be invaluable; it would no longer leave to chance and circumstance the acquiring of this information, and it would insure, through the medium of a proper incumbent of a chair of industrial chemistry, that correct information should be imparted. It would make our men <u>more immediately available and useful</u> in the

technical research laboratories of the country than they have been in the past.

Dr. Mies, the director of the research laboratory of the Eastman Kodak Co., one of the greatest in the United States, in discussing the selection of men for industrial research, classified them as follows: (1) men of thorough technical experience but without thorough theoretical training. (2) Men with thorough theoretical training but without technical experience. (3) men who have both technical experience and thorough training in theory. In the selection of men he advises the choice of men of the third class, if they can be secured, and he gives the preference to men of the second class over those of the first. The organization of our work in the chemistry department hitherto has developed successfully the men of class 2--it is proposed now to make it possible for the department to prepare men of the third class, recognized as the most efficient by leaders in the field. There is no greater and more effective step that the University could take toward aiding "industrial and scientific preparedness" for quick and effective organization for the development of the resources of the country in commercial and possibly military defense than by the establishment of a chair in industrial chemistry.

2. The Scope of the Work.

It is proposed that at first the work undertaken shall consist of:

a) Laboratory work and class-room or seminar instruction in some fundamental large-scale operations, sufficiently il-

lustrative to give the needed experience. Such operations could include distillation, filtration, furnace work with gas, coal, and electricity, or other processes. The exact selection made is of less importance than that some kind of such large-scale work be provided for. The outfits of Columbia University, The Massachusetts Institute of Technology and of Mellon Institute were studied by the Committee from this point of view, but the Committee deems it best that the specific selection should be made by the professor of industrial chemistry when he has been chosen.

b) Laboratory work and class-room or seminar instruction in complete processes--such as the preparation of some dye or dyes on a suitably large scale; the preparation of chemicals, organic and inorganic, industrial and medicinal; possibly, with a small working model, the utilization of the nitrogen of the atmosphere for the preparation of nitrate for explosives and fertilizer and of ammonia for the same purposes---operations of the greatest importance for our national welfare.

c) In connection with a) and b) practice and instruction in the calculation of costs.

d) Instruction and practice in working up a complete bibliography, including the study of patents, of processes.

e) Special lectures, by professorial lecturers, on the methods of ascertaining the needs of industry, which research in chemistry could and should meet, and on recent instances of the applications of pure chemistry to solving great problems of industry.

f) The development of facilities and opportunities for the carrying on of industrial research for the national, state, and

municipal governments and for manufacturing and commerical plants.

The new professor would form the nucleus for the development of industrial research at the University. In the selection of the man special emphasis should be placed upon the fact that the solution of problems of technical investigations may properly and desirably be undertaken by him (under conditions to be determined upon and approved by the President) but that the University would not wish to have any routine analytical or supervisional work done in its laboratories for outisde interests. The discovery of new applications of science, or of new facts of science in the interest of industry, is a proper field of effort in a University upholding the ideals of the University of Chicago, but entrance into commercial work of a routine character would not be so. In the course of time, provision for the extension of this legitimate kind of work, industrial research, would be possible on the basis of endowed fellowships, such as exist at Mellon Institute, where the concern which wishes a problem investigated must make ample provision for men, equipment, and supplies. The acceptance of outside work should be subject in each case to the approval of the President or the chiarman of the department under conditions to be formulated on the basis of the general policy of the University.

The work as contemplated is intended primarily for the graduate student and especially for the candidate for the doctorate, who may be interested in the idea of preparing for technical re-

search. It is, in particular, the intention not to attempt to develop the undergraduate work in technical chemistry---leading to the preparation of men for routine technical and analytical work, as is done in a number of institutions which give excellent courses in chemical engineering. Such work is best left to existing undergraduate schools of chemical engineering. If it is ever undertaken at the University of Chicago, it should be either in connection with a complete School of Technology or as a new and special development of a School of Chemistry. The present plan is not intended to develop chemical technology at the University and is aimed exclusively toward the development of opportunity for work of a graduate character and particularly for preparation for research---in harmony with what is the highest mission of the University. It is intended to be a connecting link between our pure sciences and our industries.

3. The Staff.

It is recommended that a man of full professorial rank be appointed at a salary of $3500 to $5000, according to the experience and qualifications of the man selected. A comparatively young man, 33 to 40, of great promise, with experience either in an industrial research laboratory or in one of the best technical schools of the country should be preferred to an older man of greater reputation. It is intended that the work should grow and develop in harmony with

the spirit of the University rather than to have a foreign, finished product grafted on to it.

Further provision is recommended for an instructor and for assistants. The budget proposed includes such provision. It is not expected that the development of the work will stop there, but it not doubted that its success will attract, and should attract for itself, any further support needed.

III. BUDGET.

In the following estimates the amounts chargeable to the establishment of the opportunities for graduate work in Industrial Chemistry are indicated in the last column.

1. Estimated Cost.

	Total.	Portion Required for Industrial Chemistry
Building	$300,000 to $350,000	$100,000 to $125,000
Endowment	300,000 to 325,000	250,000 to 275,000
Equipment	25,000 to 35,000	15,000 to 20,000
Total	$625,000 to $710,000	$365,000 to $420,000

2. Estimated Expenses.

	Totals.	Portion Required for Industrial Chemistry
a) Professor of Full Rank	$4000 to $5000	$4000 to $5000
b) Instructor and Assistants	2000	2000
c) Professorial Lecturers, Expenses	500	500
d) Supplies and Equipment	3000	3000
e) Laboratory Service	2000	1000
f) Mechanic	1000	1000
g) Annual Repairs	1000	333.33
h) Janitor Service	2000	666.67
Totals	$15,000 to 16,000.	$12,500 to 13,500

This should provide a sound basis for development. Some items could be reduced somewhat for a beginning, but it would be advisable to consider that the work would very rapidly grow up to demand the whole of the estimate.

Millikan

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The University of Chicago

Ryerson Physical Laboratory

Chicago, June 19, 1920.

Mr. Harry Pratt Judson,
President, University of Chicago,
Faculty Exchange.

Dear President Judson:-

If the plan is to present to the friends of the University the large project of the development here of an institute devoted largely to research in Physics and Chemistry, you will perhaps permit me to present what seems to me to be the possibilities and the needs somewhat more fully than I did in the suggestions formulated a year ago and recently sent to you at your request. I fully appreciate your great interest in the enterprise, and assume that the only possible question which anyone could raise is as to whether the appeal to prospective donors can be made strongest by presenting the large plan or by focusing attention upon a portion of the plan, such as that represented by the immediate needs, for example, of the Department of Chemistry. It appears to me that the appeal of the large plan can be made very strong, and I should like to state that appeal under four heads, as follows:

1. A new enterprise. There exist today a number of research institutes in Physics or Chemistry, or both, which are well endowed and adequately equipped for turning out a large research product, for example, the Reichsanstalt, and the Kaiser Wilhelm Institute at Charlottenburg and Dahlam in Germany, or the institutes of the Western Electric, General Electric, and

Westinghouse Companies in this country. But no university has thus far ever had funds or facilities or time for research which has been in any way comparable with those of these detached institutions. Yet the heads of our University laboratories are continually being called, at two or three times the salaries paid by universities, to industrial research laboratories. These same men, if kept in the universities and given there ~~the~~ facilities which are at all comparable with those which they would have in the industrial institutes, could surely be just as effective in turning out an immediate research product, and in addition, they would in the universities be creating the physicists and chemists of the future as they can never do in detached research laboratories. Universities have in the past shown what they can do in training men. They have never yet had any opportunity to show what they can do as effective centers of research, for there is probably not a department of physics in the United States which has been able to spend $25000 per year upon research, while the detached institutes mentioned above have had from a quarter of a million to two millions to spend per year. Despite this handicap, it is probably not an exaggeration to say that the departments of physics at Harvard and the University of Chicago alone have turned out within the past twenty years as much important work as any one of the detached institutes mentioned above. It is a new enterprise to attempt to give them an opportunity to show what they could do if properly organized and financed.

2. Relative expense of research in universities and in detached institutes. It is not an exaggeration to say that a given amount of money to be put into research should be able to yield from three to ten times as large returns in a university as in a detached institute. For with the Ph. D. motive young and able investigators can be drawn to a university and can be induced to devote themselves assiduously to research for periods of three or four years at a time at very little, or even at no, expense to the institution for the research work, beyond the physical equipment which that research requires. There are in the Ryerson Laboratory this year four men who last year drew, as members of the research staffs of the Western Electric and General Electric Companies, salaries aggregating approximately twelve thousand dollars. These men are working just as hard this year, and more enthusiastically, because of the larger freedom which they here have, and the larger sharing in the results of their work. They are working without any expense to the university except their equipment. They are spending about one-third of their time in teaching, and are receiving for that teaching a total sum of two thousand dollars. Their research work is probably assisted, rather than hindered, by this amount of teaching, and their whole contacts here are certainly more stimulating than is the case in any detached research laboratory. Multiply this situation, say, ten-fold, and give these men really adequate facilities in the way of shop and equipment, and they should be able to turn out a product which is many-fold greater per dollar of input than that which can be attained in any detached laboratory.

3. The Co-ordination of research in physics and chemistry. The University of Chicago has the opportunity to do a new thing in showing other institutions what can be done by co-operation between the departments of physics and chemistry; hence the desirability of emphasizing the need, not of an institute of physics or chemistry, but of a research institute of physics and chemistry. American universities today show a number of pitiful examples of the development within the same institution of two departments which duplicate equipment and courses and research problems in most undesirable ways. This has been particularly true of the departments of electrical engineering and physics in certain institutions. In German universities it has been notoriously true of departments of physics and physical chemistry. In this country we have copied to a large extent the organization of the German universities, and have rendered likely such overlapping and waste between the departments of physics and chemistry as exists in Germany. This has not been true thus far in the University of Chicago, but we now have an exceptional opportunity to set an example to other institutions of effective cooperation between these two departments. Professor Stieglitz, in his recent report on the plans for a new ~~physical~~ chemical laboratory, says, "The work in the fields of Chemistry and Physics overlap to a very considerable extent; the great fields of physical chemistry and of radioactivity (see below) to which the new laboratory will be very largely devoted are as much branches of physics as of chemistry. And in turn, as a result of the developments in science in the last twenty years, the investigations of

the fundamental properties of matter and particularly of the structure of the atom to which a large part of the attention of the staff in Physics is devoted, are of profound chemical as well as physical importance and include in all countries as well as at the University in the two sister departments, investigators among the chemists as well as physicists. In consequence of these very intimate relations between chemistry and physics, the new research laboratories will serve for the expansion of the research work in physics as well as in chemistry. For instance no less than 80 percent of the floor (20000 sq. ft.) devoted to rooms for research and for graduate work preparatory to research according to the present plans would be suitable equally for investigations in chemistry or in physics, as the needs would grow. Thus it is intended that the new laboratory should provide for physical as well as chemical investigations, giving the department of physics with some 25 (actually 32) research students ample room for research expansion". This is an admirable statement of the intimate relations which exist today between the work of the two departments.

4. Location of the new building. The Ryerson Laboratory is admirably adapted to research work in Physics, and it ought always to be the center of that research work. But if it is to continue to be so used, it is worth while to consider whether any expansion of our research force outside the building should not be made into some building which is merely a wing of the present building. Add to this the above-mentioned desirability of tying together the work of the departments of Physics and Chemistry, and keeping them from needlessly duplicating equipment

and problems, and it is clear that there is certainly something to be said in favor of making the new building in a real physical sense, the connecting link between Ryerson and Kent, provided it is found possible to do this and yet preserve good architectural effects. If we can show that the new institute of Physics and Chemistry is not merely a paper scheme, but a physical reality, the appeal to prospective donors and the influence of the Physics and Chemistry Departments upon other institutions will probably be not a little enhanced. It is at least strongly recommended that the possibility of giving such a physical embodiment to the new institute of Physics and Chemistry be given very careful consideration. The Physics Department would then extend into the new building only as far as its growth in research personnel warranted, and similarly with the Chemistry Department. This arrangement would furnish distinct advantages as the numbers in the two departments fluctuated. It would also exert a strong tendency toward cooperation and the preventing of needless duplication.

The most pressing immediate needs.

There are at the present moment thirty-two students, who are definitely at work on research problems in Physics in the research rooms of the Ryerson laboratory. This is, of course, exclusive of the permanent staff of the Physics Department. Professor Stieglitz informs me that there are about forty such students in the Kent Laboratory. To make adequate provision for the researches of these men, and for the growth in research lines in

the Department of Physics, the following are imperative and immediate needs:

1. Shop and equipment. The shop is the heart of a Physical laboratory. Our research men now have to wait sometimes for weeks for apparatus because of overcrowding of the shop. The Ryerson laboratory needs a permanent glass blower and two or three additional mechanics. It needs, further, to double its funds for research purposes.

2. Summer conferences. The University of Chicago is the most favored institution in the United States as a place for holding summer conferences in Physics and Chemistry, to which should be invited a staff of a number of the leading Physicists and Chemists of Europe, and to which should be attracted a goodly number of the best physicists and chemists of the United States. Such conferences are the most effective means known for stimulating the new advances. The new institute should immediately undertake plans for calling to the University of Chicago next summer a few outstanding men from Europe who would be asked to spend the summer here and assist in the promotion of a conference on the latest developments in Physics and Chemistry. A sum of six thousand dollars might well be spent next summer on such a conference.

3. Fellowships for teachers. The new institute ought to exert a tremendously stimulating influence, not only on the students assembled here, but also upon the Physics and Chemistry Departments in the smaller colleges of the country. Funds ought to be available for bringing teachers on sabatical leave from

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these institutions to a center in which they could spend a year or even two years in getting back into the research atmosphere and in putting themselves in touch with the latest developments in their fields. Ten thousand dollars per year spent on five or six such fellowships would net the largest returns possible to the development of the country in Physics and Chemistry.

4. Salaries of research men. Without considering the expansion of the Departments of Physics and Chemistry by the addition of, say, one first-class man in each department, there is an immediate need for the adequate provision for the maintenance of the first-class men already in these departments, some of whom are already exceedingly inadequately provided for and in danger of being forced to go to other places in order to be able to meet the necessary expenses of their families. There is further need of relieving some of them of excessive instruction in order that they may have more free time for their researches. The amounts needed for these purposes can easily be ascertained, but will not be detailed herewith.

The foregoing statement of needs relates to the Physics Department alone, but the Department of Chemistry undoubtedly has corresponding needs.

Very sincerely yours,

R. A. Millikan

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The University of Chicago

Department of Chemistry

July 1, 1920

Dear President Judson:

I am enclosing two statements in regard to the effort to secure endowment for a Research Institute of Physics and Chemistry and for a new laboratory. My idea is that the first set addressed to the friends of the University of Chicago might well go out in some form revised by yourself as a letter to various friends of the University and that the main and longer statement might be printed by the University and go out as a complete statement of the plans and of the basis for them. In this I have followed the system used by bond houses in sending out a short letter emphasizing the main points of the new issue followed up by a detailed statement in print, of the type with which our mail has been well supplied.

You will note that the second long part of the statement follows practically the outline which you have had drawn up as a preliminary plan. I would like to call your attention particularly to the contents of page 4 in regard to industrial corporations. I have put this in in the form in which I think it might do most good or least harm to the University, but with considerable hesitation and with the idea that perhaps it would be wisest in the long haul to eliminate the consideration of corporations altogether. I have thought, however, that that is a point on which you and the Trustees would wish to make the decision and hence I have put it into some form which might be the basis for further consideration. Let me say that nothing proposed there goes beyond what we are doing at present in connection with independent research workers bringing in technical problems on which they work independently. I also would like to emphasize that I have tried to make clear - and this is important - just what privileges would be granted so that no corporation would be misled into supporting the undertaking on the basis of a wrong idea of what is planned. In particular it is necessary to say plainly that the professorial staff will not be called upon to direct or guide research for corporations either in a supervisory or an advisory capacity or in any connection whatsoever.

Finally it might be that you would consider it wiser to eliminate everything after the first summary on page 5, omitting the reference to specific contributions towards special rooms and the summary on page 6. I have included this material simply that you might have it before you and cut it out if you thought it best.

I expect to leave for the east Saturday night of this week and to be engaged there on Tuesday, July 6th, but will be back Wednesday afternoon, July 7th and would be glad to hold all my time after that at your disposal for further consideration of the plans if you so desire.

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Yours sincerely,

Julius Stieglitz

JS/EL

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Yours sincerely,

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To the Friends of the University of Chicago

The University of Chicago is in urgent and immediate need of a new laboratory building to provide for the overflowing demands in its departments of chemistry and physics. In particular more space and better facilities are required for the needs of graduate instruction, for the training of rapidly increasing and large numbers of research workers who are now crowded in the chemistry laboratory into basement rooms and odd corners. Impressed, moreover, by the unanimous verdict that the sciences of physics and chemistry are so fundamental that all other natural sciences as well as the industrial development of our nation and the health of our people must find their surest foundation in them, the University proposes forthwith to develop a RESEARCH INSTITUTE OF PHYSICS AND CHEMISTRY. It is proposed to bring together in this Institute as strong a staff of experts as possible in each important field of these sciences, and to welcome to the Institute not only the University's own research students, candidates for its higher degrees, but also properly qualified research workers from all other educational institutions, from scientific institutions and, to a limited extent, from industrial corporations, who wish to avail themselves of the facilities of the research institute.

The significance of chemistry and physics in the life of our nation is most succinctly epitomized in the following paraphrase of the vision of a scientist of thirty years ago:
" The people of that nation which most successfully and rapidly develops and applies to its problems, the sciences of chemistry and physics, will be the happiest, because their health will be safeguarded by sure progress based on these sciences; the safest, because powers of self-defense and military strength are now largely based on these sciences; the richest, because their industries will thrive, their agriculture prosper and their wealth grow in proportion as they utilize these sciences; and the most populous, as these sciences tend to make the nation self-supporting, self-contained and independent of outside resources."

The new research institute and research laboratory are intended to help meet the rapidly growing needs of our country and particularly of our great Middle West, for trained research men in Chemistry and Physics toward the patriotic ends so truly expressed in the foregoing statement.

Details of the plans for the proposed Institute and new Laboratory are found in the enclosed statement. The strong support is asked of all the friends of the University, of all people who believe in the securing through scientific endeavor of the highest type, the safety, well-being and prosperity of our people. Further details will be gladly furnished to interested friends by the President of the University.

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AN APPEAL FOR THE ENDOWMENT OF A RESEARCH INSTITUTE OF PHYSICS AND CHEMISTRY AT THE UNIVERSITY OF CHICAGO AND FOR THE ERECTION AND EQUIPMENT OF A NEW LABORATORY.

WHAT PHYSICS AND CHEMISTRY MEAN TO THE NATION.

The war has brought home to the consciousness of our people the fact that all branches of modern industrial civilization are founded on the sciences of physics and chemistry, which are indeed the fundamental sciences of the transformation of matter and of energy, the two ultimate factors in all industrial processes. The hope of an intensive future development of industrial possibilities is consequently finally dependent on research progress in these sciences. No less decided is the outspoken conclusion of the leaders in all other branches of the natural sciences, notably also in biology and medicine, that we must look to chemistry and physics for the foundation stones for the further development and progress of medicine and biology, on which the very health and happiness of the human race depend most directly. This present realization of the meaning of chemistry and physics to a nation is most concisely summarized in a quotation from an article published in the North American Review in 1893 by a modern prophet whose remarkably clear vision has been amply demonstrated by the experience of the war:

"That country which has the best chemists and physicists will eventually become the richest and the most powerful. It will possess at the lowest prices the best food, the best manufactures, the best weapons and lose the least in production. Its people will make the best possible use of the natural resources of their land, and because of universal hygiene they will enjoy the best health. They will be least dependent on other nations for supplying their needs. The instruction of the people in chemistry and physics and other natural sciences is therefore to be regarded as the best investment of the nation's capital, since in the future the competition for place among the nations will depend principally on their achievements in scientific and applied chemistry and physics." +

What the University of Chicago has done for Physics and Chemistry.

In 1892, Kent Chemical Laboratory was erected at a cost of $202,270. In 1893-94 Ryerson Physical Laboratory was built and in 1910-11 it was enlarged and remodeled at a total cost of   . Within the years since that time thousands of students have been trained in physics and chemistry and hundreds of research workers have been developed.

+ Slightly modified by the inclusion of physics as well as of chemistry.

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\+ Slightly modified by the inclusion of physics as well as of chemistry.

Fifty-six students have received the degree of Doctor of Philosophy in Physics, one hundred and nineteen the doctorate degree in Chemistry. One hundred and six of these holders of the doctor's degree (39 physicists and 67 chemists) are teachers and investigators in educational institutions, — being heads of their departments (— physicists and 33 chemists). Nine doctors (2 physicists and 7 chemists) are engaged in research in government laboratories or other scientific institutions; forty-six (13 physicists and 33 chemists) are engaged on the research side of industrial development. These last named include the Chief Engineer of the Western Electric Company in New York, the head of the research laboratory of the Bell Telephone Company in New York, the director of the Mellon Institute of Industrial Research in Pittsburgh, a leading consulting chemist of the General Chemical Company in New York, the president and vice-president of prominent Chicago chemical corporations, and others, too numerous to mention.

The leading members of the staffs of the Departments of Physics and Chemistry at the University are men of international standing. Professor A. A. Michelson, head of the department of physics, was the first American scientist to receive the Nobel Prize and has been the recipient of many other signal honors, both abroad and in this country, in recognition of the value of his scientific contributions. Incidentally, during the war, as a Commander in the Navy, he invented a new range-finder of an extreme degree of accuracy. Professor R. A. Millikan, of the department of physics, known most widely for his work on the electron, was vice-chairman of the National Research Council during the war, and one of the chief experts guiding the development of anti-submarine defenses through scientific instruments. His researches have contributed also decisively to the development of wireless telephony. Professor Julius Stieglitz, the Chairman of the department of Chemistry, known particularly for his investigations in organic and physico-organic chemistry, served during the war as President of the American Chemical Society, as Chairman of the Committee on Synthetic Drugs for the National Research Council, and as special expert of the U.S. Public Health Service. He is the American Commissioner on the International Commission for the publication of Annual Tables of Physical and Chemical Constants. Professor W. D. Harkins, of the department of chemistry, has won international fame through his researches on the structure of atoms.

New Developments and Present Needs.

The close of the war finds the departments of physics and chemistry at the University of Chicago overrun with students. Particularly impressive are the numbers of graduate students coming for research work. During the year 1919-1920, the department of physics had to provide for 32 individual research students, the department of chemistry for 70. The congestion has been overwhelming, particularly in the chemical laboratories, where provision has had to be made for taking care of over 800 students in spaces which at best should accommodate only 500 ~~students~~. Research work of all kinds and such fundamental work as physical chemistry, Fifty-six students have received the degree of Doctor of Philosophy in Physics, one hundred and nineteen the doctorate degree in Chemistry. One hundred and six of these holders of the doctor's degree (39 physicists and 67 chemists) are teachers and investigators in educational institutions, — being heads of their departments (— physicists and 33 chemists). Nine doctors (2 physicists and 7 chemists) are engaged in research in government laboratories or other scientific institutions; forty-six (13 physicists and 33 chemists) are engaged on the research side of industrial development. These last named include the Chief Engineer of the Western Electric Company in New York, the head of the research laboratory of the Bell Telephone Company in New York, the director of the Mellon Institute of Industrial Research in Pittsburgh, a leading consulting chemist of the General Chemical Company in New York, the president and vice-president of prominent Chicago chemical corporations, and others, too numerous to mention.

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But, in making this appeal, the University has broader and greater plans in mind than simply the provision of further and better laboratory facilities. The University is facing squarely the issue of the fundamental importance of the sciences of physics and chemistry in the life of the Nation as outlined in the introduction to this statement, an issue on which rest the industrial prosperity of our country in world competition, the health and comfort of our people in peace, our preparedness for speedy defense in war with a minimum of the frightful wastage of life and property which war entails. Standing as the University does primarily for the development of graduate and professional work in all its branches, for the preparation of experts and leaders by the highest and severest type of training, the University has decided to develop as its first contribution to the new post-war era a Research Institute of Physics and Chemistry in which these fundamental sciences may contribute most intensively and richly to the needs of our national life in industry, education and health.

To this end the bringing to the University of further strong men, is sought to be attained by the securing of endowments for research professorships in physics and in chemistry, to supplement with leaders in other specialized branches of these sciences, the present strong staffs of the departments. In the ultimate analysis, it is the individual men who break the way into new fields of knowledge and endeavor, and who also inspire talented youths to intensive efforts in this same direction.

Research activities require ample funds for new apparatus, for adequate assistance in the laboratory, the library and the mechanics' shops. Hence endowment for equipment is a necessary concomitant of endowment for research professorships.

To such a leading and intensive research center of physics and chemistry the University proposes to invite in the most liberal fashion teachers from other educational institutions, (for instance, in their Sabbatical years), with certain limitations, research men from industrial laboratories, individuals adequately prepared, who are seeking for a place to develop and try out new ideas, new methods, new advances in science and industry.

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Co-operation with Industrial Laboratories and Scientific Institutions

Physics and chemistry as emphasized above form the foundation of sound industrial and scientific development. The demand on the University for its highly trained research men very greatly exceeds its present capacity to train such men. The greatest return which it can make to this country and particularly to contributing scientific institutions and corporations aside from the results of the fundamental investigations carried out by its staff, is in the form of an ample supply of highly trained research men. In order to insure closest co-operation between the two fundamental sciences and their applications in other sciences and in industry, it will further grant the following privileges:

1. The admission to the facilities of the laboratories of properly prepared research men of scientific institutions and of industrial corporations to work independently on problems of general scientific interest but of specific importance to the institution concerned. (In order to insure the success of the main purposes of the new Institution, the number of such research workers must be limited in any year to ten percent of the research students in the new laboratory, the problems to be worked upon must be approved by the President of the University and the head of the department concerned, and the results of the research work done must be made available by publication within three years for the benefit of the scientific world. These independent workers will enjoy the good-will but not the active co-operation and assistance of the staff of the University - their work being essentially independent. This limitation is necessary to protect the main work of the staff, their investigations on problems in pure science.)

2. Members of the scientific staffs of corporations and institutions will be entitled to the privileges of the library facilities of the University.

3. Contributing Corporations and institutions will receive at their request lists of students who expect to graduate in either department in a given year, either as college graduates or with the higher degrees, six months before the dates of graduation.

4. Contributing corporations and institutions will be free to consult representative members of the physics and chemistry staffs in regard to the question of where and to whom to turn for expert advice on given problems of interest to them.

Specific Details of the New Plan.

1. <u>A New Laboratory</u>.

For the inauguration of the plans that have been outlined the University needs immediately a <u>new laboratory</u>, primarily

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for chemistry but also with facilities and equipment for the expansion of the research work in physics. It is proposed that Kent Chemical Laboratory shall be used for the great undergraduate classes and that there be erected immediately west of Kent on the quadrangles of the University, or immediately north of Kent Chemical Laboratory and Ryerson Physical Laboratory and joining the two buildings, a new building to be devoted exclusively to research in Chemistry and Physics and to the training of such research workers in graduate courses. It is estimated that the new building will provide room and facilities for some 80 to 100 men actually engaged in research work, and for 150 to 250 graduate students engaged in work preparatory to research. About 80 percent of the floor space could be used either for chemistry or for physics, whose fields overlap in many directions, but presumably the greater proportion would be needed for the (at present) larger department of chemistry.

Go on to p. 5

It is estimated that this building with its equipment for chemistry and physics will cost approximately $470,000 and that an endowment fund of $120,000 should be provided for the maintenance of the building, as well as an endowment of $50,000 for the maintenance of the chemical equipment and $150,000 for the maintenande of the work in Physics.

2. <u>New Professorships.</u>

For the establishment of new professorships the following endowments are needed:

(1) For a Research Professorship in Theoretical Physics, with technical assistants, $200,000

(2) For a Research Professorship in Chemistry, with technical assistants, $200,000

(3) For a Professorship in Industrial Chemistry and assistants, $150,000

SUMMARY

For the convenience of ~~would be~~ donors, the foregoing plan is summarized in the following table. Each item represents a fund for a specific object (laboratory, professorship, endowment) to which on request the name of an individual donor contributing the whole amount for the specific object will be permanently attached (as for instance, the John Edward Smith Research Professorship of Chemistry)

1. A Laboratory Building, covering 10,000 sq. ft. with four stories and basement	$400,000
2. Equipment for Chemistry	40,000
3. Equipment for Physics	20,000
4. Endowment for Maintenance	120,000
5. Endowment for Chemical Equipment	50,000
6. Endowment for Physical Equipment	150,000
7. Endowment of a Research Professorship in chemistry, with technical Assistants	200,000
8. Endowment for a Research Professorship in Physics with technical assistants	200,000
9. Endowment for a Professorship of Industrial Chemistry and assistants	150,000
	$1,330,000

Specific contributions towards special rooms in the new laboratory, to be named on request after the donor, but to be included in a general fund for the construction and endowment of the new laboratory are indicated in the following table. The contributions of individuals including particularly alumni of the University, and of friends, private and corporate especially interested towards such special purposes are specifically invited.

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a.	Research Library (e.g. the John Jones Chemical Library)	$40,000
b.	Research Laboratory for High Tension Electrical work	15,000
c.	" " for Calorimetric Work	5,000
d.	" " " Low Temperature Work	7,500
e.	" " " Constant Temperature Work	7,500
f.	" " " Electrical Conductivity	10,000
g.	" " " Spectroscopy	5,000
h.	" " " Photochemistry	5,000
i.	" " " Microchemistry	5,000
j.	" " " Research on Organic Dyes (Chiefly theoretical relations)	10,000
k.	" " Research on Synthetic Drugs (Chiefly theoretical relations)	10,000
l.	24 Research Laboratories for individual students, at $2500 per room	60,000
m.	18 Research Laboratories for two students at $4,000	72,000
n.	8 Research Laboratories and offices for staff members, at $8,500	68,000
o.	General Laboratories for Organic Chemistry	60,000
p.	" " " Physical "	60,000
q.	" " " Inorganic "	25,000
r.	" " " Radioactivity	25,000
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THE Pure and DEVELOPMENT OF RESEARCH IN APPLIED SCIENCE AT THE UNIVERSITY OF CHICAGO

I. CONSIDERATIONS REGARDING THE ADVISABILITY OF SUCH DEVELOPMENT AT THIS TIME

1. The development of technological interests has long been a part of the general scheme of the University. Heretofore the time has not seemed ripe, but there are many reasons for believing that the present moment is peculiarly auspicious to launch this enterprise.

2. The University is the only one of the great universities in which technology is not now represented. This lack not only affects the symmetry of our organization, but also our educational prestige and the actual value of our contribution to the community.

3. No other institution, in this part of the world, at least, possesses a group of departments of pure science comparable in personnel and equipment to those found in this institution. To fail to build on these foundations the highest type of research in the applied sciences is to fail egregiously to improve opportunities that have few, if any, equals elsewhere.

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4. The University is put under constant request to render services of the kind here at issue, and while it has been able to do something toward meeting these demands, it has been quite impossible to deal with them at all completely or satisfactorily. To illustrate: we are constantly requested by the agricultural colleges and the experiment stations to undertake fundamental research in the botanical problems underlying agriculture. Similarly, we are continually approached with reference to the solution of problems of public health and sanitation. Again, we are repeatedly appealed to in connection with the problems of industrial physics and chemistry. The list might be carried out almost indefinitely.

5. The public imagination has been touched by the war as never before with an appreciation of the meaning of applied science for the life of the community. Congress is making large appropriations for agricultural and industrial research, and there can be no question that the present is the psychological moment in which to launch research enterprises of this kind.

6. Many persons are now considering in what form best to establish enduring memorials to those who have fallen in the war. It is certain that not a few of these will turn toward education. If the University possesses a well-conceived program of technological research, such persons

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7. Furthermore, there are not a few men who have accumulated great fortunes in the war who are disposed to offer to the community some substantial recognition of a desire to share with their fellows the advantages which they personally have reaped.

8. There is a very real danger that if the University does not seize this opportunity, some other agency will do so. Should this occur, it would seriously obstruct and indefinitely postpone the execution of such plan by the University. This outcome would not only be to the grave disadvantage of this institution in its development during the next generation, but it would also represent a distinct disadvantage to the community (using this word in the large sense), for without very disproportionate expenditures it would be wholly impossible for any other institution in this part of the world to create either in personnel or materiel the equal of our departments of pure science. Public policy as well as selfish interest, therefore, dictates the development of this enterprise.

9. As will appear from an examination of the accompanying brief, backed by the fuller statement of each of the departments concerned, this entire undertaking stands in most intimate relation to the possibilities of developing our work in Commerce and Administration. The possible interrelations

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10. It seems now fairly certain that the Rockefeller Foundation will go forward with the endowment of research in physics and chemistry, following the general lines of the plan already discussed with the National Research Council. The opportunity is therefore likely to be offered to the University, by meeting the requirements of the Foundation, to start in the very near future important phases of the physical and chemical program. There is good reason to believe that large interests can be readily induced to give financial backing to similar undertakings in agriculture, mining, public health, and the general problems of sanitation and food protection.

II. STEPS TAKEN ~~TO FILL IN~~ TOWARD THE PRELIMINARY ORGANIZATION OF A PROGRAM

1. Acting under authority of the President, several conferences have been held, at which were present Professors Michelson, Millikan, Stieglitz, Salisbury, Coulter, Jordan, and the Vice-President. As a result of these conferences, preliminary drafts have been made by each of the interests

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involved, outlining advisable modes of beginning the development in view, accompanied by rough estimates of expenditure for personnel, buildings, and equipment. A brief of the data thus compiled will be found in Section III of this document.

2. Under further authority of the President, the Vice-President, representing the Committee mentioned above, had extended interviews with Mr. George Hale, Chairman of the National Research Council, on January 15 and 16 in Washington. Mr. Hale expressed himself with the most unreserved cordiality regarding the entire program, and urged its most vigorous prosecution. He confirmed unequivocally the opinions formulated in Section I of this document regarding the peculiarities of the present situation and the opportunities which it presents for development along the lines indicated. He further expressed the opinion that the project mentioned in Section I, Paragraph 10, involving the Rockefeller Foundation, would articulate admirably with a general program of this type.

III. DIGEST OF THE DETAILS OF THE PLANS AS PROPOSED FOR PRELIMINARY CONSIDERATION BY THE SEVERAL DEPARTMENTS CONCERNED

To acquaint the reader with certain of the important considerations justifying the establishment of advanced technical research in the several lines under consideration, involved, outlining advisable modes of beginning the development in view, accompanied by rough estimates of expenditure for personnel, buildings, and equipment. A brief of the data thus compiled will be found in Section III of this document.

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1. Botany - Graduate School of Agriculture

A. Its Aim.

a) To train men in the fundamental science of agriculture, to fit them for positions in agricultural colleges, experiment stations, and the Federal Department of Agriculture.

b) To advance the fundamental science of agriculture, much as the Rockefeller Institute was founded to advance the fundamental science of medicine.

B. The Agricultural Colleges Are Not Meeting This Need.

a) The demand for agricultural education has grown so rapidly that the funds and forces of the agricultural colleges have been overstrained in instructing undergraduates.

b) The demand for extension work and control work is keeping the experiment stations and the Department of Agriculture overworked, with no opportunity to advance the fundamental knowledge in the subject. The demand for additional work in extension will, under the provisions of the Smith-Leever Bill, increase enormously for at least seven years to come.

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c) Legislators, both state and national, are unlikely to appropriate money for the advancement of fundamental knowledge, since they desire very immediate practical results, which never make for the greatest advances in the subject.

C. The Magnitude of the Demand

a) The younger men in horticulture and other fields of agriculture eagerly desire opportunities for advanced work in the fundamental principles of their subject. They have come to look for such work in privately endowed universities.

b) The need of properly trained men is keenly felt by the U. S. Department of Agriculture, and the view is frequently expressed by the Department that it desires to establish intimate relations with the big private universities, where the sciences fundamental to agriculture are organized and up-to-date.

c) Experimental stations, under the Hatch and Adams Funds, need men of such training for their research positions.

d) The announcement of such a school would bring a great influx of men from experimental stations, agricultural colleges, and the Department of Agriculture. We have been urged by representatives of land-grant colleges and of the Department of Agriculture to provide this training. The reason for selecting this University may be indicated by the fact that within the last few years graduate students in agriculture have come to us from thirty-four states for training knowledge, since they desire very immediate practical results, which never make for the greatest advances in the subject.

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D. Additions to Our Work Required by Such a School.

a) The additions to be provided would be soil bacteriology, soil chemistry, and soil physics, and plant pathology. As the work progresses, laboratories, plats of ground, and greenhouses would be needed, such as have already been planned for the block at the corner of Cottage Grove Avenue and the Midway.

E. Cost of Equipment and Maintenance.

a) The cost of initial equipment has been worked out in connection with the previous botanical garden project. In an undertaking of this character the initial expenditure can be flexibly treated. Undoubtedly it would be desirable to put as much as $300,000 into the plant, and to add funds for staff and maintenance approximating $50,000 a year - the income on one million dollars. Total expenditure at probable maximum, $1,300,000.

F. Some Probable Results.

a) Leading men in the field of agriculture have stated that such a school, properly equipped, would be of greater significance to agriculture than any movement of the last few decades.

b) Such a school would practically result in giving the University a large number of high-grade fellowships, for it seems fairly certain that experiment stations and agricultural colleges would send many of their men on full or part salary to work at problems which could be solved here.

c) Such a school would put the University in touch with one of the most important fields of production, in which our scientific equipment could be of great national service.

2. Graduate School of Sanitary Engineering and Industrial Bacteriology

A. Need for Such Work.

a) Modern communities are confronted persistently with problems of water supply, sewage disposal, heating, lighting, ventilation, and the like, which require fundamental scientific study and research of a kind at present furnished but very inadequately in this country. Questions of sanitary hygiene and the supervision of dangerous trades also create a series of problems demanding constant study. The various industries engaged in the handling and preparation of foods and

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B. Requirements for Sanitary Engineering.

a) Fundamental work in physics, chemistry, geology, and biology, as now given in our scientific departments.

b) Courses in surveying, hydraulics, etc., with work in vital statistics, bacteriology, and public hygiene. Most of the necessary courses are either available or easily provided.

c) Study of special problems, such as water supply, sewage disposal, swamp drainage, ventilation, etc.

C. Industrial Bacteriology.

a) The training required is in large measure already available in the courses given in our scientific departments. The main need here would be well-paid research fellowships. The problems of different industries vary widely, but for the most part involve men highly trained in bacteriology and chemistry.

D. Probable Expense.

a) The main expense would be connected with an

enlargement of the present laboratory space and technical assistance, together with a moderate amount of additional equipment. $75,000 might supply the necessary space if the building were of the character of the Ricketts Laboratory; proportionately more if it were adjusted to our permanent building style. Additions to salary and maintenance expense would perhaps approximate $25,000 a year - the income of $500,000. Total expenditure, $575,000.

3. <u>Graduate School of Mining</u>

A. Purposes of the School.

a) To increase efficiency in the production and utilization of mineral resources. This involves improvements in processes and machinery now in use or the development of new types; the exploitation of known but unused mineral resources. We now depend wholly on foreign countries for materials which might wisely be produced in the United States. The development of new uses for mineral resources now worked, with determination of the wisest uses to which mineral products may be put, and the discovery of uses for resources not now utilized.

b) To develop intelligent public interest in all questions concerning mineral production which are of significance to national life. This involves problems concerning the safety, health, comfort, and contentment of employees. (This

obviously touches problems to be dealt with in the School of Sanitary Engineering, in the School of Public Health, and in the School of Commerce and Administration.) It concerns also the business organization as applied to mining enterprises or mining finance. It relates to the proper basis for the taxation of mining properties, about which general and legislative opinion is now in confusion. (The last two points are obviously related to the School of Commerce and Administration and to the School of Law.) In the long run the School might be confidently expected to assist in the creation of an intelligent public sentiment tending to discourage illegitimate mining enterprises, to secure proper support for legitimate undertakings, to provide competent management for mines and mining mills, and to aid in the securing of better laws relative to all phases of mining work and workers.

c) In the attainment of these results the greatest contributions are likely to come through the fundamental study of the facts and principles involved in the deposition and discovery of ores, in the methods by which they are treated, and the ways in which they are utilized. These are questions of geology, physics, chemistry, and perhaps geography.

B. Equipment and Staff.

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E. Equipment and Staff.

a) It is apparent from the foregoing that an appreciable part of the equipment for advanced work in mining would duplicate the facilities involved in mechanical, electrical, and chemical work. If these were provided elsewhere they would not be needed in the mining division as such. If the equipment of these other divisions of the University were lacking in testing apparatus of various sorts, this would necessarily be provided for mining.

There are some advantages in furnishing a separate building, but this would not be necessary, provided the space could be secured in Rosenwald by devoting this building entirely to geology and mining, finding a separate building elsewhere for geography.

b) It would be necessary to have one thoroughly competent man as the head of the School, who should be familiar with the general problems and practices of mining. In addition there should be: (1) a metallurgist; (2) an expert in mining operations; (3) an expert in mining mill operations; and (4) an expert in geological exploration for mining purposes. The last four mentioned men should be engaged for limited periods each year, varying from three to six months. The remainder of their time should be devoted to practical work.

c) It is assumed that the Departments of Mathematics, Physics, and Chemistry can be relied upon for the fundamental work in those branches, and that the Departments of Political Economy, Law, Sociology, and Geography can contribute training in public organization, outlines of mining law, relations of mine operators to employees, utilization of mineral products, and the relations of the public to mineral enterprises.

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C. The estimated expense for this part of the work is set at $300,000.

4. A. <u>Graduate School of Chemical Technology</u>.

The need of many industries for technological research in chemical lines is so well understood as to require no explanation of the fundamental purpose of such a school.

B. Present Facilities.

The present laboratories and equipment of Kent are out of date and inadequate even for present needs. The Board of Trustees have already had submitted a detailed plan for a new laboratory to the west of the present building in which provision should be made for expansion of the present fundamental work and for work in industrial chemistry. Nothing can possibly be done without enlargement of the present plant; indeed, the present program cannot be carried much further without serious disaster.

C. Staff.

It would not be the plan to develop specialists in every direction of industrial chemistry, but rather to provide for the highest type of instruction and to develop research power in general by men who have had broad scientific training and who will be capable of developing special interests in even wider fields. A full professorship should be supplied to be held by a man interested either in the general field of metallurgy or of applied organic chemistry or of electro-chemistry. An assistant professorship and an instructorship might well be held by men so chosen that the three general fields may be covered, as

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The need of many industries for technological research in chemical lines is so well understood as to require no explanation of the fundamental purpose of such a school.

B. Present Facilities.

The present laboratories and equipment of Kent are out of date and inadequate even for present needs. The Board of Trustees have already had submitted a detailed plan for a new laboratory to the west of the present building in which provision should be made for expansion of the present fundamental work and for work in industrial chemistry. Nothing can possibly be done without enlargement of the present plant; indeed, the present program cannot be carried much further without serious disaster.

C. Staff.

It would not be the plan to develop specialists in every direction of industrial chemistry, but rather to provide for the highest type of instruction and to develop research power in general by men who have had broad scientific training and who will be capable of developing special interests in even wider fields. A full professorship should be supplied to be held by a man interested either in the general field of metallurgy or of applied organic chemistry or of electro-chemistry. An assistant professorship and an instructorship might well be held by men so chosen that the three general fields may be covered, as follows:

One professorship in industrial chemistry	\$4,000 - \$7,500
One assistant professorship	2,000 - 2,500
One instructorship	1,500 - 1,500
Assistants	2,000 - 2,000
Total...........................	\$9,500 -\$13,500

The demand for expert chemists of the research type is at present so great in the industries that the University cannot hope to retain the abler men unless it is prepared to meet to some degree the financial competition. It is, therefore, recommended that there be a gradual change in the salary scale such as will protect the need of pure scientific research side by side with industrial research. It would be recommended that in chemical technology any financial arrangements connected with industrial research should be on a University or departmental, not on an individual basis. This plan is feasible only provided the University salaries are materially increased.

D. Laboratories and Equipment.

At the outset a single new building, presumably to the west of Kent and connected with it, will be sufficient. It would be wise, however, to retain all the land west from Kent to Ellis and north to Snell Hall as possible ground for the future use of chemistry. No provision was originally made in Kent for physical chemistry. A new building should not only make it possible to provide such space, but also to care for courses in industrial chemistry and for the expansion demanded by the present work carried on in Kent. Such a building could presumably be constructed for \$350,000, with \$50,000 expended on equipment.

E. The total capital involved in this Kent chemical expenditure, capitalizing the salary accounts, would be approximately \$675,000.

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E. The total capital involved in this Kent chemical expenditure, capitalizing the salary accounts, would be approximately $675,000.

5. A. Purposes of the Graduate School of Physical Technological Research.

It is now generally recognized that the most important creative work in engineering is done by men who have been trained in the research methods of physics and chemistry. The war has made clear that national arts and industries stand in crying need of assistance from this source. There is no location in the country so favorable for the development of these interests.

It is to be recognized clearly that research institutions detached from universities tend to produce narrow specialists, that they are essentially man-consuming rather than man-producing institutions. A research institution in connection with a great university creating and stimulating in it a research atmosphere is at present a crying need in the United States. It hardly exists in the sense in which it is here conceived.

B. Staff.

Assuming that the new expansion were devoted primarily to pure science, it would be desirable to have at least three men with salaries of at least $7,000 a year. Such men would do a small amount of teaching, but their primary work would be research.

It would be an essential part of a successful scheme of this type to endow a considerable number of highly paid research scholarships (carrying $2,000 to $2,500 a year) to be awarded for a period of perhaps five years to young Doctors who gave promise of developing into research men of the highest rank.

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C. Equipment.

It would be quite essential to supply larger shop facilities, more mechanicians and more funds for instruments and supplies for research purposes.

D. Expense.

Six research professorships at the figure mentioned, six mechanics at $1,600, and $2,500 a year for each professor to expend on instruments and materials would aggregate $69,000, the income on a capital of $1,400,000. By starting with a staff of three professors and a corresponding reduction of accessory expenditures, would cut this figure in half. It may be said that there is good reason to believe that if the University embarked on this enterprise, the funds for the scholarships mentioned above might be somewhat confidently expected from outside sources.

E. Advanced Research and Engineering.

It is not altogether clear whether the program above outlined would require immediate additions of a large kind to Ryerson Laboratory. Some additional space would unquestionably be required. If the University were to undertake research professorships in engineering (one each in mechanical, electrical, civil, and either hydrographic or marine engineering) there is no question whatever that a new building costing approximately $300,000 would be essential, with equipment of perhaps $500,000. The professorial salaries would approximate $30,000 and $20,000 more should be added to cover the salaries of assistants and maintenance expenses. This would involve a total expense of $1,800,000. $2,000,000 would certainly provide for all this and the heating and lighting of the building itself.

F. Total Expense.

If the two plans mentioned under this division for development in physics were carried out, the total expense would aggregate $3,400,000. In the judgment of the senior members of the present Department of Physics the one described in paragraphs B, C, and D is the more important.

IV.

SUMMARY

It will be seen from a comparison of the formulations offered by the different departments that there is some slight diversity of ideal and very wide variation in the ambitiousness and expense of the several possible undertakings.

The development of satisfactory work in Sanitary Engineering, Industrial Bacteriology, Mining and Chemistry all appear practicable on the basis of reasonably small expenditures with relatively very large returns in the form of public service, and presumably with very considerable returns in the form of student tuition. On the other hand, the projects for botanical agricultural research and for physical engineering are relatively very expensive, particularly that in physics. To offset this greater expense it is, however, to be said that there is very wide interest in the agricultural problems which might reasonably be expected to appeal to donors of intelligence and imagination, and there is some reason to believe that very appreciable assistance can be gained in the direction of physics from some of the large foundations which enjoy the advice of scientists of insight and high repute.

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Although, as in most such undertakings, there is considerable advantage accruing from the mere magnitude of the enterprise in the appeal which it makes as a whole to public imagination, and in the advantages which it presents in exploiting to the fullest degree the phenomenal equipment in personnel and material of our scientific departments, there is nothing to prevent the successful development of any one of these divisions without regard to the others. An exception must perhaps be made for mining, which could hardly be carried forward with success without appreciable assistance from the side of chemical and physical engineering. Nevertheless, there should not be forgotten for a moment the innumerable advantages arising from the possible interrelations of the different types of research and the different forms of training. Chemistry, physics, botany, sanitary engineering, mining will all literally reinforce one another, if carried on side by side, in the most valuable and unequivocal way.

The itemized estimates of expense have been given in the preceding paragraphs. These total on the basis of the less ambitious and more conservative expenditures $3,375,000, and on the basis of the more pretentious undertakings $6,775,000.

Appendix 11
Pp. 9 & 10. Marked.

THE OUTLOOK IN CHEMISTRY IN THE UNITED STATES

JULIUS STIEGLITZ

Reprinted from SCIENCE, *N. S., Vol. XLVI., No. 1188, Pages 321–333, October 5, 1917*

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THE OUTLOOK IN CHEMISTRY IN THE UNITED STATES[1]

It is the highest privilege of the president of the American Chemical Society to express to you, citizens of Boston, the society's deep appreciation of your interest in our science and of your courtesy in providing entertainment for our numerous membership. In token of the reality of this appreciation, no less than in recognition of the honor bestowed upon me by you, my fellow members in the society, it is my pleasant duty to address you on some subject which might interest you as an important phase of chemistry or which might bring home to you as thoughtful citizens of this great country of ours some of the important functions which our science may be expected to fulfil in the life of the nation. It is the president's happy privilege also to select his own subject. In normal times, I confess, I should have enjoyed the pleasure the scientific man finds in riding his own hobby before a large and friendly public and I should have been tempted to try to present to you some phase of those wonderfully intricate worlds of atoms and molecules and of the forces controlling them, on which the peculiar power of our science rests. But the spirit of complete preoccupation in the great test to which our country is being put, which I know pervades the minds and souls of all of you, has led me rather to the choice of a subject of more immediate relation to our present situation. I have thought you might be interested in a discussion of the outlook in chemistry in the United States, with special reference to the resources of chemistry in the nation's service in war and in peace, as seen from the point of view both of chemical industry and of universities and colleges, the sources from which our chemists and our chemical lore are derived.

The great European war and now our own entry into the world struggle of free democracies against the organized military power of the last strongholds of feudal privilege in western civilization have brought home to the public as never before in the history of the world the vital place which chemistry occupies in the life of nations. What is it, indeed, that is so fundamental in this science that a country's very existence in times of great emergencies and its prosperity at any time may depend on its master minds in chemistry? It is the fact, summed up in the fewest possible words, that *chemistry is the science of the transformation of matter*. Since every phase of our existence is bound up with matter, from our birth to our return to dust, we find at every turn in life that chemistry is in demand to aid man in his effort to assure to himself a safe, scientific control in the supplying of his own needs, where nature, from time immemorial, has shown the same impersonal indifference as to his wants, his survival or destruction, that she has for every other form of life! From the transformation of our raw ores into finished metals of almost any conceivable quality and application, to the trans-

[1] President's address delivered before the American Chemical Society, September 12, 1917, at Boston.

formation of rocks and salts and the gases of our atmosphere into nourishing foods, from the transformation of the yield of our peaceful cotton fields and rich coal deposits into death-dealing explosives, to the preparation of blessed life-saving medicaments from the same crude sources—to mention only a few instances of the transformation of matter that I have in mind—it is chemistry that is giving us the power to satisfy our needs, whether it be for wise and beneficent purposes or for the fulfilment of our more baneful desires.

The crisis of the war has put this great controlling science, as it has put all other human agencies, to the fire test in every great country on the face of the earth. Acknowledgedly, chemistry has thus far staved off defeat for Germany after Joffre on the Marne had killed her hopes for a swift, crushing victory through the violation of Belgium, and had taught her that she must face a long struggle, in which, cut off from the world's supplies, she must make shift with what her own territories could yield and her chemists could produce. In the wonderful organization of power in France and in England in the midst of war, the French and English chemists have stepped in and brought their supplies of munitions of every variety, of remedies, of their new weapons of defense and offense in poison gas and liquid fire warfare up to the point of meeting now on more than equal terms an enemy prepared years in advance. And in our country too our chemists have stood the ordeal of an unprecedented time. I have in mind our splendid achievement of having solved in these three years of warfare such tremendous problems which these years have brought to us as were involved in the speeding up of the production of thousands and thousands of tons of fundamental chemical products needed by our allies and now for our own purposes—steel and iron alloys of every variety of toughness, hardness or elasticity, purified copper by the millions of pounds, aluminium for airships and motor cars, abrasives on which the trueness of every great and every small gun depends, sulphuric acid and alcohol for the preparation of explosives—foods, oils and scores of other essential products prepared on a scale never seen before—I think we may say with justifiable pride that our great basic chemical industries have successfully risen to the demands of a situation unparalleled in its scope and urgency. There have been times of delay and times of worry, but the few failures have been due rather to financial difficulties than to a breakdown in scientific efficiency. To those of us who know that the chemist is the final controlling mind, guiding in safety for the financier these vast undertakings and expansions, the record of these years is truly a wonderfully satisfactory response to the first crucial test of the efficiency of chemistry in America.

And this result justifies the faith that we will win out just as surely in the hundreds of newer problems brought to us by our own participation in the war. Some of these problems have been brought to the attention of our members by the chairman of the two chief chemistry committees, which are cooperating with the government—Dr. W. H. Nichols, chairman of the committee on chemistry of the National Defense Council, an industrial committee, and by Dr. M. T. Bogert, chairman of the chemistry committee of the National Research Council, a research committee. From San Francisco to Boston, from Minnesota to Texas, our chemists have shown the all-pervading desire to bring to the immediate practical assistance of our country every ounce of our strength and every grain of our intelligence, and have stepped into line for service not only with splendid enthusiasm, but still better, with the grim determination of purposeful men, who know well our enemies' strength, but who will do our share to eliminate, effectively, unscrupulous militarism from the politics of the world! The immediate response to the tender of the services of our membership to the President of the United States and of the organization of the members for such service through a census of chemists has been an increase in our membership from a total of some 8,000 to 10,500, an unprecedented growth, which shows unequivocally that the chemists of the United States are of one mind in ranging themselves on the side of organized, whole-hearted and forceful support of our government in this war! Indeed, one of our chief difficulties has been to restrain our men in their eagerness until proper organization would enable the central committees to designate to each man the field in which he could serve best. To the impatient chemists, waiting for their "marching orders" it may have appeared that invaluable time has been wasted and that progress even now is all too slow. But work on all the most important problems really was quickly organized and already important results are available. As an illustration of this fact we have the brilliant and speedy success of Dr. Day and his collaborators in producing optical glass, so much needed for range-finders, which will bring our shots home to the enemy.

The very nature of most of the problems makes it impossible to name them here, but I may say that improvements in explosives, multiplication of the sources of supply from which to manufacture explosives, including the utilization of the atmospheric nitrogen for the production of nitric acid, providing protection for our soldiers and sailors against poisonous gases, the making of chemicals for which we have hitherto been dependent on importations, these are some of the problems on which many of our ablest chemists have been working with all the power and concentration that the occasion demands. I may be more explicit in regard to the problem of the home manufacture of so-called synthetic remedies, for the supplies of which up to the present time we have turned to our present enemies. We need large supplies of salvarsan for our hospitals and for our armies, we need local anesthetics, substitutes for cocaine, for our surgeons, we need safe hypnotics to insure blessed sleep to sufferers in home or hospital, we need a long list of products to relieve the numberless ailments to which man is subject. Many of the best of these products are protected by patents, but the Adamson law will make it possible for American manufacturers to prepare these remedies in this country. There is nothing wonderful about their preparation—the scientific skill and experience of American chemists is coping with them as easily as an expert chess-player solves his problem in chess—and indeed with much the same kind of enjoyment. For instance, the obstacles in the way of the preparation of some drugs, most needed but prepared with considerable difficulty, such as salvarsan and atophan, have already been overcome in a way that leaves no doubt, if any ever existed, as to our ability to stand on our own feet, once Congress has removed the legal disabilities. University men and industrial firms have united in the vigorous attack on this problem.

This question brings me to another phase of my subject. Looking beyond the immediate future to the years ahead, why should we ever again be dependent on any foreign country for such fundamental needs of a nation as the best remedies for its stricken people—or, enlarging the question—for such fundamental industrial needs as dyes and dozens of finer chemicals, the need of which has seriously handicapped manufacturers and to a certain extent is still interfering with normal activity? It has been publicly urged in Germany—I am quoting from an excellent article by our friend Dr. Baekeland—that German dye manufacturers after the war should allow only a limited and conditional quantity of dyes to go to foreign countries, including the United States, in order to give her home industries a great lead in recovering the commerce of the world in textiles. Even if this suggestion should not be put into effect, for Germany has more to lose than to gain by a policy of trade-war after the reestablishment of peace, we may be sure that her own manufacturers will get the best of her supplies and every possible advantage. Our textile manufacturers and many other branches of industry will be at the mercy of competitors, assisted by government direction, unless we have a declaration of chemical independence in this country! Every thoughtful chemist, I am convinced, and I trust that every other thoughtful citizen, will acquiesce in the policy that henceforth in our *basic* needs, at least, we be independent of the friendship or enmity of foreign nations! And that conclusion brings me to one of the most important points in my discussion this evening: What are some of the main conditions, from a chemist's point of view, that must be fufilled, if we are to look forward to successful industrial and scientific development and independence, when the tremendous competition of peace must be met. These conditions are to be sought not only in the field of applied chemistry—and applied chemistry includes every great national industry, from agriculture to the manufacture of steel—but they involve also our universities, technical schools and colleges, the great sources from which our chemists come, not only equipped technically for their work, but carrying also the inspiration, the orientation, which will make or mar them and with them will make or mar that part of the nation's life which will be dependent on chemistry.

Turning first to the field of applied chemistry, I would like to emphasize that in my opinion the most important single factor which would lead to a tremendous increase in power in our industrial development is not immediately a question of scientific achievement, but a factor found in a simple psychological analysis of our industrial situation. Let our manufacturers but awaken to the great significance, to the full meaning of the simple old behest that the laborer is worthy of his hire, and they will be astounded at the results. American manufacturers at present on the whole do not treat their chemists, and especially their research and directing chemists, fairly. The tendency is to exploit the chemist as an employee, instead of treating him as a partner, who brings scientific experience, skill and acumen to the aid of capital and commercial experience and standing. Manufacturers are willing to cooperate essentially on the footing of partners with great lawyers, who solve their legal difficulties—usually a wholly sterile performance as far as the welfare of the nation as a whole is concerned—but they have not yet learned to cooperate in the same fashion with men of our profession, who solve their technical difficulties to the direct enhancement of the nation's wealth and welfare! Our chemists know and feel that they are being exploited and in conscious or unconscious resentment, after one bitter disappointment or the other in their employers' fairness, they lose their fresh enthusiasm and their capacity for the whole-hearted, unstinting effort that goes with the work in which the heart and soul support the mind! All this is wrong. Research and managing chemists should be sure that success means partnership in the fruits of their success, that success will yield immediately and not in some hazy future of a soon-forgotten promise, an equitable share in the actual benefits of the work done. This is one of the real but unrecognized sources of the unquestioned leadership of Germany in fields chemical: Dr. Bernthsen, director of the Badische Anilin-Fabrik, probably the greatest of the many great German firms, told me some fifteen years ago that from the lowliest workman up to the highest chemist in his employ, every individual is guaranteed by contract a royalty, a definite share in the money earned or saved by any suggestion or discovery on the part of the individual. Contrast this wise policy with what is common knowledge concerning the situation in the great majority of American plants. Any chemist can multiply indefinitely the single specific illustration of this attitude that I will give. One of our doctors of philosophy of the University of Chicago, as chief chemist for one of the very largest manufacturing concerns in the country—a unit in a "trust"—perfected a device, simple in itself, that saved the corporation perhaps $80,000 a year: his reward was a princely increase of $200 or $300 a year in salary! Incidentally, let me say that I promptly took him away from this corporation—we can not afford to waste good men in such places. In case after case that has come to my notice from some of our leading men, chemists have been cuddled and patronized until their improvements have been completed and then recognition has come munificently in the form of a few hundred dollars a year and—oblivion. These men, leading men, let me remind you, have acknowledged to me that this treatment killed outright all the fire of enthusiasm with which they had been wont to work! There are a few noteworthy exceptions among corporations, but their strength and prosperity confirm the validity of the appeal I am making, for they have recognized that in large measure their continued prosperity has been the result of the brain-work of their chemists, cooperating with the brain-work of their directors and the capital of their corporations. There are also prominent exceptions among individual chemists: we have men in our Society who have worked their way to positions and incomes on a par with those of successful lawyers and physicians—but manufacturers should heed well that almost invariably these are men who withdrew from their original direct employment by corporations and have developed their own independent establishments, either as consulting chemists or as independent, competing manufacturers! How much wiser it would have been for the manufacturers—I am not saying, for the chemists—if these brilliant, forceful men had been kept in their establishments, as they would have been abroad, by fair treatment as partners in success as well as in effort.

I have dwelt long on this plea because I consider this message to our manufacturers from an outside observer, a university man without any industrial affiliations, to be perhaps the most important service I can try to render our country in this privileged address. Let me summarize my point with the aid of an analogy which I owe to my friend Dr. Eisenschiml's remarks after a presentation of this subject to our local section in Chicago: Just as Napoleon let every soldier feel that he carried a marshal's baton in his knapsack and thus secured the enthusiastic and self-sacrificing support of his hundreds of thousands, so our manufacturers should let their chemists feel that each one carries in his brains a contract of partnership—and all that is involved therein! If this is done, we will witness through the tremendous power of the combination of psychological momentum and trained, scientific minds, the dawn of an era of power and prosperity in our industries, in which no one need fear the after-the-war competition for which all Europe is now preparing. Enlightened self-interest is slowly revolutionizing and improving our whole social fabric by a fairer, more honest conception of the relation of capital to workers—with harm to no one, least of all, and to their own surprise, to those who have blindly been opposing the movement. And my plea for fairer treatment of productive chemists is the point at which the great world movement touches our scientific body.

Another vitally important factor in the outlook for chemistry in the United States is the adoption by our legislative bodies of a definite national policy looking toward the establishment of that independence of our country in the matter of chemical supplies to which reference was made before. Action in this direction has been happily inaugurated in the fundamental matter of the fixation of atmospheric nitrogen for the manufacture of explosives in war times, of fertilizers in peace and war. The fixation of nitrogen plants in Germany have unquestionably saved her thus far both from a military collapse and from starvation. As has been indicated before, it is important too that we become independent in as large a measure as possible also in regard to all manufactured chemicals and particularly also the finer organic chemicals, including the dyes and the synthetic drugs. The most important measure necessary to this end is protection by duties such as a non-partisan commission of experts may find necessary. American textile manufacturers, who have opposed this action in the past as far as dyes are concerned, have, I trust, learned their lesson, and will not, I hope, need a second more sharply pointed one. And other manufacturers, having found their supplies of needed chemicals cut off or enormously increased in cost, will also, I imagine, favor the establishment of conditions making home production possible. It is a source of gratification to me to state that the United States Tariff Commission, which is making a scientific study of the vexed tariff problem, most courteously asked for, and received, the cooperation of this society in the choice of an unprejudiced expert on the chemical schedules.

Wise patent legislation is another fundamental consideration in a declaration of chemical independence. The public—that is, their representatives in Washington—should understand what is obvious to any professional student of the problem, namely, that independence is altogether a question of capital, not of science—of dollars, not of chemists. Our unqualified success in every line of applied chemistry in which investment of capital has been an attractive proposition is positive evidence that we have the chemists and the knowledge to achieve this independence, if wise legislation by tariff and patent laws will insure to capital a return sufficiently attractive and stable to have it enter these needed fields.

To illustrate concretely what this policy would mean for the nation let us consider the following: Much more than a question of coloring materials is concerned in a conscious policy to have our dye industries established on a permanent basis. It has often been emphasized that the manufacture of dyes is so closely related to the preparation of explosives that a flourishing dye industry in times of peace means ample facilities for explosives in times of war. No American would care to contemplate what our position would be in the matter of large scale production of explosives if we had become engaged in a struggle with a first class power without the benefit of the great expansion in our dye and explosives factories which our commerce with England and France brought about after 1914! When peace comes, let no American forget this lesson! One way of insuring ourselves against a lack of facilities for a sudden expansion in the production of explosives is to keep capital invested in dye factories.

Independence in the preparation of medicinal remedies, especially also of the finer modern products which we call synthetic drugs, should be as conscious an aim of the United States as independence in the manufacture of dyes. It is worth noting that the two aims support each other, for nearly all of the basic products needed for the large scale preparation of synthetic remedies are either prepared in aniline dye factories as intermediate steps toward the dyes or are so closely related to such compounds that it would be a mere detail to include these products in the normal output of a dye factory. As an instance pointing in this direction, recent correspondence with a prominent American firm, which has invented and is manufacturing what promises to be a valuable substitute for cocaine in producing local anesthesia, brought out the fact that the chief difficulty in the way of the production of the drug on the large scale which the situation demands, lies in the securing of sufficient quantities of the chemicals diethylaniline and cinnamic acid. Now, the former could and should be manufactured in dye factories with the greatest of ease, side by side with dimethylaniline, which is a common intermediate in the manufacture of many dyes, and cinnamic acid could be prepared from benzaldehyde, another intermediate. Furthermore, large research departments in well-organized dye factories will be centers of research in applied organic chemistry and practically all of our valuable synthetic drugs are such organic compounds. Indeed, it will be a matter of time only—and I should like to see that time shortened as much as possible—when some of our best equipped and most progressive dye factories will turn to the problem of these remedies as a question of the economic utilization of their equipment. That has been the history abroad and it will be the same here. In fact, together with our long-established great pharmaceutical houses, they should find even richer, unexploited fields of effort in the problems of synthetic drugs than in those of dyes. Without question the average man spends on necessary drugs for his family at least a thousandfold the value of the dyes in the wardrobes of his whole family—the ladies, of course, included. The twitchings of rheumatism or gout, sleepless nights or a cantankerous cold are most urgent and persuasive drawers on a family purse. My professional friends in the audience know well how the modern dye industry has been built up on an accurate scientific knowledge of the connection between color and what we call the structure of the molecules, those minute worlds on the knowledge of which our power to reconstruct matter rests. We know too that the dye industry has reached, or almost reached, its full maturity and capacity. But we are only on the threshold of exactly the same kind of development in the discovery of improved remedies for curing human ills because the connection between the structure of our molecular worlds and their medicinal effect is just beginning to be systematically elaborated. Great industrial establishments founded on organic chemistry, like the dye manufacturing and the great pharmaceutical houses, collaborating with research laboratories in universities and in medical institutes, would hold out to this country the promise of a share in realizing a duplication of the conquest of the world of color, which has occurred in the last fifty years, by the greater conquest of the world of scientific medicine! A brilliant beginning has been made in this campaign by the preparation of excellent substitutes for cocaine, less toxic than cocaine itself—by the elaboration of salvarsan, by the isolation in our own country, and the artificial production, of adrenalin, a vital regulating principle produced by an organ, the suprarenal capsule, in our bodies. The isolation and exhaustive study by Kendall of the active principle of the thyroid gland, which no doubt will be followed by its artificial preparation, is a second brilliant instance of American success in this great field! When we consider the countless number of animal preparations—gland extracts, serums and antitoxins—the pure active principles of which are all we really want, but which are injected into us or fed to us, with an extraordinary amount of unnecessary and often harmful animal matter, we can realize what a boon to humanity this line of effort really means. Let me emphasize again, it is chiefly a matter of wise and foresighted legislation to make our independence and perhaps our leadership in this great field possible—we have proved that we have the scientific ability—it is a question only of putting this work on the basis of an established industry!

There are other important considerations bearing on the outlook for chemistry in the United States from the point of view of industrial chemistry—such as a law making possible commercial agreements and divisions of labor among competing houses, which exist abroad—but I must neglect no longer to turn to the third important theme embraced in my subject, the outlook for chemistry from the point of view of our universities and colleges, in which I will include the outlook for the development of the theory of our science in this country.

One can not well overestimate the importance of the standing of chemistry in our universities and colleges: they are not only the main sources of supply of chemists in the United States, but they are also the fountain-heads for the knowledge which keeps us in touch with the progress of chemistry the world over and which makes available for rapid absorption in any field of pure or applied chemistry new discoveries, new methods of attack, new, clarifying points of view. Let me remind you that applied chemistry includes not only industrial chemistry, but also fundamental and most promising fields of effort in other major sciences. Botany through the inspiration of Liebig was probably the first of our sister sciences to apply chemistry to the solution of many of its problems. Physiology followed and now we see even zoology awakening under the stimulus of chemistry from its long morphological trance to a live science of animal life. In fulfilment of the promise contained in the life of our great fellow-chemist Pasteur, chemistry is now at last guiding not only the physiologists, but also the bacteriologists, pathologists and laboratory clinicians toward the raising of medicine from the uncertain realm of art to the safer one of science. All life is indeed but a transformation of matter in its loftiest phase and the world is at last realizing that the fundamental science of the transformation of matter holds the key which should unlock the secrets of all aspects of life, of birth, health, disease and death, and probably even of such subtler manifestations as heredity and character.

I have outlined some of these far reaching applications of chemistry in order to emphasize the fact that if we are to meet all of these demands on chemistry, if the outlook not for chemistry alone, but for all of these lines of human progress which are dependent on our science is to be one of sure promise in the United States, it behooves our people to see that the departments of chemistry in our universities and colleges be kept not only prolific as to the output of men—the vast expansion in laboratories and attendance bears witness to quantity being insured if the war does not affect us too severely—but that they also be maintained on such a high level of scientific quality that the product will consist of the very best type of men! We have received from the period from which we are now passing a magnificent heritage of world standing and ideals in our university life. The last twenty-five years witnessed an era of expansion of our resources for research and instruction, of the raising of standards of scholarship and productivity of such moment that many years before the war began the migration of our students, especially also of our chemistry students, to Europe for the pursuit of graduate work and the securing of the highest type of professional training had practically ceased. It has no longer been a question of Berlin or Munich, of Goettingen or Heidelberg; for the prospective chemistry student it has been a choice of Harvard or John Hopkins, of Chicago or Columbia, of Illinois or California, the Massachusetts Institute of Technology or Cornell—I could extend the list much longer, but fear it would tire you. And it has been so because our young men have felt that they could secure just as thorough an education here as there, just as inspiring guidance from men whose research had made them masters in their own fields. Our Remsens and Michaels, our Richardses and Nefs, our Noyeses and Gombergs, Lewises and Morses—to mention only a few of our leaders of this period—founded that independence in university education in chemistry which our country has the right to demand that we maintain.

Now, thoughtful men in our society, looking ahead, see that this great uplift in our scientific life is facing dangers which unless they are met frankly and effectively, will bring on a period of depression which will be a grave menace to all the varied fundamental interests in the life of the nation that depend on chemistry.

The first and greatest of these menacing developments has its root in the recent unprecedented demand of our industries on our schools for research men. From university after university, from college after college, the combined lure of great research opportunities and of much larger financial returns has taken from our academic life far too many of our most promising young men, the very men on whom the country has been depending for the filling of our great university chairs as the older men now holding them gradually will age and retire. Unless prompt measures are taken we shall witness in a few years such a dearth of first-class tried material for professorships that second-rate men will be placed where the national welfare needs the best we have, and third- and fourth-rate men will be occupying positions in which we should have young men of the highest promise in the period in which they are reaching full maturity. Indeed, it is greatly to be feared that even now we are witnessing a gradual lowering of standards. It would be futile to appeal to our industries not to call the men they need, although in the not distant future they will suffer most severely from the situation which is developing, if the present tendencies remain unchecked. The only possible source of relief lies, I believe, with the presidents and trustees of our great universities, and to these the second main plea of this privileged discussion is addressed. These authorities should recognize the fact that their institutions have now entered a period of severe competition between the industries and academic life for chemists of the highest type and greatest promise.

They have already learned the only method of meeting this kind of competition successfully, for they have faced the same problem in two other professions, medicine and law: in the face of the tremendous financial attractions of the practise of either of these professions our most progressive universities have simply put their law and their medical faculties on a higher, more nearly professional scale of endowment of professorships than obtains for their other faculties. They must, it seems to me, take the same measures with their chemistry staffs: it is primarily a question whether they can be awakened to that need now or whether they will let the country suffer from their lack of foresight and let us learn from the most efficient of our teachers, bitter experience. Wise provision now would not only safeguard our present standing in a critical period of our history, but in this time when the importance of chemistry has been brought home to our young men as never before, the new attitude, properly announced, would attract a large proportion of the men of brains, talent and ambition who enter professional life, but tend to study law or medicine as holding out much greater opportunities for the satisfying of their ambitions.

Adequate compensation is important for a research man—and to his type in university and college I must restrict my remarks—it is important both from the point of view of his self-respect and also especially for the sake of comparative freedom from worry concerning a fair provision for his family. But inadequate compensation is not the only danger seriously threatening the outlook for chemistry in our universities. Let us remember that healthy progress in our science is dependent primarily on university men pursuing great lines of original investigation. It is true that we now have well-endowed national institutions of research, such as the Rockefeller Institute and the Carnegie Institution, but universities can not afford to surrender to these the main burden of insuring progress in the theory of our science, because these *are not teaching* institutions. To take from our universities the choicest of our research men would deprive our young men of that inspiration and fertilization of their minds in the period of their greatest acceptiveness which early intimate association with great investigators alone can give. To my mind it is clear that if universities would fulfil their highest mission they must remain the seats of the best type of research. But such research is the product of an extraordinarily sensitive state of mind. Only the greatest powers of concentration of thought make it possible. The investigator is groping for truth in unexplored regions, wary of every pitfall, most fearful indeed of possible illusions of his own highly excited imagination. Let any one imagine himself groping in a dark and unfamiliar room and he will easily realize that the undisturbed concentration of his every faculty is the only way for him to attain his goal! Let the rush of an automobile or the screech of a locomotive detract his attention but for an instant and he may well have to rue a stubbed toe or a grazed shin! Now, figuratively speaking, there are too many noisy automobiles and screeching locomotives in the lives of our distracted investigators. American universities, in general, have the unfortunate custom of loading down their best investigators as heads of departments with administrative duties of all varieties, ranging from clerical functions to committee work, important for the institution, but always a grave obstacle in the path of successful research. Younger men, even when they show marked research ability, are too often worn out with excessive duties of instruction and laboratory detail, when their minds need their keenest edge to cut their path to the elusive truth! Men in whom the research instinct is inborn and overpoweringly intense, will break through these difficulties—usually at the cost of the neglect of other duties—but our system is one that means an extraordinary waste of talent for the highest type of work on duties that minds of lesser fineness could do just as well or better. On top of these older defects, which we have been only slowly recognizing and removing, have come in the last few years the further distracting duties of necessary public service. Let me repeat what I stated earlier in the evening: every one of our great chemists, as well as of our less well known ones, is eager to devote every particle of his knowledge and strength to the sacred duty of the moment. Theoretical work has been set aside except as it contributes directly to the cause of national defense. But let us begin to realize now that when peace comes we must let our investigators return to the service of pure science, we must leave them severely alone, free from committee work of any kind, so that they may recover that opportunity for concentration which is needed for productive research of permanent value! Some of our research men, I dare say, are being spoiled forever for this service, exactly as many a returning soldier will have lost in a craving for adventure his fitness for ordinary civic responsibilities.

There is a strong movement too in our society to bring universities and industries into closer relations, a laudable movement with which I am in heartiest sympathy, but which can bring unmixed benefits only if it is most wisely guided. It would be fatal if it were allowed for the sake of temporary advantage to injure in any way that search for truth for the sake of the truth itself on which, after all, the great structure of our science as of all sciences rests. Let the large proportion of members in our society who are primarily interested in applied chemistry, recall as a typical illustration of a very general truth that chemists had tried for fifty years to manufacture sulphuric acid by the contact process and had utterly failed, and that success finally came only when the laws of physical chemistry, products of the research of guileless university professors, were available and were applied to the problem! Who can doubt that we still need the efforts of new Faradays, van't Hoffs, Roozebooms, Bertholets, Kekules! The question has impressed me as so vital a one for the outlook for chemistry in this country that as president of our society I have put on the committee charged with the development of relations between industries and the universities primarily university research men, with the understanding that they will give to pure research in our universities the benefit of every doubt in their recommendations. I trust that our society, as a whole, will realize that it were better that our industries suffer somewhat temporarily than that our national strength in chemistry be crippled at the source. My personal opinion is that we can attain both of our objectives—to use a war phrase. Thus, our present war duties are making university men personally acquainted with numerous practical problems which in many cases after the war, will probably form the basic material for investigations of theoretical relations. Even if they are only in a measure as successful as those of Baeyer, when through the study of the structure and synthesis of indigo he opened up the great theoretical fields of knowledge of tautomerism, of the theory of unsaturated compounds and of cyclic derivatives, they will advance both branches of our science, applied and theoretical chemistry. Efforts along the lines of developing the theory of the connection between molecular structure and physiological or medicinal properties are now taking root in a number of our universities. But, on the whole, I would recommend that technical research problems—routine analytical and control work should be altogether barred from our universities—that technical research problems be limited in universities to picked men interested in applied chemistry and holding possibly professorships or other appointments in industrial chemistry. In time, these men will become dependent on their colleagues devoted to pure science for keeping step with the progress in our science. I would urge, too, the perhaps novel recommendation that remuneration for such work be made a departmental and not an individual affair. This wise provision is being enforced in those modern medical schools which demand research work of their staffs, fees for practise reverting to the university hospitals and not to the individual. As applied to chemistry, such a provision would be desirable, in the first place, because it would to a large extent reduce the temptation of financial inducements for the men whose talents fit them for work in pure science and whom the country needs for such work. In the second place, one will find that the university man interested in a technical problem is, after all, less useful in a teaching department than the man devoted to pure research: the pressure from outside will lead him to throw a greater mass of administrative detail, of instruction or of the care of research men, on his colleagues. The result is that the department and not the individual really carries the burden of the problem in applied chemistry—exactly as in the medical schools, which still allow their staffs to practise for their own financial benefit, this is all too often done with the drawbacks of inefficient teaching, the ignoring of administrative responsibilities and the leaving to the care of others the provisions for education in research.

I have dwelt on the details of this great problem which is confronting our society, because I would protect the outlook for the growth and success of theoretical chemistry in our country by every means in my power. We have a splendid record: we are easily leaders in the domain of knowledge based on the exact determinations of atomic weights—a knowledge which leads among other results to habits of more exact, more critical methods in all fields of our science. Arrhenius told us that America is leading in the difficult work of the rigorous examination of the theory of ionization and of establishing it on a finished basis. The development of the field of free energy relations is more intensely cultivated, here I imagine, than in any other country. In the application of modern theories of atomic structure and of the electron theory of valence to all branches of chemistry, especially also to organic chemistry, we are, I believe, easily in the front. Our very youth, as a people, has preserved to us in science as in national sentiment, that wholehearted enthusiasm for ideals, which in world politics has made us the most altruistic nation on the face of the earth and which in science finds its expression in the pursuit of knowledge for the sake of the pure truth alone, a pursuit characteristic of the best research in our universities and colleges!

And so let me conclude my remarks on the outlook for chemistry in America by emphasizing that we have a goodly heritage of success both in our great industries and in our great universities, which will form the safe basis of a brilliant future, if we will but approach the problems of the moment and of the immediate future in characteristically American fashion, with a spirit wisely combining altruistic principles with practical, worldly common sense. This means the "square deal" in industrial life for the product of the brains of the research chemist, combined with wise laws to insure to capital a fair and tolerably safe return for investment in chemical industries, needed to make our country chemically independent. And it means too the placing of chemistry in our universities on a plane with the other great professions, law and medicine, in order to hold in this great science, so important for the welfare of the nation, the needed numbers of men of brilliant minds and energetic ambitions —combined with the devotion on their part to the search for the truth, for the establishment of the great laws of our science, for the sake of that truth, that science, alone!

JULIUS STIEGLITZ

UNIVERSITY OF CHICAGO

+58

GENERAL ELECTRIC COMPANY
RESEARCH LABORATORY
SCHENECTADY, N. Y.

February 9, 1921

President Harry Pratt Judson
The University of Chicago
Chicago, Illinois

My dear President Judson:

There is just a diluted trace of a shade of mental reaction gained from your nice letter of February 7, which I want to straighten out before I even think it over.

In Professors Michelson and Millikan your University has the very best and most useful scientists, and if I had infinite power and were in your position, I do not believe I would try to change their natural orbits by the width of a hair.

I think I am just wise enough to see that if we had more men like them, we should have little to worry about in this country.

Yours very truly

W. R. Whitney
W.R. WHITNEY

WRW C

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...ch Laboratory
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WRW C

February 11, 1921

My dear Mr. Whitney:

Yours of the 9th is received. I am able to discern the shadowy fragment of a mental reaction without a microscope. You are quite correct. At the same time to complete the field of your investigation, for your illumination I will add that the direction of their orbits has been measured in accordance with their own suggestions.

Very truly yours,

Mr. W. R. Whitney,
General Electric Co.
Research Laboratory,
Schenectady, N.Y.

HPJ:JN

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HP[illegible]:JM

<u>The Necessity for the Creation of New Conditions in America in the Field of Research in Pure Physics and Chemistry.</u>

It is probable that the world is now entering upon a period of the sharpest industrial competition which it has ever known. German scientific efficiency has been greatly enhanced under the pressure of war necessity. England has made an initial appropriation of one million pounds for the promotion of research. Japan, Australia and Canada have appropriated funds for great research laboratories. France, Italy, South Africa and New Zealand are moving rapidly in the same direction.

Many of the larger industrial corporations have already established great industrial research laboratories, and others are following. The British cotton manufacturers have formed a co-operative research association, to study cotton in every stage, from the plant to the finished product, and other groups of manufacturers in England are following their example. Self-interest, once fully aroused, will amply provide for industrial investigations. But this is not true of the fundamental scientific research on which industrial progress depends.

If, however, research in pure physics and chemistry is not stimulated equally with industrial research, the stream will dry up at its source. Almost all great industries rest upon discoveries and developments which were first made in the laboratory of the pure physisists and chemists. A very recent and very striking illustration is furnished by the tremendous and increasing uses which have been found for the advances made in the field of electronics and high vacuum research,--advances

made for almost two decades solely by the pure physisists, which have now gone over into the industries and have cheapened and extended enormously the process of communication by both wire and wireless. When one reflects that communication is the lifeblood of civilization, and of international goodwill, he realizes the debt the world owes to men, who, urged on merely by the desire to find out how nature works, made the fundamental discoveries which have been utilized in these developments.

The advancement of research in pure science must be financed from private funds. At present almost all research in physics and chemistry is done at odd moments by overworked teachers, inadequately equipped and without assistants to relieve them of petty details. There is the most urgent need for the establishment of a new method for the conduct of research in connection with some of the American Universities. An effort is being made to find ways by which a few of these universities placed in strategic positions throughout the country may develop great research institutes in physics and chemistry.

Research Institute in Pure Physics and Chemistry at the University of Chicago.

Fifty national research fellowships in physics and chemistry have been established by the Rockefeller Foundation, because of the recognition of the fact that the basis of modern civilization, both on its industrial and on its intellectual side, is research in the underlying sciences of physics and chemistry. The hope and the expectation of the originators of these fellowships is that, through this stimulus, there will develop, in connection with five or six American Universities,

great research institutes in physics and chemistry, such as do not exist at all in America to-day---institutions in which there will be as many highly trained investigators devoting two thirds of their time and energy to research, as are now found in the detached research institutions like those of the Carnegie Institute and the Rockefeller Institute for medical research, or the research laboratories of the large industrial organizations like the General Electric Company or the Western Electric Company. It is believed that such institutions, in connection with the American universities, where they will be freed from the limitations of industrial laboratories, divorced from the narrowing influences of detached research institutes, so placed that the research atmosphere which they create can be breathed by the most talented youths who pass through the American Universities, will exert a very marked influence upon the development of preeminent scientific men in America, upon the scientific and industrial growth of the United States, and upon the making of this country the center of the world's scientific life and progress.

The fifty research fellowships provided by the Rockefeller Foundation will go to those universities which create the best conditions for research in physics and chemistry. Steps have already been taken by some universities to expend from one to two million dollars in new research professorships and new facilities for research in physics and chemistry.

The University of Chicago must be one of the institutions which develops in this way, else it will fail to retain its preeminence as a research institution in these fields.

In order to create a research institute of the kind contemplated, there is needed:

1. Three new research professorships in physics and three in chemistry, carrying with them an average stipend of $7500. This represents the income on about $1,000,000.

2. Four new mechanics and four new laboratory assistants at $1500, thus making a total of $12,000 per year for the salaries of helpers; $2000 a year for each professor for equipment, or $12,000 in all for this purpose; $1000 a year for equipment for each fellow, which with ten fellows would amount to $10,000; making a total for the equipment and helpers of $12,000 plus $12,000 plus $10,000, or $34,000 per annum. This represents the income on about $700,000.

3. A new research building for physics and chemistry which with equipment and endowment for maintenance would cost $500,000.

The above estimates make, then, the new capital required for the establishment of such a project amount to $2,200,000.

It would, of course, take years for the full development of such a project. Six men of the calibre and reputation in contemplation could probably not be found at once, but it is exceedingly important that new funds be provided, which are to be expended solely for the purpose of research, and which, by the terms of gift, cannot be diverted from this purpose by the growth of the University as an educational institution.

A Programme.

The first step in the development of such a research institute as that in contemplation, might well be the immediate en-

dowment of two professorships; One in physics and one in chemistry, to be known by the name of the Donor, or at his designation, the endowment for each professorship to be $250,000, and the income from this endowment to be available only for the purposes of the professorship, that is, first for the payment of a salary such as would make the holding of the professorship an exceptional honor, available only to men of the highest attainments; second, for the payment of a mechanician and an assistant, or of two assistants; and third, for the purchase of supplies and equipment, the distribution of the available funds between the assistants and equipment to be made upon the recommendation of the holder of the professorship.

If these two professorships could be immediately created, and the present heads of the departments of physics and chemistry given the honor of becoming the first holders of them, the plan would be started in a way which would be both dignified and inspiring. More able men in these two fields do not exist in the United States, and the prestige which they would give to the positions would be a great stimulus to their successors for decades to come. Further, the award of these positions to these men would be a fitting recognition by the University, of the services of two of the most productive members of its faculty.

The present salaries of the two heads should be used for freeing, to a larger extent than is now possible, the most promising of the younger men in the two departments, from the excessive instructional demands, which have, in recent years, grown so as to encroach seriously upon the research possibilities of the departments. If sufficient funds were left, they should be used for

bringing into each department a new man, of such calibre as to give promise of ultimately succeeding to one of these endowed professorships.

The programme in succeeding years would be the adding of new professorships, patterned after those already described, as suitable men, and funds could be found.

Such professorships, held continuously by fertile men, whose work would carry the name under which the professorship was known to every country in the world, would make an even more fitting and attractive monument than the most stately and beautiful of buildings.

The finding of half a million dollars for the erection of a new building to house the contemplated extention of the departments of physics and chemistry, is an urgent need, which must be given attention at the earliest possible date, but the immediate step should be the endeavor to create two new endowed professorships of the sort described.

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Schlesinger

June 2, 1921

Mrs. Ferdinand Schlesinger
La Fayette Place
Milwaukee, Wisconsin

Dear Mrs. Schlesinger:

In the summer of 1919 I had the pleasure of a conference with your late husband, Mr. Ferdinand Schlesinger, in regard to the urgent need for a new chemical laboratory at the University of Chicago. I had appealed to him as the most progressive and leading spirit in the West in the application of chemistry to great industrial undertakings. In Ocyober 1919 Mr. Schlesinger was kind enough to write me that while he would not be in a position to undertake the erection of a new laboratory, he would be pleased to be one of the contributors to a fund for such a building.

The plans were held in abeyance for some months and then further delay was caused by the financial depression and by Mr. Schlesinger's unfortunate illness and death.

I am writing you now to enquire whether you and your sons would be at all interested in considering the erection of a Ferdinand Schlesinger Chemical Research Laboratory as a memorial to the late Mr. Schlesinger, comparable with the Ryerson Physical Laboratory, the Rosenwald Geological Laboratory and others of our laboratory buildings. The University of Chicago has always been dependent on its friends in Chicago and elsewhere for the funds for new buildings, its endowment

Schlesinger

funds being devoted to instruction, research, upkeep, and similar current expenses, and hence I am not hesitating to present our needs to you.

That you may judge whether such a memorial in the form of a chemical laboratory for graduate and research work, dedicated to the great pioneer in the West in developing industry with the aid of science, would find a worthy location at the University of Chicago, I am appending a short statement concerning the work and aims of our present chemistry department.

Let me add that it would take at least two years for the drawing up of detailed specifications for the new laboratory and for the erection of the building. Payments for the cost of the building could then be made to cover any time interval that would be most convenient to the donor.

If you are at all interested in this project, I shall be very glad to have an opportunity to confer with you in Milwaukee or to arrange that you may see at first hand the work the University of Chicago is doing in the service of our great Middle West. I am

Yours respectfully,

The Department of Chemistry at the University of Chicago.

The work and standing of the department may be judged by its output - in men, in research, in books and by its record in attendance by men of maturity seeking the most advanced type of work in chemistry.

Doctors of Philosophy. The department of chemistry has sent out over one hundred thirty doctors of philosophy and expects to graduate some twenty more at the June and Summer Convocations this year. While most of these men are still young, their promise is indicated by the accomplishments of some of the older graduates. A few instances must suffice. Dr. E. E. Slosson, Ph.D., 1902, is the author of Creative Chemistry, the most widely read book on chemistry in the country. Dr. R. F. Bacon, 1904, is the Director of the Mellon Institute of Industrial Research, and during the war was in command of the first chemical research unit sent to France. Dr. Lauder W. Jones, 1897, is Research Professor of Organic Chemistry at Princeton University, Dr. Otto Folin, 1898, Professor of Biological Chemistry at the Harvard Medical School and a member of the National Academy of Sciences. Dr. R. H. McKee, 1901, is Professor of Chemical Engineering, Columbia University, Dr. Herbert N. McCoy, 1898, and Dr. Ethel M. Terry, 1913, are co-authors of the most up-to-date chemistry text book written in this country (Dr. McCoy is the Vice-President of the Lindsay Light Co.). Dr. H. S. Adams, 1914, was a successful research chemist and later superintendent for Squibb & Sons, add is now a research chemist of the U. S. Rubber Co. Dr. H. A. Spoehr, 1909, is chief research chemist of

the Carnegie Institution in the field of chemical plant physiology. Nineteen of the Ph.D.s are heads of departments of chemistry in universities and colleges of some importance, over twenty have already gained distinction in industrial research.

National Research Fellowships. For the year 1921-22 four University of Chicago Ph.D.s in chemistry have been awarded National Research Fellowships in Chemistry, two in Organic Chemistry and two in Physical Chemistry, the highest fellowship awarded in this country.

The Staff. The research work of the late Professor John U. Nef gave him international standing; his work on bivalent carbon was recognized as a contribution of lasting value to chemistry. The work of the present director, Professor Stieglitz, in the field of organic chemistry, has led to his election to membership in the honorary scientific societies of this country, the National Academy of Sciences, the American Academy of Arts and Science, the Philosophical Society, etc. He has recently been especially active nationally and locally in advancing the cause of the application of chemistry to the great problems of medicine, the prevention and cure of disease. Of the recent work of two members of the present staff, of Professor W. D. Harkins---also a member of the National Academy of Sciences---on atomic structure and of Assistant Professor Gerald L. Wendt, on a new form of hydrogen, the following quotation from Dr. Baly's Review of Chemistry in 1920 (England) will be most expressive: "There have appeared during the year four papers by Astor and Rutherford (eminent British chemists), Harkins and Wendt, which outshine all others in importance, and without question

they bid fair to revolutionize the fundamental conceptions of chemistry". Two out of these four men are on the chemistry staff of the University of Chicago.

The other members of the staff, Associate Professor Schlesinger, and Assistant Professors Ethel M. Terry, Glattfeld and Nicolet have done valuable work of real promise; the effort of the department has been to secure for its staff men who are both able teachers and productive in research.

Books. From the chemistry department of the University of Chicago have gone forth the best and most widely used text-books on General Chemistry, the first editions of the books by Alexander Smith having been written while Dr. Smith was a member of the staff. The text-book of McCoy and Terry mentioned above is by many considered the strongest competitor of the Smith texts. Stieglitz's Qualitative Analysis was greeted as a "milestone" in the field of scientific treatment of the subject. Lauder W. Jones's widely used laboratory outline of organic chemistry was evolved at the University of Chicago.

Apparatus. It is no coincidence that the two most widely used groups of electrically regulated heating devices---the thermostats, etc., of Freas and de Khotinsky---were both evolved in the mechanics' shop of our chemical laboratory. The Wendt apparatus for measuring hydrogen-ion concentrations is meeting a long felt need in scientific, medical and industrial laboratories.

The Urgent Need of a New Laboratory. The present quarters of the department, Kent Chemical Laboratory, were designed to meet the needs of at most two hundred fifty to three hundred students. The department now has

as many as eight hundred students taking laboratory courses in a single quarter.

Of special importance is the large proportion of graduate students and particularly of students engaged in research work for the graduate degrees. An average of fifty to sixty men have been engaged in work on problems of original research in any quarter of the past two years. For the care of these students Kent Chemical Laboratory is far too small; research students and other graduate students are using every available hole in the basement, the halls are used on two floors and in the basement for laboratory purposes. Where a research investigator should have the freedom from interference and disturbance offered by a small private laboratory, where he can set up all the apparatus required, he is now fortunate if he can secure six feet of laboratory table space for his equipment. With four National Research Fellows anxious to work in the department, we have a private room for but one! Store-rooms and library are so congested that valuable time is lost to all. Only the splendid spirit of staff and student body has made serious and successful work possible but there is no question that the effort in time, strength and ability used to contend against the difficulties of space are a real loss to the student body and community. It is almost marvelous that under such trying conditions work is being done attracting the attention of the whole scientific world.

To meet the needs of the department it is proposed to build next to Kent (to the west) a building to be used exclusively for graduate and research work in chemistry, including some special work in industrial

chemistry (dyes etc.) and certain related lines of work in physics. Kent will then be used exclusively for undergraduate work.

With such a new building it is thought the facilities for the development of chemists in every fundamental line would be second to none in this country.-

Schlesinger

The University of Chicago

Department of Chemistry

February 25, 1921

President H. P. Judson,
Faculty Exchange

Dear President Judson:

I am sorry to report that on my visit to Milwaukee (Feb. 21st) I found all the essential members of the family had left Milwaukee for California and other resorts. I did not wish to weaken our chances by discussing the matter with subordinates, and simply stated that I would be glad to call again with my business when the seniors have returned. This may be some weeks, I was told. I think it would be advisable to wait patiently until I can have a conference either with the widow or one of the two elder sons.

Yours sincerely,

Julius Stieglitz

JS/MRG

+61

The University of Chicago

Department of Chemistry

January 7, 1921

President Judson
Faculty Exchange

Dear President Judson:

I regret to report to you that Mr. Ferdinand Schlesinger passed away on Monday, January 3, while en route to California. I have written a letter of regret to his son, Mr. Armin A. Schlesinger.

Yours sincerely,

Julius Stieglitz

JS/ML

January 11, 1921

Dear Mr. Stieglitz:

Thank you for yours of the 7th. I have observed in the press dispatches with regard to the death of Mr. Schlesinger, which of course I greatly regret.

Very truly yours,

Mr. Julius Stieglitz,
Faculty Exchange.

HPJ:JN

January 11, 1921

Dear Mr. Stieglitz:

Thank you for yours of the 7th. I have observed in the press dispatches with regard to the death of Mr. Schlesinger, which of course I greatly regret.

Very truly yours,

Mr. Julius Stieglitz,
Faculty Exchange.

HPJ:LM

August 5, 1920

Mr. Armin A. Schlesinger,
First National Bank Bldg.,
Milwaukee, Wis.

Dear Mr. Schlesinger:

About a year ago I had the pleasure of a brief conference with your father, Mr. Ferdinand Schlesinger, in which I took the liberty of presenting to him as the head of the most progressive and scientific chemical industrial plants in the west the needs of the University of Chicago for funds for a new chemical laboratory for expanding our facilities for the training of research chemists. Some time after this conference Mr. Schlesinger wrote me that, while he could not undertake to give the University all the money needed for the new laboratory, he would recommend raising the funds by contributions from various sources and very kindly added that he would be willing to contribute to a fund for this purpose.

The University has now completed its plans for a campaign to raise the funds for the new laboratory for graduate and research work in Chemistry and we are ready now to submit to Mr. Schlesinger the various possibilities, in which his assistance would be of the greatest benefit to our undertaking and which might yield him also the greatest personal satisfaction (Such as "a Ferdinand Schlesinger Research Professorship in Chemistry").

With great regret I heard from various sources that Mr. Schlesinger had been quite ill this Spring but on a recent visit to this laboratory of your Dr. Gubelmann and Dr. Oesch I have learned with great satisfaction that Mr. Schlesinger is fortunately now quite restored to his old health. I hesitate, however, to intrude on him under the circumstances until I receive some assurance from you that a visit at this time would not be inconvenient and inopportune in view of his physical condition. I should greatly appreciate your advice in the matter, as the University is hoping to take up the campaign vigorously at an early date and Mr. Schlesinger could help us doubly at this time by starting the contributions. I am sure you appreciate the

the fact that we are anxious only to serve by attempting to give the West facilities for developing research men in chemistry second to those of no other university in the country.

Awaiting the courtesy of your reply, I am,

Yours sincerely,

JS/EL

The University of Chicago
Department of Chemistry

July 22, 1920

President H. P. Judson,
Manoir, Richelieu,
P. Q. Canada

Dear President Judson:

I have your note of July 19th in regard to Dr. Schlesinger's rank. From our conversation in regard to the matter this Spring I rather anticipated this decision.

I am taking this opportunity to report to you that Mr. Ferdinand Schlesinger very fortunately has recovered his health and is rather active in business again. Professor Schlesinger reported that to me on Tuesday and yesterday it happens that the Chief Chemist of the Newport Chemical Company of which Mr. Schlesinger is President, visited Kent. Speaking of Mr. Schlesinger he stated that he had been out to the works two or three times rather recently and was as active as formerly.

Under the circumstances I am wondering whether you would like to have me try to have an interview with Mr. Schlesinger in Milwaukee or whether you would prefer to wait until your return to Chicago. I am not a good money-getter and I do not wish to risk this precious opportunity.

Awaiting your advice I remain, with best wishes,

Yours sincerely,

Julius Stieglitz

JS/EL

+√7

The University of Chicago
Department of Chemistry

May 5, 1920

Dear President Judson:

I am sorry to say that I have learned on inquiry that our friend in Milwaukee has had a rather serious set-back. Under the circumstances there seems to be no early prospect of my seeing him. I would not hesitate to take up the matter with his sons if it would not look as if I would be rather disregardful of the condition and health of the father. Possibly under the circumstances it would be wisest to await a turn for the better. I should be glad to have your advice in the matter.

Yours sincerely,

J Stieglitz

JS/EL

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Yours sincerely,

JS/EL

Dear Mr. Stieglitz:

Your note of the 5th instant is received. Of course it would be highly improper to proceed with the Milwaukee matter under present conditions. The matter I have in New York is encouraging but has not been brought to a head as yet. I am leaving this morning for Washington to attend a meeting of the American Council on Education. Perhaps we can have a conference on Monday next pretty well along in the afternoon so that we may proceed at once with the organizations listed in the matter.

Very truly yours,

Mr. Julius Stieglitz,
Faculty Exchange.

HPJ:JN

The University of Chicago

May 6, 1920

Dear Mr. Stieglitz:

Your note of the 5th instant is received.

Of course it would be highly improper to proceed with the Milwaukee matter under present conditions. The matter I have in New York is encouraging but has not been brought to a head as yet. I am leaving this morning for Washington to attend a meeting of the American Council on Education. Perhaps we can have a conference on Monday next pretty well along in the afternoon so that we may proceed at once with the organizations listed in the matter.

Very truly yours,

Mr. Julius Stieglitz,
Faculty Exchange.

HPJ:LH

August 16, 1919

Dear Mr. Schlesinger:

Professor Stieglitz of the Department of Chemistry, the University of Chicago, informs me that he has had some chat with you on matters relating to the development of research work in his special field. I am strongly of the opinion that applied science absolutely depends for its progress upon pure science, and that the best results in the industries will be obtained from the development of research work in the scientific departments of universities.

Our Department of Chemistry is a very strong one and we have men highly qualified to conduct research work. The National Research Council, aided by the Rockefeller Foundation have established a system of endowments, and several of those appointed have selected the Department of Chemistry in the University of Chicago for their work. We are anxious

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August 16, 1919

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I wish you might visit the University of Chicago at some time convenient to you. I shall be very glad to receive you and let you see what we are t trying to do. The graduating excercises at the close of this quarter are to take place on the 29th of this month. I should be glad if you could be here at that time. Otherwise perhaps it would be best for you to come in October when all the work is in operation.

Very truly yours,

Mr. Ferdinand Schlesinger,
Newport Chemical Co.
Milwaukee, Wis.

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Very truly yours,

Mr. Ferdinand Schlesinger,
Newport Chemical Co.
Milwaukee, Wis.

The University of Chicago

Department of Chemistry

+53

August 9, 1919.

President Judson,
Office of the President.

Dear President Judson:

Last Wednesday I paid a visit to Mr. Ferdinand Schlesinger of the Newport Chemical Company in Milwaukee. I laid before him our need of a new chemical laboratory. I told him at once that it was not my intention to ask for an immediate reply, but that I simply wished to lay the matter before him and to leave with him certain papers which would inform him on the subject. These papers included the statement made by you at the last Commencement, the report of the Committee to the Trustees which was handed in three or four years ago, and two articles by myself as President of the American Chemical Society and as President of the Institute of Medicine in Chicago, Mr. Robertson's Guide to the University of Chicago Campus, and one or two other documents.

Mr. Schlesinger received me very kindly and said at once that if he could not give us the laboratory he would try to interest other men in the plans. I explained to him, on his inquiry, that Mr. Rockefeller has not given any laboratory buildings to the University, and that we are dependent on the far seeing men of the West for our laboratory facilities.

I suggested to Mr. Schlesinger that I call on him again in five or six weeks, but he proposed in return that when business brought him to Chicago he would be glad to let me know and see me here.

I saw Mr. Arnett yesterday and we agreed that it would be a wise thing to write to Mr. Schlesinger inviting him to visit the Campus about Commencement time as a guest of the University, and particularly, of the President of the University. I am writing Mr. Schlesinger, informally to this effect, and would suggest that, if this meets with your views, that you send him a formal invitation. He is gone now on his vacation of two or three weeks, but could be reached by addressing him

c/o Newport Chemical Company,
Milwaukee, Wisconsin.

In my informal letter to him I stated that if it would not be convenient for him to visit us at the end of August, it would be best to come early in October when the University is in its full stride. I am sorry that I had no opportunity to consult with you in regard to the matter of inviting Mr. Schlesinger to the University, but Mr. Arnett and I thought you would surely approve the idea. I also suggested to Mr. Arnett that in case the visit is made at the end of this month, I be informed by telegram, and arrange to be here at that time so that I could be responsible for any technical information.

I am leaving for the East tonight and my address will at all times be on hand in the office of Kent.

In conclusion, I am informed that Mr. Schlesinger is one of the ten wealthiest men in this country. In presenting my project, I emphasized the fact that I came to him because I knew that of all the men in the West he had the greatest insight into the value of chemistry for the development of the country----and I believe from his career that that is true.

I am

Yours sincerely,

Julius Stieglitz