Physical Sciences, Div.

A SUMMARY OF PURE AND APPLIED MATHEMATICS AT THE UNIVERSITY OF CHICAGO

PUBLISHED BY THE

COMMITTEE ON

DEVELOPMENT

1925

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1952

I. Science and Civilization

A. Science is here to stay! Its contributions

1. $60,000,000,000 wealth produced yearly by labor and effort of people of country

About $45,000,000,000 should be directly accredited to the application of science.

2. Improved health; longer life span

3. More leisure time

B. Chicago the center of a vast industrial and business empire

C. The University of Chicago the intellectual center of Chicago--the University is the "pre-eminent representative and promoter of science"

II. Mathematics, the basis of all science

A. Mathematics guides the construction of machinery

B. Celestial mechanics applied to ballistics

C. Importance of mathematics in business and finance

D. Mathematics as the cultivator of man's highest faculty, his reason

III. The Mathematical Sciences and University of Chicago

A. Physics

1. Robert a Millikan and A. A. Michelson--professors of Department of Physics at University of Chicago and Nobel Prize winners

2. (Describe work of these two men)

3. Professor Arthur H. Compton--his work on x-ray

4. Associate professor Dempster--constructed in Ryerson Lab. first apparatus for clearly analyzing chemical elements into isotopes.

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2. Honors given to men in Department
   a. 5 of 15 proffessors members of National Academy of Sciences
   b. 3 have been Presidents of the American Mathematics Society
   c. 2 editors-in-chief of transactions of that society
   d. 1 a corresponding member of Paris Academy of Sciences and
      an Honorary President of the International Mathematical Union
   e. 1 vice-president for U. S. of that Union
   f. Fields of mathematics originated by staff of University of Chicago --general analysis, the arithmetic of algebras, modular invariants, projective differential geometry
   g. Professor Dickson--$1000 prize from AAAS for most important contribution to science for year
3. Higher mathematics not so far removed from life as it might seem--ballistics work, building, etc.
4. The University of Chicago has a larger number of bona fide graduate students in mathematics than any other institution in the country.

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a. 131 Ph.D. graduates--86% these engaged in teaching in 71 colleges and universities

b. Occupations of these graduates:

Professors	52
Associate professors	30
Assistant professors	19
Instructors	12
Private Research	3
Business	6
U. S. Navy	2
Deceased	7
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(Needs of Mathematics Department then stated)

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Physical Sciences 1145

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I. Science and Civilization.

Mankind has set for itself the stupendous task of discovering Nature's secrets and of using the material universe for its benefit. In a period shorter than that covered by the struggle between Rome and Carthage, or that of the Crusades, or even that of the exploration and settlement of America, the ways of living of the civilized world have been completely transformed. Since the days of our grandparents such terms as tallow candles, ox teams, scythes, couriers, homespun, and log cabins have become obsolete, and in their place has grown up a much more extensive vocabulary for things that were undreamed of a generation ago.

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Within a night's ride of Chicago, there are, in unparalleled variety and abundance, nearly all the essentials for the prosperity and happiness of the human race, - grain, live stock, cotton, timber, salt, iron, petroleum, copper, and lead. Within the same radius, living under a stable government, there are more than fifty millions of virile, intelligent, and ambitious people, whose wealth exceeds the wealth of both Europe and America in the days of Washington. Chicago is the industrial and business center of this empire, and in the midst of it is the University of Chicago symbolizing, and capable of becoming the center of, its intellectual life. The City builds skyscrapers and terminals and establishes financial institutions to care for the commerce that floods its gates. The University must erect buildings, provide libraries and laboratories, and secure endowment to care for the students who, in ever-increasing numbers, enter its doors for information and inspiration, and to support the researches upon which the continued progress of our race depends.

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one can adequately forecast, science is confident that the record of its accomplishments and the trend of the times justify large investments in its further advancement. And the University, as the preeminent representative and promoter of science, is an ideal agency through which such investment may be made, with the confident expectation that the dividends will be still more of those discoveries which on the one hand, improve the physical world, and, on the other, add to the dignity and glory of the human mind.

II. Mathematics, the Basis of all Science.

In all the service of science to humanity, Mathematics plays a very important - indeed an essential - part. As a science becomes more quantitative and exact, and its laws more accurately known, it becomes more mathematical and its achievements more dependent on the services of Mathematics.

Newton established the fundamentals of mechanics by mathematical study of the motions of the planets, and thus laid the foundations for the design of practically all modern machinery. The laws of reflection and refraction of light were found by experiment, and Mathematics took them and designed telescopes and microscopes, cameras and projection lenses, and other marvelous optical instruments, that could never have been made by the cut-and-try methods of earlier days. Mathematics has guided the construction of generatiors, motors, high-tension transmission lines, and other electrical machines and devices. Without the use of modern higher Mathematics, the problem of long-distance telephony could never have been solved. The methods

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of celestial mechanics were applied to ballistics during the World War with astonishing results. In some cases the ranges of artillery were doubled, and the firing made eight times more accurate.

The role of Mathematics in the world's progress has already been notable, and it is daily becoming more essential in science, business and finance. The higher mathematics of today has in every generation been the everyday mathematics of tomorrow.

Mathematics not only serves all other sciences, but it enriches human life itself. It cultivates the highest faculty of man, that which most distinguishes him from the lower animals, the human reason. To foster mathematics is to promote a kind of human thinking which is fundamental to the advancement of civilization.

III. The Mathematical Sciences at the University of Chicago.

In Mathematics, especially on this continent, a generous share of accomplishment has been achieved at the University of Chicago. The history of Mathematics and the closely allied sciences of Physics and Astronomy at this institution is a record of the work of notable men.

Physics.

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were established a quarter of a century ago, has the science prize come to an American. Michelson and Millikan are two of those prize winners. The former is the head of the Department of Physics at the University of Chicago, and the latter was for twenty-five years a member of that department. The Physics Department, since the beginning of the University, has probably been the outstanding Department of Physics in the entire country.

And Professor Michelson has undoubtedly been the most noted experimental physicist in the world. Fascinated as a youth with the subject of the velocity of light, he has made that subject one of his life passions. In a room with a temperature kept so constant that no human being, not even himself, could be allowed to enter, he succeeded in ruling a grating with 150,000 lines in a space of 10 inches, to be used in connection with his study of the spectrum. He is the inventor of the interferometer which has made possible measurements of a delicacy previously far beyond the power of man. He was the first person in the history of the world to measure the diameter of a star; and, in obtaining this measurement for the star Betelgeuse, he performed a feat equivalent to measuring the diameter of a penny at a distance of 1,000 miles! He has measured the meter in terms of light waves. Through observations which, with Professor Henry G. Gale, he made on the tidal effect of water in a pipe line at Williams Bay, Wisconsin, he has measured the rigidity of the earth. And he is now working on the effect of the ratation of the earth upon the velocity of light, a piece of research which is looked upon as a test of the Einstein theory of relativity.

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Other important investigations are in progress under other members of the staff.

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Working closely with the Department of Physics, and in the same building, have been the kindred Departments of Mathematics and Mathematical Astronomy. Here Professors Eliakim H. Moore, Leonard E. Dickson, Gilbert A. Bliss, Ernest J. Wilczynski, Forest R. Moulton, and their colleagues have been making a brilliant record which their fellow mathematicians the world over have not failed to appreciate and applaud.

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Five of the fifteen mathematicians now members of the National Academy of Sciences are members of the faculty of the University of Chicago. Three of the mathematicians of the University have been Presidents of the American Mathematical Society, and two have been Editors-in-Chief of the Transactions of that Society. These are the highest honors in the American mathematical community. It is significant also of the wide influence of the members of these Departments that one of them is a Corresponding Member of the Paris Academy of Sciences and an Honorary President of the International Mathematical Union, and that another is the Vice-President for the United States of that Union.

Scientific honors have importance only as the symbols of scientific achievement. Unfortunately it is not always easy to describe in popular terms the results of mathematical research. It will suffice here to say that general analysis, the arithmetic of algebras, modular invariants, and projective differential geometry are fields of mathematics which were entirely originated by the staff of the University of Chicago and which have since received international recognition. Last year Professor Dickson was awarded for his work in the arithmetic of higher complex number systems, the $1000 prize offered by the American Association for the Advancement of Science, for the most important contribution to science presented at the annual meeting of the Association in Cincinnati.

Some of the contacts between mathematics and the affairs of practical life have been indicated in the preceding pages, and they might be multiplied indefinitely if one undertook to examine the applications of mathematics in detail.

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primarily engaged in the intimate applications of mathematics to engineering or business problems, but they are frequently called upon to advise upon mathematical questions with members of the neighboring departments of Geology, Chemistry, and Physics, and also at times with others who are not engaged in university work, as the following anecdotes will show. Recently a physicist approached a member of the Department of Mathematics with a problem requiring the solution of fifteen simultaneous equations upon which he had worked for two months with no success. The solution was furnished in two hours. In another case a graduate student working under the direction of one of the faculty members devised for a manufacturing concern a graphical method for a complicated cost problem which effected substantial savings. Again it was found after some study, for a manufacturer of large reservoirs, that a formula of differential geometry overcame a crucial difficulty in design which had baffled the more practical engineers of other institutions. During the war three of the mathematics faculty members entered the service of the Government in ballistic work. One of them became, in the course of a few months, the leading ballistician in this country. The problems in this domain which arose during the great struggle were insoluble by the classical methods of the science, and they yielded only to types of analysis which have been developed in connection with problems of astronomy and the so-called higher mathematics. These are a few only of the instances which go to show that higher mathematics and higher mathematicians are not so far removed from the practical affairs of life as is popularly believed.

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Another field in which the mathematical departments at the University of Chicago have been notably useful is the training of instructors and professors of mathematics. The University of Chicago has a far larger number of bona fide graduate students in mathematics than any other institution in the country. The Departments of Mathematics and Mathematical Astronomy have graduated 131 Doctors of Philosophy, of whom 86 percent are now engaged in teaching in 71 colleges and universities. The following tabulation shows the present occupations of these graduates:

Professors	52
Associate Professors	30
Assistant Professors	19
Instructors	12
Private Research	3
Business	6
U. S. Navy	2
Deceased	7
Total	131

Among the 40 institutions at which one or more University of Chicago Doctors in Mathematics are now engaged as full professors are Harvard, California, Chicago, Minnesota, Texas, Yale, Princeton, Cornell, Bryn Mawr, U. S. Naval Academy, Mighigan, Wisconsin, Northwestern, Tulane; and in Canada, Manitoba, Saskatchewan and British Columbia.

IV. The Needs of the Departments and a Proposal.

At the present time, the work both in Physics and in Mathematics (including under the latter term Mathematical Astronomy) at the University of Chicago is being conducted in a single building, the Ryerson Physical Laboratory, erected in 1893 and enlarged in 1911-12 at a cost equal to the original expenditure.

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Professors	82
Associate Professors	30
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Instructors	12
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Total	181

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The association of these departments in the same building was natural and mutually helpful, when their development was such that the building was adequate to house them both. But that time has long ago passed. At present the departments suffer serious detriment from sheer lack of space in which to do their work. They should still continue their association but in greatly increased space.

What Mr. Ryerson's generosity years ago enabled the University to do for Physics in building the Ryerson Laboratory and devoting a goodly sum annually to its maintenance, should now be done for Mathematics, by the erection of a proper building for it and the creation of an adequate andowment. Both departments have made for themselves a record of achievement unsurpassed, perhaps scarcely equalled, by any other departments of the University or by like departments elsewhere. But the very success of their work has created conditions which threaten seriously to check their development in the future. It has become difficult to increase the faculty of these departments or even to hold some of the best men because of inadequate space and facilities.

It is extremely difficult to maintain satisfactory working relationship with advanced students in a department such as Mathematics, which, with a staff of eleven members and a present maximum attendance of 200 graduate students in addition to many undergraduates, has but five classrooms, one small library, and five offices. Adequate space provisions for students engaged in advanced mathematical research would greatly increase their enthusiasm for their work and their success in it.

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1. Building, with it e nt nd a and or it maintenance	1,000,000
. ndowment or instruction ese ch in ure and plied thematics	1,000,000
Total	$2,000,000

The building should be erecte direct east o e on hysica boratory and be connected itn i by a tunnel on he basement level b a ridge on he econd loor. There ould, of cour e, be a free e c o co e ies etween the de art ents and buildings, as there has been in erson or thirty years. The oint de rtmental lib ar o the e artments should be l cated in either b ildin , a be ound ex e ient, and other adjustments de as neces i te b he common intere t. The cost o the buil i div des i el into he

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There are few more attractive proposals within the power of the University to offer to its generous friends than the opportunity which this situation makes evident. It is an opportunity not only to perpetuate the name of a donor in connection with a great University and the future development of a fundamental science, but also to make a lasting contribution to human knowledge and welfare.

The financial need falls into two parts:

1. Building, with its equipment and a fund for its maintenance	$1,000,000
2. Endowment for instruction and research in Pure and Applied Mathematics	1,000,000
Total	$2,000,000

The building should be erected directly east of Ryerson Physical Laboratory and be connected with it by a tunnel on the basement level and by a bridge on the second floor. There would, of course, be a free exchange of courtesies between the departments and buildings, as there has been in Ryerson for thirty years. The joint departmental library of the departments should be located in either building, as may be found expedient, and other adjustments made as necessitated by the common interest. The cost of the building divides itself into the

following items: construction, $600,000; equipment and maintenance fund, $400,000.

The University is proposing to establish a number of "Distinguished Service Professorships," which shall carry a salary of $10,000 each and which shall be awarded only to men of distinguished ability and achievement. To hold one of these would constitute the highest honor that the University could bestow on any professor; and a professorship, bearing the name of the donor, would associate that name with a long line of the University's most eminent men.

The cost of endowing a Distinguished Service Professorship is $200,000, and it is proposed that at least one of these should be preferentially designated but not restricted for Mathematics, Pure and Applied. Thus, at least $200,000 of the proposed $1,000,000 for the endowment of Mathematics should be for the establishment of a professorship. The proposal to establish Distinguished Service Professorships at the University is explained more fully in a separate folder.

The remaining $800,000 for the general endowment of instruction and research in the Department and the $200,000 for a professorship would at once put the University in a position to make for Mathematics, Pure and Applied, an annual appropriation that would guarantee to the work in this field a future of stability, progress, and distinguished achievement. The addition of this endowment of $1,000,000 would also contribute to the fulfillment of the requirements of a conditional gift of the General Education Board which is to give the University $2,000,000 if it raises an additional $4,000,000 for endowment.

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The remaining $800,000 for the general endowment of instruction and research in the Department and the $800,000 for a professorship would at once put the University in a position to make for Mathematics, Pure and Applied, an annual appropriation that would guarantee to the work in this field a future of stability, progress, and distinguished achievement. The addition of this endowment of $1,000,000 would also contribute to the fulfillment of the requirements of a conditional gift of the General Education Board which is to give the University $2,000,000 if it raises an additional $4,000,000 for endowment.

In other words, this $1,000,000 for the endowment of Mathematics would bring to the University a further gift of $500,000 from that Board.

It is not often that $2,000,000 can be invested to better advantage in educational work. A gift of this amount would give a great impulse to the development of a fundamental science. It would add strength to the University at large and to the movement for the increase of its funds and its usefulness. It would, for all time, yield large dividends in the contributions to human knowledge and welfare which it would make possible.

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