

Mathematics

The University of Chicago

(25)

July 29, 1902

To

The President

My dear Dr. Harper,

I wish to write to you concerning the laboratory method of instruction in mathematics. First, it should be understood that the notion has already considerable currency and that, besides its partial realization on the continent and in England, beginnings are being made in this country. However, in this country the field is as yet decidedly open, and there is for Chicago the opportunity to take the lead in the systematic realization of the notion. Indeed, I think that the method will appeal with especial force to our natural constituency as being evidently the proper method.

July 22, 1902

To The President

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I think that the method will appeal
with especial force to our natural
constitutions as being eminently
the proper method.

We consider first the (secondary and)
Collegiate courses in pure mathematics,
 at least through the first year of calculus.

- 1) These courses are to be so shaped that their interrelations, and their relations to the later courses in pure mathematics and to the simultaneous and later courses in applied mathematics, receive constant emphasis.
 - 2) The pure theory will be illuminated (not merely by the development of its ^{theoretic} applications but also) (and this is where the laboratory method enters) (in the narrower sense) by the constant use of numerical computations, graphical illustrations, models and mechanisms of all kinds.
- The student will learn not merely verbally or even logically but also by the use of all the intuitions and senses. And what he learns in this way he will really understand and control for later use in whatever field.

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Collegiate courses in pure mathematics

at least through the first year of college. These courses are to be so shaped that their interrelations, and their relations to the later courses in pure mathematics and to the physical sciences and later courses in applied mathematics, receive constant emphasis.

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by the constant use of numerical computations, graphical illustrations, models and mechanical devices not merely. The student will learn not merely verbally or even diagrammatically but also by the use of all the intuition and reason. Good but not the lessons in this way he will really understand and resort to for later use in whatever field.

3) The laboratory will be in so far as (3
the more complicated mechanisms^{etc} are
concerned of the nature of a students' working
museum, — but provision should be
made for the actual construction by the
students of many of the simpler drawings,
models and mechanisms.

As to the special courses in mathematics:

On the basis of these introductory
courses in pure mathematics would
rest the more advanced and special
courses in pure mathematics, much
as at present, and also a body
of courses specializing along the
line of the theory and construction
of mechanisms. This second
direction of specialization would
surely be very attractive to a
considerable percentage of students.

Further you recall the plan of
developing a body of courses in theoretical
applied mathematics, in the direction
of physics, to parallel the work now
being done by the department of astronomy in mathematical
astronomy.

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This organization of our work has been more or less in mind for a number of years, — and, as I said, the general notion has considerable currency. We ought at once to begin to carry out the plan in a systematic way. This summer I have begun, establishing a Calculus Laboratory in the fourth floor of Ryerson. And I propose to make things move in this direction as well as I can until the new building for Mathematics and Astronomy comes to provide adequate facilities.

In order to enable me and later others in other courses to carry out this plan there is need of laboratory assistants.

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In order to enable me and
later others in other courses
to carry out this plan there
is need of laboratory assistants.

For next year we need one assistant for work with me in the Calculus Laboratory and as a personal assistant.

There will be much more to do than I can properly do myself, if the plan is to have its full fruition, and I am zealous that it may speedily receive recognition and adoption wherever possible in all our dependent territory.

As such assistant I wish to propose Mr. F. La Motte, who studied with us a number of years, who took our Master's degree, who will in time take our Doctor's degree (his thesis being now nearly completed), who held a supply-position last year in the ~~at~~ University of Nebraska. We could get him for \$800. I know him well. He would be a good man. Can you not arrange to have him engaged?

Yours faithfully, E. H. Moore

The University of Chicago

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for work with me in the Calculus
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who holds a Geography position last year
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We would get him for \$800. I know
him well. He would be a good man.
Can you not arrange to have him engaged?
Very faithfully,
J. H. Moore

The University of Chicago

October 11, 1902.

To The President

My dear Dr. Harper:

I wish to write you concerning the results of the first nine days of the laboratory course in calculus. Knowing perfectly that Mr. Lunn's qualifications would abundantly and more than fully supplement my own, I arranged with him to conduct the course in conjunction with myself. My understanding is that for this I am at present personally responsible, and that if you do not find it possible to persuade the Trustees of the fundamental importance of the new methods which we are just beginning to introduce you will permit me to arrange suitable supply instruction to replace the instruction which Mr. Lunn would but for this work with me be expected to perform in the first year of the Junior College. I have no doubt that if the need arises I shall be able to arrange for this instruction. But I am bold enough to confess my belief that I can make you see the matters so clearly that seeing with you the Trustees will have a way of providing for this instruction. I have spoken of this matter now in order that you may understand the situation perfectly.

We have in the class about twenty four students, and the success of the first week and a half has really been something highly gratifying to every one concerned.

The University of Chicago

There is in my mind no doubt whatever that the laboratory method of instruction in mathematics will work a revolution in mathematical instruction, strictly analogous to that which we have seen in the case of any one of the physical sciences. In case I retain my health, I propose with your concurrence that this revolution shall take place under the auspices of the University of Chicago. The new method will be similarly efficient for students in arts and science and in the technological school. I mean of course the method in all its general aspects. We should plan to treat the students to a certain extent differently with respect to the type of special work assigned to the one and the other, etc., according to the purposes of the individual student. Thus in our present class we find students expecting to teach mathematics, others expecting to go into electrical engineering, others into mining engineering, one into "medical research", and so on, and we shall see that the individual receives to a certain extent individual attention. The course in one of its phases will thus become like a seminar.

At present the method of treatment seems in outline very clear from the beginning of the secondary school work in mathematics to the end of the Junior College course, that is, through the first year of calculus. I suppose that in that way we shall join hands with the representatives of the newer primary education, on the

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The University of Chicago

one hand, and that on the other hand in this way we shall train up students whose mathematical insight will be such that they can go forward powerfully either into pure mathematics or theoretical applied mathematics, or any of the lines of the physical or technical sciences, involving mathematics, and that furthermore we shall remove ultimately the stigma upon mathematics that there are those quite incapable of comprehending mathematics.

It is clear that proper laboratory facilities will be needed for this type of instruction. With respect to these needs I may not now go into details, but in view of the fact that the laboratory provisions for the manual training school are now being determined, as I understand from Mr. Owen, I am writing to request that in the planning of those buildings the needs of the department of mathematics in the way of laboratory facilities (rooms and equipment) be carefully borne in mind. I should be very glad if I might be permitted to cooperate in the planning of the buildings.

From our earlier conversations and correspondence, you know that everywhere to a certain extent this new type of instruction in mathematics is more or less consciously under consideration, and in some of its elements it is already in use. As a systematic whole, however, I am well convinced that the plan is essentially new, and that it is based upon fundamentally sound pedagogic and scientific principles. If we are to succeed in securing its intro-

University of Chicago

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The University of Chicago

duction in the schools and colleges of the central West and later on of the whole country, it is clear that it will be only by the mediation of a strong body of teachers of mathematics who have been trained in the new method and who have been trained to teach according to the new method. I wish to write concerning the possibility of the establishment in connection with the laboratory instruction in mathematics of what might be called a laboratory in the pedagogy of mathematics. More precisely, it seems to me that after a student who expects to teach mathematics has been initiated into the laboratory method, he should be encouraged to take over again precisely the same courses as practice courses in the pedagogy of mathematics, receiving new credit for the work. These student assistants would be of much value in the actual handling of the classes, and of course they would gain vastly by being brought still more immediately ⁱⁿ connection with all the difficulties experienced by the slower students in mastering the subject under treatment. This suggestion will, I suppose, appeal to you at once as feasible and desirable, and I am sending a copy of this letter to Mr. Dewey with the hope that he may with you see a way whereby the department of mathematics may be permitted to arrange its work in the secondary schools and in the Junior Colleges in such a way as to train up a strong body of thoroughly initiated teachers of laboratory mathematics.

Yours very truly,

E. A. Moore

The University of Chicago

November 20, 1902

MY DEAR COLLEAGUE:

At the regular autumn Educational Conference of Academies and High Schools held at the University of Chicago, November 8, 1902, the Mathematical Section had an unusually interesting meeting.

Mr. W. S. Jackman read a paper on *The Interrelations between Mathematics and the Other Branches of the Curriculum*, and in opening the discussion Mr. G. W. Myers turned the thought particularly to the secondary schools.

It was generally agreed that at present in the secondary schools the various courses in mathematics and the physical sciences are far from closely interrelated. Reference was made to the very animated discussion in England as to the teaching of elementary mathematics, called forth by the proposals for reform made by John Perry,* of the Royal College of Science, South Kensington, London. Various questions arose; in particular:

Would it not be possible to organize the mathematics and physics of the secondary school into a thoroughly coherent four years' course, so that the mathematical relations of number, of measure, of form, would always and in manifold ways emerge from simple physical phenomena of experience or of experiment, to be used in turn in the investigation of more complicated physical phenomena?

Would it not be possible immediately for a teacher to gain many of the benefits of such a reorganization by coöperation with other teachers and by use of laboratory methods:

*Perry: *Practical Mathematics*; Eyre & Spottiswoode, London, 1899. *The Best Education for an Engineer*; *Nature*, October 12, 1899. *England's Neglect of the Sciences*; Unwin, London, 1900. British Association Meeting at Glasgow, 1901. *Discussion on the Teaching of Mathematics*. Edited by John Perry. Macmillan, New York, 1902. Perry: *The Education of Engineers*. Address as President of Section G (Engineering) of the British Association, at the Belfast Meeting, 1902. *Science*, November 14, 1902.

Current discussion in *Nature*, the English general journal of science, from April, 1900, on; in particular: vol. 61, p. 582; vol. 62, pp. 317, 548; vol. 63, pp. 367, 370; vol. 64, pp. 226, 477, 592; vol. 65, pp. 258, 297, 404, 457, 484, 510; vol. 66, pp. 30, 201, 530.

Report of the Committee of the Mathematical Association on the Teaching of Geometry; *Mathematical Gazette*, May, 1902. Report of the British Association Committee on the Teaching of Mathematics; *Mathematical Gazette*, October, 1902.

laboratory record books with cross-section paper, colored chalks and inks, much work of numerical and of graphical character, the cultivation of the laboratory spirit in the class, that is, the spirit of independence on the part of the individual student, and as well the spirit of natural and lively coöperation of the students one with another?

It was recognized that as to such questions the teachers of mathematics and the teachers of physics must meet, and the approaching meeting on November 28, of the Central Association of Physics Teachers was found to give an early opportunity for this conference. I am enclosing an announcement of this meeting; you see that the discussion is arranged for the afternoon of Friday, November 28; we are all very cordially invited to be present and to take part in the discussion; I hope that you will arrange to accept the invitation; you should send the enclosed card to Mr. C. E. Linebarger, indicating also whether you will take lunch at the Lewis Institute (25 cents).

The results of the Perry movement and experience in this country in college teaching by the laboratory method seem to show that there are great possibilities in the way of gaining for both mathematics and physics in the primary and secondary schools a deepened appreciation on the part of the students. These possibilities will of course be realized but gradually and only by the efforts of individual teachers and of groups of teachers.

I understand that the meeting on January 13, 1903, of the Mathematical Section of the High School Teachers' Association will be devoted to a renewed discussion of these questions. By that time some reports of progress may be available.

Is there need of an organization of teachers of mathematics for coöperation with the Central Association of Physics Teachers?

Yours very truly,

E. H. MOORE.

Mathematics

The University of Chicago

December 3, 1902

John D. Moore

To the President

My dear Dr. Harper:

I wish to write as supplementary to the general letter concerning the department for the year 1903-1904 a note concerning the needs of the department in the domain of the University Secondary School. I am thinking at present merely of the laboratory facilities.

As a unit room, for laboratory instruction in mathematics, I propose a room of approximately the shape 39x29 feet. I gave to Mr. Judson for the use of the architect of the temporary building for women a plan of such a room, and I am very glad that the committee was able to recommend the provision of such a room in that building. This room will accommodate from forty six to fifty students at a time.

The University Secondary School will contain next year I do not know precisely how many students, but it seems to me that the school ought to be a great success and that the following estimate ought not to be beyond the easy possibilities within a few years:

First year, 300	students
Second year, 300	students
Third year, 250	students
Fourth year, 200	students
Total,	1050 students.

Such an enrolment would call for the first year six sections, the second year, six sections, the third year, three or four sections, the fourth year, three sections; in all, eighteen or

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a note concerning the needs of the department in the domain
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As a unit room, for laboratory instruction in mathe-
matics, I propose a room of approximately the shape 32x23 feet.
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The University of Chicago

nineteen sections. You understand that I am writing on the supposition that the work of physics and mathematics will be brought into the closest correlation in the Secondary School, and my computations are intended to cover the sections in physics. One room could be used for at most three sections a day, each section having the room for two periods. As things are in the secondary school, with the shorter periods, it is possible that the rooms could be used for recitation purposes for one or two additional periods, but it would not be safe to suppose that one room could be used for four laboratory sections. Accordingly, we see the need of at least six of these laboratory rooms, if every room can be used to its limit. This means that at least eight rooms should be provided.

In the preceding statement I have considered merely physics and mathematics. The other laboratory departments would have likewise to be considered.

In the present great building of the School of Education Mr. Dewey finds it impossible to make adequate provision for the needs of the various institutions under his charge. I write with the hope that you will with me see the very great desirability of securing a laboratory building for the use of the Secondary School, and that you will find it possible to take up the question in connection with the budget for 1903-04, and even more that it will turn out to be possible to proceed at once with the drawing of plans and the letting of contracts so that the building may be in readiness for use next autumn.

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The University of Chicago

Mr. Dewey is calling a conference of all the teachers of mathematics and science in the secondary schools and in the primary schools with those of mathematics and physics in the Junior Colleges, in order that we may consider more closely the pedagogic problems arising in connection with the proposed reorganization. Of the importance of the movement of reform in the methods of instruction in elementary mathematics, and in particular of the importance of the proposition that the various mathematical subjects of the secondary curriculum and physics should be made into one closely coherent whole, I have absolutely no doubt, and I feel confident that you would agree with me even more than you do now if you were to find it possible to read the literature connected with the Perry movement in England, as cited in the circular letter which is enclosed.

This Professor Perry of the Royal College of Science, South Kensington, is the man of whom Mr. Michelson has written you with respect to the School of Technology. He must be a man of uniquely strong personality, and I very much wish that you could secure him in some capacity for the coming summer quarter. He would add strength to the summer faculty, and what is more important, you would thus have an opportunity to know him at first hand.

Believe me,

Yours very truly,

E. A. Moore

The University of Chicago

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Believe me,

Yours very truly,

W. A. Rouse

4 copies

Building

The University of Chicago

Department of Mathematics

To Vice President James H Tufts

A Statement rendered Feb 1 1924

Concerning a Building for Mathematics and Mathematical Astronomy
to occupy the space east of Ryerson and south of Mandel

The ground-area in question is slightly larger than the ground-area of the main Ryerson Laboratory. A building on this ground-area, four stories in height, of which the internal design should be, on the whole, more closely comparable to Rosenwald than to Ryerson (since Rosenwald makes more economical use of the ground-area than Ryerson), would meet the following important needs of The University, at least for the next thirty or forty years:

- 1) The provision of class-rooms for the Graduate and Senior College courses of the two departments---- and, for the more immediate future, also for the Junior College courses.
- 2) The provision of office- and study-rooms for the professors and associate and assistant professors of the two departments.
- 3) The provision of a Joint Library for the Mathematics-Astronomy-Physics Group, to be administered as are the joint libraries now in Classics and in Rosenwald. This includes stack-rooms, one large reading-room, and numerous small studies or research-rooms for the use of the more advanced students,-- together with a room for the collection of models.
- 4) The provision of a large Lecture Room for the Mathematics-Astronomy-Physics Group as well as for general University use.
- 5) The provision of a Laboratory of Applied Mathematics, a room in which may be readily exhibited and explained in detail mathematical methods of use in various departments of the University.

The University of Chicago

Department of Mathematics

- 6) The provision for a 10-12 inch Equatorial Refractor on a pier, preferably outside but at its summit accessible from the main building.
- 7) The provision of a Computing Machine Room with padded walls.

Remarks. This Memorandum is drawn up after conference with my colleagues in Mathematics and Mathematical Astronomy.

The building would relieve a painful congestion of the departments of Mathematics and Mathematical Astronomy which now occupy a small part of Ryerson together with three rooms outside, one in Rosenwald, one in Cobb and one in Ellis.

The building would, however, not merely provide adequately (perhaps I may say, for the first time) for the needs of the two departments. It would relieve in two or rather three ways the congestion in Ryerson: ~~at~~ By freeing for the exclusive use of Physics a) the space now occupied by the two departments; b) the room now occupied by the Physics Library; used as the c) the room 32 now ~~occupied by~~ Physics Lecture Room.

Here items b)c) are to be compared with items 3)4) above. Relative to these matters I have conferred with Mr Michelson and Mr Gale; they agree that the provision of a Joint Library and a ~~large~~ Lecture Room for the Group of three departments is much to be desired. Of course the plan contemplates the joining of Ryerson and the new building by attractive bridges on the floors containing the Library and the Lecture Room.

Submitted Feb 1 1924

Edw. H. Moore

a) The provision for a 10-12 inch horizontal ductwork on a plan, preferably outside but at its summit accessible from the main building.

f) The provision of a connecting heating loop with padded walls.

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congestion in Ryerson: by freeing for the exclusive use of

Physics a) the space now occupied by the two departments;

b) the room now occupied by the Physics Library;

c) the room 82 now ^{used as the} ~~unoccupied~~ Physics Lecture Room.

Items b) and c) are to be compared with items 3) and 4) above. Relative

to these matters I have conferred with Mr. Nicholson and Mr. Gale;

they agree that the provision of a joint library and a large

Lecture Room for the Group of three departments is much to be

desired. Of course the plan contemplates the joining of Ryerson

and the new building by attractive bridges on the floors containing

the library and the Lecture Room.

Submitted Feb 1 1924

W. H. Wood

The University of Chicago

Department of Mathematics

April 5, 1924

To The President

My Dear Dr. Burton,

Relative to the question of the restoration of
Oskar Bolza to the status of Non-Resident Professor of Mathematics:

Dr. Bolza was Associate Professor of Mathematics 1892-93
Professor of Mathematics 1893-1910
Non-Resident Professor of Mathematics 1910-1917

that is, from the time of his return to Germany with resumption of German citizenship until the time, after the entry of the United States into the War against Germany, when his name, with those of other enemy aliens, was removed from the list of the Faculty of the University.

He was appointed Non-Resident Professor in recognition of the extremely important services which he had rendered the University in making our Department of Mathematics the equal of any other department of Mathematics in the country.

Since now our country is at peace with Germany it is the very earnest desire of the staff in Mathematics that he be restored to the status of Non-Resident Professor of Mathematics,-- in case of course that this restoration is, or rather would be, agreeable to him.

Accordingly, if this idea appeals to you, may I suggest that you determine whether the restoration would be granted by the Board of Trustees, and, if so, that I determine from him whether the restoration would be acceptable to him, when and if so the restoration would be made effective.

This is not a matter which has budgetary significance. But I think that it has real importance in the formal reestablishment of friendly relations between him and the University where he has so effectively expended the major part of his scientific energy.

Hoping that you will agree with me in the desirability of this action, I am

Yours faithfully,

E. H. Moore

What do you & Gale
recommend?
I approve. J.H.Y.
I approve H.S.C.

Sent from PRESIDENT'S OFFICE

APR 8 1924

to Mr. Tufts

Upon return send to FILES

Received from PRESIDENT'S OFFICE

APR 8 1924

to Mr. Gale

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Received files APR 11 1924

The University of Chicago

Department of Mathematics

April 2, 1954

To The President

My Dear Mr. Norton,

Relative to the question of the restoration of

Oskar Bolza to the status of Non-Resident Professor of Mathematics:

Dr. Bolza was Associate Professor of Mathematics 1922-23
Professor of Mathematics 1923-1930
Non-Resident Professor of Mathematics 1930-1937

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German citizenship until the time, after the entry of the United
States into the war against Germany, when his name, with those of
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Since the war, during its absence from the country, it is the very
earnest desire of the staff in Mathematics that he be restored to
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This is not a matter which has budgetary significance. But
I think that it has real importance in the normal reestablishment
of friendly relations between him and the University where he has
so effectively expended the major part of his scientific energy.

Hopefully that you will agree with me in the desirability of
this action. I am

Yours faithfully,

W. V. Moore

COPY.

Free Translation.

Muse XVII.

Freiburg I.B.

Marienstrasse 7, 31 May, 1924.

Math

J. Spencer Dickerson, Esq.,
Secretary of the Board of Trustees,
The University of Chicago,
Chicago, Illinois.
My dear Sir:

Bolger

I acknowledge with grateful appreciation the receipt of your letter of May 7, with the notification of my restoration to the status of Non-resident Professor of Mathematics, and I hereby tender my formal acceptance. To this acceptance I wish to add certain remarks.

I have spent eighteen years of my life - from the opening of the University to the year 1910, - in active service of the University. Especially with the mathematical department, in the upbuilding of which, under the genial leadership of Professor E. H. Moore, I co-operated with enthusiasm and with utmost energy, I was most closely indented. Accordingly, I was filled with a proud joy, when, at my departure in 1910, the University honored me by the appointment as Non-resident Professor and thereby maintained for the future my membership in the University.

You will therefore understand with what feelings of deep sorrow and injury I learned in 1919, that my name has been erased from the list of the University. These feelings were, however, lightened by the immediate

J. Spencer Dickerson - #2.

thought that the erasure of my name was not so much an act of personal antipathy to me, as rather one of those effects of war-psychology, which confused even the most enlightened spirits in fact in all the warring lands, and led to such regrettable steps as the expulsion of the German scholars from the French Academy; the return, by German Scholars to English Universities of Doctor-diplomas conferred upon them, the resolution of the inter-allied academies to maintain, even after the war, the discontinuance of relations with German scholars, and so on.

On the present action of the Board of Trustees in reappointing me Non-resident Professor, I see with satisfaction, a sign of the beginning of the return of that open-hearted "spirit of good feeling", which before the war used to characterize, in such high measure, precisely the scholars of America; and since furthermore, from the friendly tone of your letter accompanying the notification of my reappointment, I may infer on the part of the Board of Trustees a feeling of regret for the injury done me formerly, I have had no hesitation in accepting the reappointment in the same spirit of reconciliation with which it has been tendered. I am sincerely rejoicing now again to be a member of the University of Chicago, and I hope with you most earnestly, that this spirit of reconciliation may everywhere steadily increase and gradually lead the world back to a true peace.

I remain with sincere esteem,

Yours very truly,

(Signed.) Oskar Bolza.

The University of Chicago

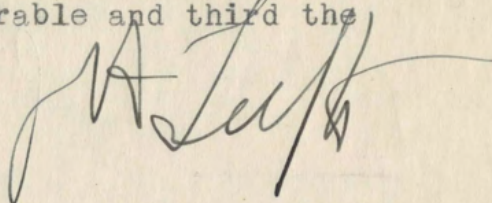
Office of the Dean of Faculties

January 16, 1924

Memo. to the President.

On the basis of your approval in conversation, I authorized Professor Moulton to organize the courses in Applied Mathematics for next year and to prepare them for publication. I understand that he is doing this, although I have not yet seen the copy.

As there was some difference of opinion among the different persons interested concerning the precise status of this work, i.e., whether it should be regarded as a fully fledged department, I thought it would be safer to follow the analogy of "Courses in Medicine", and use the heading "Courses in Applied Mathematics" instead of the more formal heading of "Department of Applied Mathematics". Under this I suggested might be placed first the names of those offering courses and second such descriptive matter as seemed desirable and third the list of courses.



T.S

Return

January 12, 1924.

My dear Mr. Tufts:

There was some talk last Summer about the organization of a Department of Applied Mathematics, with Mr. F. R. Moulton as the Head. Would you care to consult with Mr. Gale and decide whether you wish to take up this matter with Mr. Moulton?

Yours very truly,

President.

Dean J. H. Tufts,
Faculty Exchange.

EDB:AW

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EDB:AW

1924-25

XVIII

January 19, 1923

President Harry Pratt Judson
University of Chicago

Dear Mr. Judson:

Since the termination of the recent war we, of the Ryerson group, have discussed repeatedly the advisability of expanding the work in applied mathematics, and of announcing it in a little more formal manner. Our ideas respecting what is desirable in the immediate future have been so far crystallized that I should now like to take up with you the question for your consideration. In order to place the matter before you in a concrete form I will make two recommendations, the understanding being that while they represent our ideas they are now placed before you for consideration and such discussion as you may think desirable.

RECOMMENDATIONS

- I. That authority be given to announce all the courses in applied mathematics together under the heading "Applied Mathematics" in the form used for announcing the courses in the several departments. Further, that the President designate some member of the Ryerson group to act as Chairman in arranging for and announcing the courses.
- II. That steps be at once taken to cultivate the general domain of statistical mathematics; and that to promote this field, Professor W. L. Crum, of Yale University, be offered an Associate Professorship in the department of Astronomy or Mathematics, with the understanding that if the offer is accepted he will begin his work here in October 1923.

APPLIED MATHEMATICS IN THE PAST

The Department of Astronomy, at the University, has from the beginning interpreted its field broadly, and has made a notable success in several parts of applied mathematics. Among its Doctors now holding either headships or important positions in mathematics are Hamilton, of Beloit, Lunn, of Chicago, Wilson, of Case School, Griffin, of Reed College, Longley, of Yale, MacMillan, of Chicago, H. E. Buchanan, of Tulane University, Hopkins, of Michigan, Miser, of Armour Institute, D. Buchanan, of Vancouver, Warren, of Manitoba, Campbell, of Alberta, Buck, of California, and Carr, of Oberlin. It has given minor work to a large fraction of those who have taken their doctorates in pure mathematics.

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Since 1919 both the War and Navy departments have been sending officers here to take instruction in Ballistics, and it is probable that officers will continue to be sent for some time in the future. In addition, Mr. Lunn, of the Department of Mathematics, has been giving courses in many branches of theoretical physics.

COOPERATION WITH OTHER DEPARTMENTS

For more than twenty years there have been the most cordial relations between the Departments of Astronomy and Mathematics. For nearly that long the courses offered by the two departments have been planned at joint conferences, and they have had a joint departmental club. For many years there have been close relations with the Department of Geology, particularly in reference to problems of Cosmogony, Geophysics, and Isostasy. The relations with the Department of Physics have been similar, the largest single piece of work carried out by cooperation being the earth-tides experiments and theory. There have been pleasant, but less frequent, contacts with the Departments of English, Chemistry, Athletics, Egyptology, and with the Divinity School.

REASONS FOR RECOMMENDATION I

The character of the work given by the Department of Astronomy is exceptional in the whole country. Consequently, the University is not getting full credit with the educational world for the courses that are actually being given, and the work here is hampered to some extent by the fact that students learn of its character only after some period of residence. A formal announcement of the courses in applied mathematics as being "applied mathematics" will remedy both defects.

A second reason for the recommendation is that Professor Swan, who will come to the Department of Physics at the beginning of next year, is a prominent mathematical physicist, and his courses will assist greatly in fairly covering the field of the physical sciences.

A final reason for the recommendation is that ever since the recent war there has been great interest in applied mathematics, partly due to the applications of mathematics to war problems, and the University should make plainly evident the fact that it fosters work in this field.

REASONS FOR RECOMMENDATION II

In the first place, the use of statistical material and the employment of statistical methods have greatly increased in both Astronomy and Physics in the last few years.

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In the first place, the use of statistical material and the employment of statistical methods have greatly increased in both Astronomy and Physics in the last few years.

The problems presented in these sciences have led to extensive researches on the foundations of statistical methods.

In the second place, a considerable number of subjects are rapidly become quantitative and, from their nature, subject to treatment by statistical methods. I need mention only Economics, Sociology, Biology, and Education. In fact, modern life and human relations are so complex and dependent upon so many individual cases possessing individual differences, yet necessarily related to the whole, that progress will be inevitably wrapped up with statistical questions.

In the third place, several universities have already recognized the importance of statistical work and are vigorously cultivating it. We should not be behind them.

The last part of the second recommendation refers to a specific appointment. Professor Crum seems to be by far the best man there is a possibility of getting. His vita is briefly: Born Hoosick Falls, New York, 1894; A.B. Williams College, 1914, major in Physics, minor in Mathematics; M.A. Yale, 1916, in applied Mathematics; Ph.D. Yale, 1917, in Celestial Mechanics; Instructor in Mathematics in Yale, 1917; instructor in Gunnery in A.E.F. Heavy Artillery, 1918; instructor in Mathematics and Mechanics in A.E.F. University at Beaune, 1919; instructor in Mathematics in Yale first half of 1920-21; Assistant Professor of Mathematics in Williams College second half of 1920-21; Assistant Professor of Mathematics in Yale 1921 to date.

Dr. Crum is building up the work in Statistics in Yale with marked success. His reputation is indicated by the fact that he is being offered a position in Harvard, and the question of his going there will come to a conclusion very soon. Hence the problem of attempting to secure his services must be decided promptly or there will be no chance of success.

Dr. Crum is a man of good appearance and attractive personality; he seems to be very well balanced and to be well endowed with that common sense which is essential in his field; and he will cooperate with the departments with which he is associated and make new contacts with other departments.

If further information is desired it will be gladly given.

Very truly yours,

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PURE AND APPLIED
MATHEMATICS

at the

UNIVERSITY OF CHICAGO

I. Science and Civilization.

math

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.

In the last hundred years, the ability of civilized men to produce the necessities and luxuries of life has increased four-fold as a consequence of scientific discoveries and applications. The wealth produced yearly by the labor and effort of the people of this country now measures sixty billions of dollars, and about forty-five billions of this amount should be directly credited to the applications of science. But even this is a very inadequate statement of

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In the last hundred years, the ability of civilized men to produce the necessities and luxuries of life has increased four-fold as a consequence of scientific discoveries and applications. The wealth produced yearly by the labor and effort of the people of this country now measures six billions of dollars, and about forty-five billions of this amount should be directly credited to the applications of science. But even this is a very inadequate statement of

the benefits of science; it does not take into account the improved health and the increased span of life due to better living conditions, or the leisure and opportunities that have been afforded for cultivating the mind and higher faculties. Progress in these latter directions, in the long run, probably constitutes by far the largest contribution of science to the welfare of mankind.

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.

Although the city is enormously indebted to science for its prosperity, science asks no payment on back accounts. But in the interest of future development, the extent of which no

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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 generators, 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 rôle 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.

The discoveries of Professors A. A. Michelson and Robert A. Millikan and of others of the Physics staff constitute one of the most brilliant chapters in the history of modern science. Only four times since the Nobel Prizes

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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 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 rotation 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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Professor Arthur H. Compton has done important work on the X-Ray which may reverse the idea that light consists of waves and confirm Newton's old theory that light consists of streams of particles.

Associate Professor Dempster constructed in the Ryerson Laboratory the first apparatus for clearly analysing chemical elements into isotopes, thus introducing a great development in our ideas of the structure of matter.

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, and 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.

The scientific honors which have been awarded to the members of these two departments are conclusive evidence of their responsibilities of leadership in the mathematical affairs of the country and of the esteem in which their colleagues hold them.

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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 our mathematicians 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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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.

The mathematical departments of the University are not

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, who was also a mathematician of some attainments, approached a member of our department with a problem requiring the solution of fifteen simultaneous equations upon which he had worked for two months with no success. The solutions was furnished in two hours. In another case a graduate student working under the direction of one of our 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 our faculty members entered the service of the Government in ballistic work. One of them became the leading ballistician in this country in the course of a few months. 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. The higher mathematics of today has in every generation been the every day mathematics of tomorrow.

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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 the 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	33
Business	6
U.S. Navy	2
Deceased	7

Total	<u>131</u>
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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, Michigan, Wisconsin, Northwestern, Tulane; and in Canada, Manitoba, Saskatchewan, 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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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 endowment. 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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A building for Mathematics would relieve both Physics and Mathematics from their embarrassment in the matter of space; and adequate endowment would ensure to Mathematics the continued expansion justified by its brilliant past and the increasing demands upon it.

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. (a)	The Building, including equipment and a fund for its maintenance.....	\$800,000	1,000,000
	(b) The Establishment of a "Distinguished Service Professorship.....	200,000	\$1,000,000.
2.	The Endowment of 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

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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. At least one such professorship should be available for award in Pure and Applied Mathematics. The Distinguished Service Professorships are explained in a separate folder.

The million dollars for the endowment of the Department 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 and a Distinguished Service Professorship fund of \$200,000 would also contribute to the fulfilment 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 \$1,200,000 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

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