Dr. Aydelotte: September 3/41

Prof. Veblen has asked me to give you the papers attached, that to Dr. Abraham Flexner of June 10/24 being an outline of Prof. Veblen's proposal for an Institute of Mathematics.

G.Blake

Members

Number of Members (Memberships)

1933-34	23	
1934-35	35	
1935-36	45	
1936-37	58	
1937-38	40	
1938-39	46	
1939-40	46	
1940-41	52	
1941-42	53	
1942-43	28	
1943-44	19	
1944-45	25	(first term)
Total	470	

1941 vert. file "M" May

MATHEMATICS Academic Activities

MORSE Biographical

Morse's article on "Mathematics in the Defense Program."

Filed in Vertical File under "M" for Mathematics.

F. A., 1/8/57

(Reprinted from The Mathematics Teacher for May 1941)

Mathematics in the Defense Program*

By MARSTON MORSE
Chairman of the War Preparedness Committee of the American Mathematical Society and Mathematical Association of America
Institute for Advanced Study, Princeton, New Jersey
and
WILLIAM L. HART
University of Minnesota, Minneapolis, Minnesota

THE American Mathematical Society and the Mathematical Association of America number some 5000 members. The American Mathematical Society is devoted primarily to the development of research in mathematics, and the Mathematical Association of America to the teaching of mathematics. About a year ago these societies appointed a committee known as the War Preparedness Committee, to prepare the two societies to be useful to our nation in time of war. The ways and means of doing this were not prescribed, but were left to the committee. Before I give you details about our organization and aims it will be helpful to make a few remarks concerning the role of science in defense in general.

The most effective employment of science in a defense program must include the use not only of the facts of science, but also of the methods and men. In time of war science must be resourceful and inventive and capable of *quick* analysis of emergency problems. The defense against the magnetic mine by the English is a magnificent example of the immediate application of theory to practice. Theoretical science can not be neglected; for it is the reservoir of general methods any one of which may be needed. But theoretical science should be in a form in which it can be quickly applied. We should further develop the technique of making applications.

This is particularly true of mathematics. North America leads the world in pure mathematics. We are also strong in the simpler applications appearing in ordinary engineering or industrial practice; but we have preferred experiment to theory and have tended to use the laboratory to obtain results which might have been predicted. This is in contrast to the situation in Europe, where tradition as well as material necessity have produced engineers with greater theoretical knowledge and training. This state of affairs should be

* Address delivered before the National Council of Teachers of Mathematics at Atlantic City on February 21, 1941 by Professor Morse. The part with special reference to the secondary field, and certain other sections, comprise the essential portions of an address by Professor Hart on "Mathematics for National Service" before the National Council at Baton Rouge, La. on January 1, 1941.

remedied; for in time of war we cannot take the time to experiment.

We are beginning to correct this situation. In this we are aided by a number of European experts of great talent and ability. Several of the leading authorities on aerodynamics of Germany are now refugees in this country. The leading mathematical authority on ballistics of Italy, is also a refugee and is lecturing in this country. In addition, there are a few Americans who are well trained in these fields. But these authorities are in such demand from industry for immediate purposes that they have little time for teaching or general education and research.

I have given you one reason why this bottleneck has arisen. There is another reason which goes very deep. It is our national suspicion of theory, on the part of the general public. We are perilously lowbrow. This is dangerous in a democracy where the great motivating forces must come from the people. One result has been a lack of cooperation between the theoretically-minded scientist and the practically-minded scientist. The pure scientists have intensified their study of science for science's sake, and the applied scientists have adhered to "common sense" and the laboratory. It is one of the problems of education to show that the more mature and socially-minded way is to respect both theory and practice, and particularly their combination.

In this connection I wish to refer you to a pamphlet on *Science in War*, written by twenty English scientists during the last year. This book is in the Penguin series, costs twenty-five cents, and may be ordered from New York at any bookstore. It is an illuminating account of the success of science when used in the English defense, and of the difficulties in getting science used. Here are discussed the problems of nutrition, of agriculture, of stock-breeding and planting, and of the reactions of the Civil Service and tradition to these problems. There is the problem of rationing, of the hours of labor, of the care of the wounded and prevention of disease, the dispute between the artists and naturalists over camouflage, the uses of mechanical science, the problems of morale and propaganda. On reading this book one sees clearly the necessity in a democracy of an adequate understanding of science by the general public, and as a corollary the fundamental need of education in the methods and aims of science, as well as in the facts.

With the foregoing in mind I shall now describe the aims and organization of the War Preparedness Committee.

Our objectives may be listed under five heads:

1. *Research.* The solution of mathematical problems essential for military or naval science, or rearmament.
2. *Preparation for Research.* The preparation of professional mathematicians for such research.
3. *Education for Service.* The strengthening of mathematical education in our schools and colleges to the point where it affords adequate preparation in mathematics for military and naval service or rearmament.
4. *Military and Naval Texts.* The study by a large group of mathematicians of the current routine military texts and sources wherein mathematics is involved—to obtain *certain* knowledge of what should be taught in the schools and colleges, and in order that mathematicians may be able to aid in the revision of these texts if and when their aid is needed.
5. *Roster of Personnel.* The collection of specialized information concerning mathematicians, similar to that in the national roster but more detailed as to mathematical training; and the making of this information available to all scientific or military committees or organizations aiding in the defense.

To carry out these objectives three subcommittees were appointed with the following titles:

1. Research
2. Preparation for Research
3. Education for Service

It is the last committee, on Education for Service, in which you are naturally most interested, but I shall first tell you about the other two committees.

Committee on Research. This committee is headed by Professor Dunham Jackson of the University of Minnesota. It is ready to receive mathematical problems important for the national defense, and will seek to solve these problems. To aid this committee we have appointed consultants in each of six fields. These fields are as follows:

Aeronautics
Ballistics
Computation (numerical, mechanical, electrical)
Cryptanalysis
Industry
Probability and Statistics

The chief consultant in *aeronautics* is Professor Bateman of the California Institute of Technology. This is perhaps the most difficult of all the fields, and one of the most important. Thousands of hours of mathematical labor go into the design of each new type of aeroplane. There is the problem of the flow of air by moving objects and the problem of the determination of surfaces of least resistance and greatest lifting power. The problem of flutter is a very troublesome one, but nevertheless admits a mathematical approach. An essential tool here is the theory of conformal mapping. Those who wish further details may refer to a paper entitled "The engineer grapples with non-linear problems" by Theodore von Kármán, in the *Bulletin of the American Mathematical Society* of 1940.

The chief consultant in *ballistics* is John von Neumann of the Institute for Advanced Study at Princeton, New Jersey. The Government maintains its proving ground at Aberdeen, Maryland, and Dahlgren, Virginia, and has several able mathematicians at work in this field. These men are charged with the proper design of guns and projectiles, with their testing, and the making of tables. The problem of bombsights is also referred to them. An interesting discovery of the last few years is the close connection between the theory of projectiles and that of high speed aeroplanes. High speed projectiles move at a velocity somewhat greater than that of sound, while the maximum speed of aeroplanes is now nearly two-thirds that of sound. It is therefore natural that ballistics and aerodynamics should be intimately related. The speed of sound is critical for bodies moving in the air. The tremendous resistance met at this speed seems to indicate that the maximum velocity at which aeroplanes can fly is fast being approached.

Professor Norbert Wiener of the Massachusetts Institute of Technology is the chief consultant in *computation.* A great deal of the computational work at the Aberdeen Proving Ground is now done by mechanical means by the so-called Bush Analyser. This is an intricate and expensive machine occupying a large room and capable of giving the numerical solutions of an important class of differential equations. Since the original machine was set up at Massachusetts Institute of Technology some ten years ago, several larger and better ones have been built. In the whole world at the present time there are not more than ten such machines. Professor Wiener is working on the problem of using this machine or similar machines to solve partial differential equations. If accomplished, this would be an important aid for applied methematics. In spite of the existence of these machines, much computation still has to be done in the old-fashioned way. Fortunately for this country, we have a number of experts on numerical computation.

Cryptanalysis is the science of the making and solving of codes and cyphers. There is ample literature on the subject and by virtue of its intriguing nature it might appeal to students of high school age. The chief consultant is Professor Engstrom of Yale. Professor Engstrom is an officer in the Naval Reserve and with his aid a number of able young mathematicians are making an intensive study of crypt-analysis. It is possible to use the latest and most powerful algebras to make codes that are unbreakable. The catch is that complex codes are difficult to transmit without mutilation. Ordinary code theory involves a use of frequency tables and much ingenuity. It was only during the last war that the Germans discovered that it was better to employ statisticians than philologists in this branch of the military service. Here is a field in which mathematicians are very useful.

The chief consultant in *Industry* is Dr. Thornton C. Fry, Mathematical Research Director of the Bell Telephone Laboratories. There are more than fifty corporations employing more than 100 mathematicians. He finds that integral equations are used in prospecting for oil, matrix algebra in studying the vibration of aircraft wings, and in electric circuit theory, the calculus of variations in improving the efficiency of relays, the theory of numbers in the design of reduction gears, and in splicing telephone cables, and topology in the classification of electric networks. He points out that there is no place in this country where a mathematical consultant for industry can be trained as such. Such a man studies as an engineer, or a physicist, or a mathematician, and must be partially self-trained to serve as a mathematician in industry. Fry's plea for better training in the field confirms the emphasis of our committee on training in applied mathematics. Moreover, in this field the demand for men exceeds the supply.

Professor S. S. Wilks of Princeton University is the chief consultant in *probability* and *statistics*. I shall quote Wilks as follows:

> In a war emergency the greatest service which can be rendered by probability and statistics is of the nature of routine and practical applications. Because of the extreme importance of mass production techniques in modern warfare the feeling is very general that statistical methods of quality control such as those used by Shewhart in the Bell Telephone Laboratories would be valuable. Another main technique is that of sampling surveys and their application to the problem of stores and supplies, personnel selection, transportation, communication, etc. There is also the problem of statistical analysis of data obtained in bombing practice and in range firing.

Preparation for Research. The second main subcommittee on "Preparation for Research" is headed by Professor Marshall H. Stone of Harvard University. It is concerned with the professional education of mathematicians to the end that they may be available for research on mathematical problems of the defense. Up to date expositions of ballistics, aerodynamics and hydrodynamics are not available. This committee is concerned with this lack. It seeks to encourage the giving of special courses on applied mathematics in the various graduate schools, and a number of these courses are now being given. Bibliographies need to be published and special seminars on mathematics of the defense need to be arranged at various scientific gatherings. This is a work of great importance, but one that will take time. It is an essential part of the proposed development of applied mathematics.

Education for Service. The third subcommittee, and the one in which you are undoubtedly most interested, is on Education for Service. Its Chairman is Professor William L. Hart of the University of Minnesota. At my suggestion his committee embarked on a vigorous campaign of investigation of mathematical education in the secondary schools and of undergraduate mathematical education in the colleges, in relation to the national defense. The objectives as formulated by his committee are as follows:

1. To investigate what mathematics is of prime utility in industry and in the Army and Navy in the national defense.
2. In accordance with the results of this investigation, to make useful recom-

mendations in regard to mathematical curricula at both the secondary and college levels.

3. To determine in what ways mathematicians may aid in the preparation of textbook material and in the teaching of those who will have mathematical duties in industry or as enlisted men or officers.

Professor Hart conferred with the officers in charge of the R.O.T.C. at the University of Minnesota with teachers of aeronautical engineering, and with teachers of ground school courses in the Civil Aeronautics Program. He visited two warships and some major coast defenses of the Army, and examined the workings of a major aircraft plant. He has drawn upon his experience as a major of artillery during the World War. At my recommendation his committee obtained textbooks of a mathematical nature employed in the R.O.T.C., for ground school courses for pilots, and for various service schools maintained by the Army. No consideration was given to training at West Point and Annapolis because the officers from these schools are exceptionally well prepared for their duties. His report concerns mathematical aspects of the preparation of all others, officers or men, who will eventually enter the national service.

A representative sample of the military textbooks which such men would study was sent to various mathematicians to review. I have some of these reviews with me and shall be glad to show them to anyone of you who may be interested. I shall continue with a reading of parts of an address presented to the National Council by Professor Hart at Baton Rouge.

"One object of these reviews is to learn at first hand what mathematics is a minimum essential for the study of the texts and for the performance of field duties by officers and enlisted men in various branches of the military services. As a second object, in these reviews, we wished to observe the nature of the exposition of mathematical material in the texts, with the possibility in mind that mathematicians might aid in the construction of any future editions of the books. In this outline of my sources of information, I take pleasure in acknowledging assistance received by me from President Mary Potter of the National Council in connection with viewpoints for the secondary field and mathematics appropriate for skilled industrial workers.

"I shall now summarize some of the evidence at my disposal and then, later, I shall draw certain conclusions, principally concerning effects at the secondary level.

"Permit me to be very brief on the non-military side. It appears to me that the aircraft and munitions industries, with their demands for skilled workers and draftsmen, the drain on the national supply of skilled workers due to Army and Navy calls for enlisted specialists, and the statistical work associated with the activities of government agencies and industry, will operate to require largely increased numbers of men and women who have appropriate training in mathematics. It would be desirable if skilled workers in industry had substantial secondary mathematics, through the stage of computational trigonometry, with at least an intuitional knowledge of solid geometry, and with emphasis on numerical applications at all possible stages. For these non-military activities, as many women as possible should be trained at least through substantial high school mathematics; a more select group should be trained through the stage of elementary college mathematical statistics to create a reservoir of computers for government and industry.

"I evaluate the pure mathematical needs of the various Army and Navy services as follows, if we eliminate the requirements of those exceptional officers whose work can be designated as military research.

"*First*, the Infantry, motorized or not. Even this supposedly non-technical branch of the Army places demands on mathematics. All enlisted men in the infantry find use for arithmetic and intuitional geometry.

The officers, non-commissioned officers and private first-class should have familiarity with elementary geometry to permit map reading, map construction, appreciation of contour designations on maps, the use of coordinate systems. These men also should be able to appreciate the complicated mechanical drawings and the internal workings of the rifles, light anti-aircraft guns, and other materiel assigned to the infantry. In brief, for these men I would specify elementary algebra and geometry as frequently taught in training for industry. In addition the officers should have some acquaintance with the notions of probability and probable error as met in elementary statistics.

"*Second,* the *Coast Artillery Corps.* This exceedingly mathematical branch includes all artillery for seacoast defense, all high altitude anti-aircraft artillery, and all mobile artillery of heavy caliber. The officers of this corps have to perform the duties of surveyors on some occasions, and they deal with very complex optical instruments, motorized machinery, and complicated guns. These men should have very strong training in mathematics—in fact they should be engineering graduates as the most desirable stipulation. But, as a minimum, they must know mathematics through computational plane trigonometry, and elementary spherical trigonometry, with some background in solid geometry. They should also have an acquaintance with the notions of probability and probable error as met in elementary statistics, in order to appreciate the theory of gunfire. All enlisted men should have a background of geometric and algebraic knowledge equivalent to the training suitable for skilled workers in industry. In addition, about 25 per cent of the enlisted men should be as well qualified mathematically as the officers.

"*Third,* the Field Artillery, or light artillery. We can make the same minimum stipulations for mathematical training as in the Coast Artillery with the omission of mention of spherical trigonometry, and with somewhat less insistence on the need for mathematics in the case of the enlisted men.

"*Fourth,* the Signal Corps. The officers should be electrical engineers and the enlisted men should have the mathematical training suitable for skilled men in industry.

"*Fifth,* the Ordnance Dept. It needs various specialists, both officers and enlisted men, with highly mathematical backgrounds such as possessed by engineering graduates or college majors in mathematics.

"*Sixth,* flying officers in the Air Corps of the Army and Navy, and all other officers in the Navy. They require at least the same *minimum* training as officers of the Coast Artillery, because of the necessity for studying *navigation* in all present cases, aerodynamics and meteorology for air-force officers, and numerous other technical subjects. In fact, it bewilders a civilian, who has seen the workings of a warship, to conceive of any Navy officer who is not a trained engineer. These officers of the air-force and Navy should have substantial courses in solid geometry and spherical trigonometry, far beyond what is satisfactory for the artillery service.

"*Seventh,* the ground force of the Air Corps. It requires a large number of graduated engineers, men with college mathematics and physics especially for the meteorology section, and a large force of men with mathematical backgrounds suitable for skilled industry.

"*Eighth,* enlisted men in the Navy. All of them should have the mathematics suitable for skilled workers in industry. A substantial number of the enlisted men should be as well qualified as stipulated in the description of *minimum* mathematics for the officers.

"In summary, I believe that the preceding specifications of mathematical training for officers give minimum levels if our Army and Navy are to be well led. The training which I specified for various types of enlisted men may exceed the *true mini-*

ease, the dispute naturalists over echanical science, and propaganda. one sees clearly racy of an ade- science by the orollary the fun- n in the methods ll as in the facts. mind I shall now ganization of the ittee.
listed under five

ion of mathema- ntial for military rearmament.
earch. The prepa- onal mathemati- ch.
ce. The strength- ical education in eges to the point dequate prepara- s for military and rmament.
Texts. The study f mathematicians ne military texts n mathematics is n *certain* knowl- l be taught in the es, and in order ns may be able to of these texts if s needed.
The collection of ation concerning milar to that in but more detailed training; and the mation available tary committees ing in the de-

ves three sub- with the fol-

mum but probably is the *desirable* level if it can be attained. I hazard the guess that, without special effort on the part of the high schools, colleges, and centers for adult training, the nation will *not* have a proper reservoir of men with the mathematics necessary for the needs of industry and the military services.

"Now let me present certain personal recommendations for viewpoints and actions as a consequence of the nature of the probable mathematical needs which I have just enumerated.

"Item 1. In the secondary field, it would be very undiplomatic and harmful if the national emergency were taken as a crude excuse for a violent attack on certain curricular trends, even though it is possible that weaknesses of some features of these trends may become apparent when analyzed under the searchlight of our present national requirements. I recommend that initially we should make our proposals and state the mathematical objectives in the preparedness program *without* any stipulation as to the pedagogical details involved in attaining the objectives.

"Item 2. The National Council of Teachers of Mathematics and all organized bodies of mathematics teachers at all levels should advertise the utility of mathematics in industry and military service. In high schools it should be advertised that Army and Navy R.O.T.C. units in colleges *require* trigonometry and *should require* solid geometry and spherical trigonometry.

"Item 3. I recommend that every club of secondary teachers of mathematics should promptly hold a special meeting devoted to a discussion of the role of mathematics in the present national emergency and to a discussion of possible local actions in the high schools.

"Item 4. I recommend that in the junior and senior high schools, every boy and girl of sufficient mathematical aptitude should be *urged* by the high school advisers, to take as much mathematics as possible, through the stage of trigonometry and some solid geometry, as a national service. And, I recommend that a *new definition of socialized mathematics* be adopted in the curricula for students of *all* ability levels, where we would recognize that, at least for boys, *mathematical content with military uses* is the most socialized variety of mathematics to which they can be exposed at present.

"Item 5. The military necessity for spherical trigonometry and space diagrams in many important places leads me to recommend that the high school course in solid geometry be given much more emphasis than in recent years. I suggest that it be modified by replacing some of the classical content with a treatment of the elements of spherical trigonometry, thus giving a combined course in solid geometry and spherical trigonometry. In fact, this combination appeals to me on purely mathematical and pedagogical grounds apart from the requirements of the preparedness program.

"Item 6. I recommend that a *single* set of courses be used for secondary students of *ability* in attaining the desired ends, rather than separate curricula, some designed to fit men for industry and some planned for men and women who will proceed more deeply into mathematics.

"Item 7. As a temporary measure, I suggest that boys of intelligence, now in grades 11 and 12, who have previously omitted substantial mathematics, should be offered an *abbreviated* treatment of logarithms, plane trigonometry, intuitional solid geometry, and an introduction to spherical trigonometry, to permit these students to train themselves rapidly for their practically certain entrance into skilled industry or the Army or Navy.

"Item 8. I advance the opinion that a severe shortage of men with engineering training is at hand. This should be brought to the attention of interested boys of mathematical ability in the high schools.

"Item 9. As a final recommendation for the secondary field I urge the National Council to appoint a special committee on

"Mathematics for National Service," to coordinate and direct appropriate activities in the secondary field."

The applications of mathematics in the national defense will be made by men in all branches of the national service and in the various scientific professions. Some of the men contributing in this way will be mathematicians. The one thing for which mathematicians are mainly responsible and in which they have the greatest influence, is the education in mathematics for this service. I know that we can count on the teachers of mathematics for the fullest aid.

1941 Vert. file M

7/30
8/26
9/3

SCHOOL OF MATHEMATICS Academic Organization

VEBLEN, O. Biographical

AYDELOTTE, F.

Veblen to Aydelotte with material on School of Mathematics for Aydelotte report to the Board of Trustees.

Filed in Vertical File under "M" for School of Mathematics.

Find copy to Kellogg in V. Vert.

F. A. papers, 1/8/57

Brooklin,
Hancock Co. Maine

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

30 July 1941

Dear Frank:-

I have sent a night letter to Miss Blake making suggestions as to how ~~f~~ she might find a copy of one of my memoranda on a proposed mathematical institute. It should reach her to-morrow morning, and I believe she leaves at the end of the day for her vacation. Also, I have found, in the bottom of a drawer where old letters have been dumped, part* of a copy of a letter that I wrote to Vernon Kellogg, at that time secretary (or some such title) of the National Research Council. ~~It was on~~ The occasion was the completion of my year as chairman of the Physical Science Division of the National Res. C. The exact date could be derived from the publication of the N.R.C. It might have been 1923-24. At some later time I ~~prepared~~ think I used this in preparing a memorandum to send in response to a request from Simon Flexner who (if my memory is right) wanted to show it to his brother. There is doubtless a copy of this knocking about somewhere and you are welcome to it, if it can be found. My ideas fell short

* the rest has disappeared.

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

of Dr. Flexner's both in scope and in precision. There was nothing about ~~[illegible]~~ dignifying the position and raising the standard of life of the profes[sor]. I thought only of relieving him of the load of irrelevant teaching, of which I was extremely conscious ~~[illegible]~~ at that time. Also I felt it necessary to provide him with routine work. I did not realize how automatically this is done under any scheme of life.

Karl Compton probably heard me trying to get ideas of this sort incorporated in the program of the Princeton Fund a money raising ~~[illegible]~~ enterprise of the middle or late '20's.

I suppose that finding a forgotten screed like this (I had completely forgotten about the letter to Kellogg, of which this may be a draft) stirs mingled feelings. In this case satisfaction that our Institute does the thing so handsomely is mingled with regret that the Rockefeller people have practically terminated the N.R.C. fellowships. (You can read the dat[a] from the st[a]tendance figures which Miss Blake made up for you.)

Givens & Taub are working well and there is a good chance that our jig saw puzzle will be put together by the end of the summer.

We badly wa[nt] sti[rring] beyond our own borders and are both feeling a lot better than at the end of June. We are delighted to hear that your house has turned out so well.

As ever,

Oswald Veblen

Dear Dr. Kellogg:

My experience this year has made me rather acutely conscious of the fact that the needs of mathematical research have not yet been brought to the attention of those whose position enables them to have a view of the strategy of Science. This, I think, is chiefly the fault of the mathematicians themselves, who have too easily assumed that an outside world which cannot understand the details of their work is not interested in its success. That such an idea is erroneous has been well illustrated by the generous action of the Rockefeller Foundation in providing funds for Research Fellowships in Mathematics of the same type as for Physics and Chemistry. This was done immediately, and apparently as a matter of course, when the need for such fellowships was pointed out. This experience, as well as much evidence of a less tangible sort, of the friendly interest in mathematics, leads me to hope that it may be worth while to draw attention to the fact that we are now in a situation where another very important step of a similar sort may be taken.

~~Mathematical research is done almost entirely by university and college teachers.~~ A mathematics department in an American university has to deal with an enormous mass of freshmen, a very large number of sophomores, and with extremely small numbers of juniors, seniors and graduate students. The situation is entirely different from that of a European University, which has to deal only with the last class of students. The subjects taught to freshmen and sophomores are taken up in the Lycee's and Gymnasia. Under our conditions, the men responsible for the conduct of a Mathematics department are obliged to give their primary attention to providing instruction for the freshmen and sophomores. This obligation is due not merely to the number of men who have to be dealt with but also to the intrinsic importance of such instruction.

Nevertheless there has been a great development of mathematical research in this country. Twenty or thirty years ago there were very few men doing such research and they were receiving very little consideration from the Universities. Now they are very much in demand. A man with good mathematical gifts and normal personal qualities has little trouble in obtaining as good a position as is available under our system. But when he obtains it he has a teaching schedule of from nine to fifteen hours a week as compared with three hours a week for his colleague in the College de France, for example. Moreover, he becomes tremendously interested in this teaching; he sees the manifold ways in which it could be improved, and he plays his part in the committees and other administrative devices which are trying to do the obvious tasks of the university in a better way.

He was preferred to other men when appointed, because of his scientific distinction. But just because he has a sense of responsibility and reacts in a normal way to his environment, it is only a small fraction of his energy that goes into research. The university authorities never know the difference (it does not show in the number of his publications, only in the quality) and give him his rightful share of respect as a loyal member of the community.

So we have arrived at the stage where we recognize ability in scientific research as a basis for university appointments but not as a primary occupation for the appointees. This statement is not strictly true in sciences like Physics and Chemistry for the universities which have great laboratories usually recognize the absurdity of maintaining such plants without a respectable output of research. It is brilliantly untrue in Astronomy. But in Mathematics it is true almost without an exception.

The way to make another step forward is obvious. Indeed it has already been partially recognized by the Rockefeller Foundation in establishing a series of Fellowships in various sciences which afford opportunities for research to men of promise at the outset of their careers. What remains to do is to find a way of assuring the continuance of their research to men who have already proved their ability. This is already provided for, to a certain extent, in the laboratories of the experimental sciences, but, as already indicated, there is no provision in Mathematics. To provide it, there are at least two ways which would be justified by the actual amount of mathematical talent in the country. The first of these would be to found and endow a Mathematical Institute.

The physical equipment of such an institute would be very simple: a library, a few offices, and lecture rooms, and a small amount of apparatus such as computing machines. There should also be provision on a small scale for stenographers and computers. But the main funds of such an institute should be used for the salaries of men or women whose business is mathematical research. These people should, however, be provided with the equivalent of the routine work which is always present in laboratory sciences. This work could consist, for example, in editing a mathematical periodical or in preparing a new edition of the Encyclopedia of Mathematics. The latter enterprise would be a very large one but would be tremendously important both for pure mathematics and for its applications. The members of the Institute should also be expected to give lectures to advanced students in their own fields of research.

Such an institute, in my opinion, could operate successfully either in conjunction with a university or as an entirely separate institution. In either case it would treat mathematical research as a profession. There are plenty of men in the country who have shown that they are capable of living up to such a position.

The second plan which I have in mind is essentially that followed by the Royal Society in the Yarrow Research Professorships. It consists in establishing and endowing a number of research professorships which are

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

Brooklin,
Hancock Co.
26 Aug. 1941 Maine.

Dear Frank:-

Please forgive me for not having sooner answered yours of the 4th. Givens & Taub have been with me for several hours nearly every day & before times I have been preparing for them. This lasted till yesterday. They are now on their way west. Givens carries with him the M.S. of the first eleven chapters, to which he is to give the final polish. Taub has two, and I have the final one. Givens & I are to have another session during my week in Chicago. I feel that the rather strenuous summer session has been worth while — and won't enumerate the other things than letters that have been neglected.

Now I have to write my address for Chicago — including a non-committal abstract for the press which was due yesterday — At present the plan is to stay here till about the 15th, then drive part way to Chicago, perhaps to Cleveland, put up the car at a friend's garage, and go from Cleveland to Chicago & return by train. We are to be in Chicago from the 22nd to the 29th, after which the date of arrival in P. is determined by the time it takes to drive from Cleveland.

Your plan for your report on the Sc. of Math interests me intensely, of course, and I should think it would interest the Trustees much more than any attempt

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

to describe our technical work in detail. I should not think that my little dream of a Math. Inst. should be stressed too much. There are two circumstances which seem to me to have contributed in a major way to the success of the Inst. and to its actually being placed in Princeton: (1) In the years between the two world wars there was an extraordinary amount of travel by research workers in the mathematical and physical sciences to various centers of study. In earlier times such pilgrimages had been made chiefly by students (e.g. candidates for the Ph.D.) but during this period ~~those~~ they were made by men who had already won their spurs. This travel was greatly facilitated by fellowships, of which the Rockefeller Fellowships were the most important. Simon Flexner was one of the individuals most responsible for the founding & success of these fellowships (and also for the inclusion of mathematics in the American ones) (2) The building of a mathematics department in Princeton Univ. which ~~had gone~~ was completely out of proportion with the standing of the Univ. in other fields of scholarship had been going on under the leadership of H. B. Fine since 1905 and even earlier. The local situation was such that the number of advanced undergraduate students was very small, as was also the number of graduate students. But during the 1920's the number of post Ph.D. students became very large actually larger than the number of graduate students. This had a marked effect on the type of lectures given in advanced courses which became less and less pedagogical and more and more the sort of exposition which ought to be taken down and converted into books. I think that there was a year when all (or all but one) of the N.R.C. fellows in math. came to Princeton (~~and~~ and so scandalized the Rockefeller administrators). Perhaps this was after the Inst. was founded. Anyhow the Institute seemed like an extension and intensification of what was already going on. Dr. Flexner's fond boast, repeated at nearly every meeting of the trustees, that one did not in general know who was in the Institute and who in the University was founded on fact.

The movement (1) ~~made possible~~ which sent mathematicians and theoretical physicists on their travels enabled them to make use of the nucleus (2) and thus convert it from a remarkable collection of mathe-

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

where one could count on finding what one wants to seek in almost any field of math.

maticians attached to an unlikely college in a recognized world center ~~meeting place~~. Then followed the founding of the Institute which makes it possible to preserve this center and, simultaneously, the political movements which have destroyed analogous centers in Europe.

The move to Fuld Hall has altered the situation in ways that are not yet clear to me. Perhaps something more definite about our common interests should be negotiated between the two groups which now exist. In the mean time, you know how important it seems to me to have adequate quarters for the distinguished visitors who still come in spite of the war.

I gathered from Miss Blake that she had looked through my locked file without finding the missing memorandum. The keys were in my desk as I told her. Perhaps she might look again. Also she or Schwartz could find a copy of an obituary notice I wrote about H. B. Fine and which was published in the Bulletin of the American Math. Soc. about 1930. There are several copies in the file in the hall outside my door. It contains something about the P. Math. Dept.

Also I can look up anything that you want or I have when I return to Princeton. There will still be at least 10 days before the Trustees meeting.

This reminds me that I spent some time getting together material about early faculty meetings & hope to give you a report as soon as I can check up with a couple of my colleagues.

Elizabeth* joins in best greetings to Marie & yourself.

As ever,

Oswald Veblen

* Handicapped by a sprained ankle

F

June 10, 1924.

Abraham Flexner, Esq.,
61 Broadway,
New York, N. Y.

Dear Dr. Flexner:

Some time ago I sent your brother, Dr. Simon Flexner, who has shown a practical interest in mathematical as well as other research, a letter about my ideas as to the best way of furthering such research. He suggested that I should talk the matter over with you. I should like very much to do so some time at your convenience. In the meantime, I am sending you the following statement, which is practically a copy of a sort of a valedictory statement which I left with Dr. Vernon Kellogg:

My experience this year has made me rather acutely conscious of the fact that the needs of mathematical research have not yet been brought to the attention of those whose position enables them to have a view of the strategy of Science. This, I think, is chiefly the fault of the mathematicians themselves, who have too easily assumed that an outside world which cannot understand the details of their work is not interested in its success. That such an idea is erroneous has been well illustrated by the generous action of the Rockefeller Foundation in providing funds for Research Fellowships in Mathematics of the same type as for Physics and Chemistry. This was done immediately, and apparently as a matter of course, when the need for such fellowships was pointed out. This experience, as well as much evidence of a less tangible sort of the friendly interest in mathematics, leads me to hope that it may be worth while to draw attention to the fact that we are now in a position where another very important step of a similar sort may be taken.

The step which I propose is a very obvious one which doubtless should be taken in many other fields also. I wish to make the argument only for mathematics, however, for I am sure of my facts if I limit myself in this way. The step is simply to give a number of the men who have proved that they can do productive work in this field a chance to concentrate their efforts on it. A business man or a European scientist would probably ask at once: Are the universities not already doing exactly this thing in all subjects? The answer would have to be that unfortunately they are not doing it - certainly not in mathematics.

It is true that mathematical research is done almost entirely by university and college teachers. But a mathematical department in an American university has to deal with an enormous mass of freshmen, a very large number of sophomores, and with extremely small numbers of juniors, seniors and graduate students. The situation is entirely different from that of a European university, which has to deal only with the last class of students. The subjects taught to freshmen and sophomores are taken up in the Lycée's and Gymnasia. Under our conditions, the men responsible for the conduct of a mathematics department are obliged to give their primary attention to providing instruction for the freshmen and sophomores. This obligation is due not merely to the number of men who have to be dealt with but also to the intrinsic importance of such instruction.

Nevertheless there has been a great development of mathematical research in this country. Twenty or thirty years ago there were very few men doing such research and they were receiving very little consideration from the universities. Now they are very much in demand. A man with good mathematical gifts and normal personal qualities has little trouble in obtaining as good a position as is available under our system. But when he obtains it he has a teaching schedule of from nine to fifteen hours a week as compared with three hours a week for his colleague in the Collège de France, for example. Moreover, he becomes tremendously interested in this teaching; he sees the manifold ways in which it could be improved, and he plays his part in the committees and other administrative devices for doing the obvious tasks of the university.

He was preferred to other men when appointed, because of his scientific distinction. But just because he has a sense of responsibility and reacts in a normal way to his environment, it is only a small fraction of his energy that goes into research.

So we have arrived at the stage where we recognize ability in scientific research as a basis for university appointments but not as a primary occupation for the appointees. This statement is not strictly true in sciences like Physics and Chemistry, for the universities which have great laboratories usually recognize the absurdity of maintaining such plants without a respectable output of research. It is brilliantly untrue in Astronomy. But in Mathematics it is true almost without an exception.

The way to make another step forward is obvious. Indeed it has already been partially recognized by the Rockefeller Foundation in establishing a series of Fellowships in various sciences which afford opportunities for research to men of promise at the outset of their careers. What remains to do is to find a way of assuring the continuance of their research to men who have already proved their ability. This is already provided for, to a certain extent, in the laboratories of the experimental sciences, but, as already indicated, there is no provision in mathematics. To provide it, there are at least two ways which would be justified by the actual amount of mathematical talent in the country.

The first of these would be to found and endow a Mathematical Institute. The physical equipment of such an institute would be very simple: a library, a few offices and lecture rooms, and a small amount of apparatus, such as computing machines. There should also be provision, on a small scale, for stenographers and computers. But the main funds should be used for the salaries of men or women whose business is mathematical research. Such an institute, in my opinion, could operate successfully either in conjunction with a university or as an entirely separate institution. In either case it would treat mathematical research as a profession. There are plenty of men in the country who have shown that they are capable of living up to such a position.

The idea of such an institute is by no means a new or untried one. We have several institutes for research in other sciences in this country, and there are several mathematical institutes in Europe.

The second plan which I have in mind is essentially that followed by the Royal Society in the Yarrow Research Professorships. It consists in establishing and endowing a number of research professorships, which are awarded to individuals who have shown in their own environments that their impulse to research is a vital one. The appointees are not moved to new places. The only difference brought about is that they are freed from all other obligations and thenceforth paid for devoting their energies to research.

In our country it would be advisable actually to limit the amount of teaching or other routine that a research professor is allowed to do. He should not be allowed to give more than two or three lectures a week. Perhaps, also, he should not be allowed to accept more than a limited number of research students. With such restrictions, I think that one of our philanthropic foundations could carry a number of research professors on its salary roll and be confident that no better use could be made of its funds.

The second plan has the advantage that it could be tried out by gradual steps. The mathematical institute has the advantage that it would provide a definite nucleus for mathematical research and foster cooperation in a subject that has been treated in the past in perhaps an unnecessarily individualistic way.

Yours sincerely,

Oswald Veblen, Chairman,
Division of Physical Sciences.

OV/NER

GEROSA DEPLORES CLOSING OF SCHOOL

Controller Charges 'Waste' in Plan for Bronx Unit —Move Is Defended

Controller Lawrence E. Gerosa and the Board of Education, who have been at odds over the desirability of the proposed $500,000,000 school bond issue, clashed again yesterday. This time the cause was the desirability of an elementary school in the Bronx.

In an address before the Kiwanis Club of the Northeast Bronx, Mr. Gerosa took the board to task for its projected closing of Public School 56 at 207th Street and Hull Avenue. The school is forty-four years old. The club met at Mayer's Parkway Restaurant, 613 East 233d Street.

The Controller said the school was still in "excellent" condition. He said the city had not finished paying the fifty-year-corporate stock by which the construction was financed. He cited that as an example of "waste and extravagance" in the school construction program.

The original construction and site acquisition costs, Mr. Gerosa said, were $200,000, and by the time the stock matured it would have cost the taxpayers $530,000.

He asserted that Public School 56 was 76 per cent filled and that mothers in the neighborhood objected to having their children transferred to Public School 8, a new school on the south side of busy Mosholu Parkway.

"According to mothers in the area, they tell me the school is in execellent condition," he said. "Brand new plumbing was put in about three years ago and just recently the roof was repaired.

"The mothers now have to take their children ten blocks away and have to cross Mosholu Parkway going south—to fill up the new school—when the new school was built for the purpose of keeping the mothers in that area from crossing the Parkway going north. How ridiculous can you get!"

In answer to the Controller, a spokesman for the Board of Education said:

"We are considering closing Public S[...]

Father of Cybernetics Is Honored by M. I. T.

Dr. Norbert Wiener

Special to The New York Times.

CAMBRIDGE, Mass., April 29—Dr. Norbert Wiener, the father of cybernetics, has been appointed an Institute Professor at the Massachusetts Institute of Technology. He has been a member of the Mathematics Department forty years.

Dr. Julius A. Stratton, president of M. I. T., said that the appointment would free Dr. Wiener from departmental strictures and allow him to teach or devote all his time to research. He said that Dr. Wiener was "undeniably qualified" for the honor of becoming the fourth Institute Scholar.

Dr. Wiener entered Tufts College at the age of 11. He received the degree of Doctor of Philosophy from Harvard University at 18. Now, at 64, he is about to publish his first novel.

The new Institute Professor is best known for his theory of cybernetics, a science concerned with finding common principles in the function of automatic machines and the human nervous system.

NEW DEW POSTS READY

MAYO[...] IN CIG[...]

Continued

the new ci result in or 30 cent popular b 28 cents, paying mo his "smok
The law was passe on April the Boa April 22.
The onl increase i the Mayo by Eric for the of Ameri
He sai tax woul lose the sale of ci He pred bought c would ta prices in Jersey a munities impost.

Reg

Soon the ne Lawren ulation and col
City Schwa be bus pleting affixin stamps alread tailers.
Mr. earlier tors had b stamp tax would two heari the said, a ta was
M was arra tion taxe prov latic
Sl beg whi

MANKIND WARNED OF MACHINE PERIL

Robot 'Brain' Can Destroy Its Creators and Users, Prof. Wiener Declares

By MURRAY ILLSON

Man may contribute to his destruction by creating machines he cannot control, one of the world's leading mathematicians warned yesterday.

Prof. Norbert Wiener of the Massachusetts Institute of Technology asserted here that the notion that machines werenecessarily limited in their capabilities to the scope intended for them by their human creators might be erroneous.

He suggested that man might be building into such machines as electronic computers and automatic control devices possibilities of performance of which he was unaware. He indicated that these machines could have capacities for originality akin to those possessed by the human brain.

Professor Wiener spoke at the New York University Institute of Philosophy, held in Vanderbilt Hall, 40 Washington Square South. His topic was "The Brain and the Machine." Prof. Sidney Hook, chairman of the Department of Philosophy at the university, presided.

Chess-playing machines can be built with a high order of self-correction and adaptability, Professor Wiener observed. Such a machine, he said, can store up in its "memory" details of games played in the past with human opponents to the extent of learning their "favorite tricks."

He declared that in some circumstances it would not be easy for a human player to be sure whether he was opposing a machine or a person.

Professor Wiener, who coined the word "cybernetics" to cover the field concerned with similarities between the "thinking" of men and machines, asserted that what could be done with a game-playing machine could also be done with a computing machine or an automatic factory.

The machine, rather than its builder, can to some extent become the controller of its performance, Professor Wiener said, and this places on man new obligations and new responsibilities.

He observed that the machine was "literal-minded" and did what man told it to do rather than what man wanted it to do or what he imagined he had told it to do.

In this connection Professor Wiener cited Goethe's poem of the Magician's Apprentice and the Arabian Nights legend of the fisherman and the genie. The apprentice learned the words by which the broomstick was made to fetch water but had not learned the words to stop it. The genie, released from the bottle by the fisherman, had a will of its own and was a destructive force.

The automatic factory will not work automatically for man's good unless it has been determined in advance what that good is and unless the factory has been constructed to contribute to that good, Professor Wiener said.

He pointed out that if the only orders to the automatic factory were for an increase in production, for example, the vast productivity might also bring great unemployment and related problems that could contribute to man's destruction.

In reply to statements by other participants at the meeting to the effect that there were important differences between man's consciousness and the machine's "consciousness," Professor Wiener said that he was not certain how to define consciousness.

Likening of the human brain to a machine in functioning was disputed at the afternoon session.

Dr. Wolfgang Kohler, Emeritus Professor of Psychology at Swarthmore College, cited recent experiments that "destroy the theory that the brain operates like a machine."

THE

SOVIET APOLOGIZES TO M.I.T. EDUCATOR

A Soviet magazine has published a public apology to Dr. Norbert Wiener, a leading American mathematician for the denunciation of him and his work in cybernetics by the Soviet press during the Stalin era.

Dr. Wiener is generally considered to be the founder of cybernetics, a science concerned with finding common principles in the function of automatic machines and the human nervous system. He was denounced as an "obscurantist" and his work was ridiculed in the Soviet press earlier in the post-war era. The Soviet magazine Ogonyok now attributes this attitude to what it recognizes as the present backwardness of the Soviet Union in the important field in which Dr. Wiener has pioneered.

Written by a leading Soviet essayist, Marietta Shaginyan, Ogonyok article denounces the Soviet philosophers who had attacked Dr. Wiener and says that their attitude was "criminal."

She says public recognition of the error about Dr. Wiener is necessary to assure that these philosophers do not "repeat their errors in the future."

Dr. Wiener has been honored in the United States and abroad for his fundamental work in the mathematics of electronic computers and automation. Last Wednesday he was named an Institute Professor at the Massachusetts Institute of Technology, where he has taught for forty years.

Mitrany

THE INSTITUTE FOR ADVANCED STUDY

Princeton, New Jersey

May 10, 1949.

Dear Aydelotte:

It is awful to have to leave without seeing you. If I had known earlier that you would be away, I would have changed my own arrangements. As it happens, I shall actually have a day less to spend here, as I have just heard that we are embarking aboard on Thursday evening.

I am all the more sorry, as I should have liked to have told you privately of my discussions with the Director. Before going for my little holiday, I suggested to him my coming for one term each year till 65, at the present stipend of $4,000. I frankly told him that I needed that to keep up the payments, which amount to some $2300 yearly. He said he would consult the faculty, and on returning here this weekend he informed me that by a majority of 4 to 2 those he consulted were against my being promised more than one visit at that rate of payment. He added that this might be reconsidered if my work seemed to justify, or words to that effect.

That of course put my back up, especially as I had heard that Earle has been saying both here and abroad that I was not wanted because I was not doing anything. So I had another very frank talk with the Director yesterday, in which for the first time I spoke out, and the talk was quite friendly, and the Director much more outspoken in his views of Earle than I myself, and I said that in the circumstances I would have to write him a letter, putting my views; therefore leaving it it to him to make use of it or not if the issue should arise again.

It is really incredible that my colleagues should be so mean as to obstruct an arrangements of so a nature; and fantastic that they should seek to justify their attitude with such an argument, when I am the only one of the five who has done any work at all, and not without some success in academic and general quarters. You may rememberthat when in 1946 you asked me whether I was ready to come back, I gave you as one ground for my hesitation, apart from the fact you yourself were leaving, and that I knew not what would happen to the social sciences here, that Earle on a visit to London had used such abusive language about Riefler that I could not face such a cantankerous atmosphere. The man is really pathological and someone should check him, for he is doing harm to the Institute. And I can't understand how decent men like Stewart and Warren, who must know of his antics, do not tell him to behave like an adult. It is partly because I know this would lead to trouble that, as much for Dr. Oppenheimer's sake as for mine, I refrained from suggesting my coming back on a permanent basis; and the disappearance of the social science program is another reason, though I well understand and sympathize with the reasons which led the Director to take such a step.

Anyhow, this is the situation, very unsatisfactory for me, and I think very unfair to me. I have not pressed the Director to change his mind, as this would have meant his writing the faculty.

Are you likely to be coming over to England this fall? In any case, I wish you and Mrs. Aydelotte a very happy summer, and I think you again for all your encouragement and good will, and both of you for your friendly receiptions.

With all good wishes,

Sincerely yours,

D. Mitrany

(NOTE FOR DR. OPPENHEIMER)

There were three reasons why I did not return to Princeton as soon as the war was over. One was personal - my wife was still not well enough to leave alone when things in England were so difficult - but of course that was something which I should have had to deal with in one way or another. A second reason was professional - many changes and experiments were taking place in the political and social fields, and there was much to learn from watching them at close quarters; without becoming part of any movement, I have been active in this both in England and on the Continent. The third reason was the position at the Institute; the financial side I will mention below, but the immediate question was that of working relations.

Quite a few of us had difficulties during the first regime, but I doubt if anyone was thwarted in his work as I was. I was the first appointment in the social science group, at a time when I was visiting at Harvard and had just been offered an attractive position at Yale; I came here on a clear understanding that I would help to organise the group and carry out a program for it enthusiastically approved by Dr. Flexner - but the whole thing was twisted before it got started. There were no working relations within our group; and, what was worse, as an indirect consequence of top policy, personal relations also were unhealthy. All this, one hoped, would be set right under Dr. Aydelotte. It was therefore a shock, when he asked me in 1946 whether I was ready to come back, to hear at the same time that he himself was leaving; all the more, as only a little earlier during a visit to London I was much distressed to hear Mr. Earle speak in pretty strong language of Riefler and say that "I can't stand the man and won't have anything to do with him!" I put all this frankly to Dr. Aydelotte, and we agreed that it would be better to wait and see who the new director would be and what would then happen to our particular group; he appreciated that after being through the war, apart from personal inclinations, one could hardly come to work in such an atmosphere - especially in the social field.

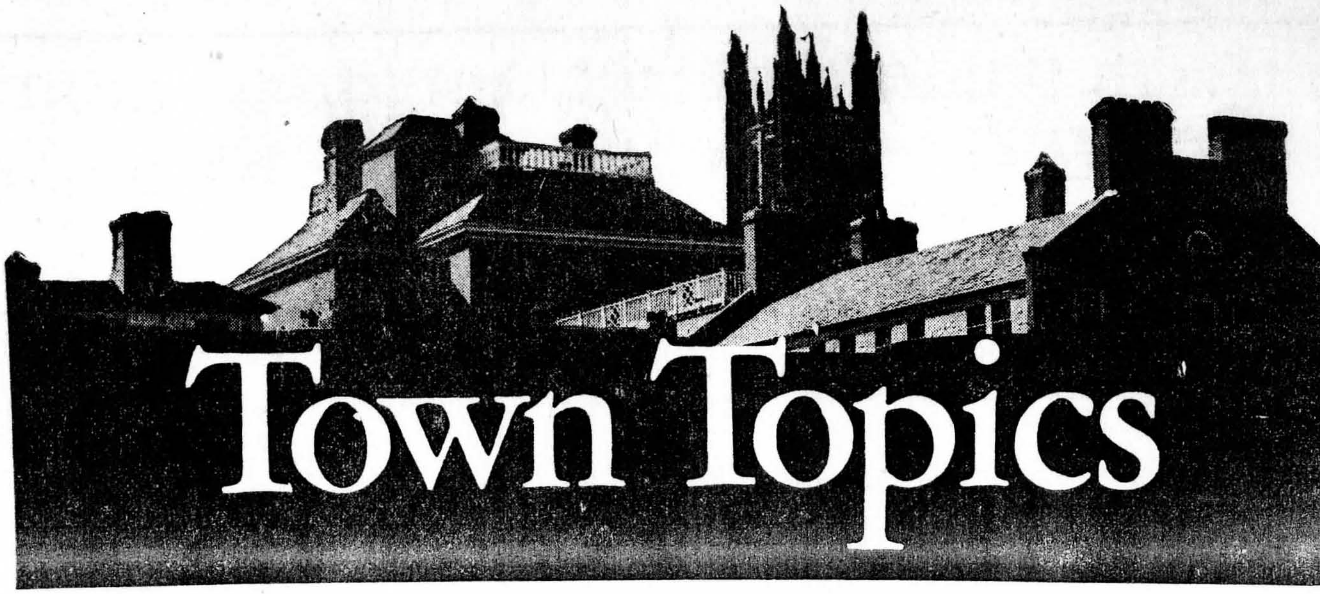
Perhaps I should add that I consulted Dr. Aydelotte also when I was offered the Unilever appointment at the end of 1943. I only consulted two other friends - Mr. Leonard Elmhirst, founder with his wife of the Dartington Trust, well known here and in England as a sponsor of many social experiments (like P. E. P. in London and here, and the National Planning Association); and Mr. Leonard Woolf (husband of Virginia Woolf), perhaps the ablest and most scholarly intellectual in the Labor Party on the international side. All three were enthusiastic about this chance to see the working of one of the biggest international concerns from the side. It was understood from the first that I would have nothing to do with the business side of the concern and would remain quite free to carry on my own work and writing - and this has never in the slightest been interfered with; I have only been a consultant, as occasion arose, on their international problems. On their side they wanted me to feel that I knew everything that was going on, and arranged from the first that I should be free to attend, as a matter of right, all the meetings of the Board of Directors. The experience has been invaluable, not least because instead of thinking at random about "big business" I have been brought into close contact with a group of people who, as regards intelligence and character and general sense of responsibility, could well be envied by any institution, public or private. (The President, Sir Geoffrey Heyworth, apart from other public charges, is Chairman of the Advisory Committee on Scientific Research, which deals with all public expenditure for scientific research, and that as a Labor Government appointment).

Throughout these years I have been active with various study groups and privately in watching or working on what was going on in my field, and have had a part in a number of groups and conferences. I have also worked with quite a number of advanced students who came to me or were referred to me by the Universities. I have never written or worked to put through a particular policy - but only to study problems and to further a detached approach toward their solution. To that end in the latter part of the war I organized a private study group of experts from Central and Eastern Europe to try and have its problems examined in a detached way - and the results, widely used at official conferences, were published by the famous English non-political organization P. E. P. as a volume on "Economic Reconstruction in South-Eastern Europe". Because of the important part which relations with America were to play after the war, I published a volume of four solid (solid in more than one sense, alas!) essays called "American Interpretations". Apart from a number of ordinary articles, I have published a number of academic essays - such as "The International Consequences of Economic Planning" (Yale Review, as a sequel to one some years ago on "The Political Consequences of Economic Planning"); "Human Rights and International Organization" (Dutch-Belgian Review of International Studies, and also a similar version in the review of the Indian Council for World Affairs); "Functional and Federal International Organisation" (Journal of the Royal Institute of International Affairs); "Mental Health and World Unity" (paper read at the International Congress on Mental Hygiene, London 1948, where I was the only political scientist invited to serve on the editorial committee and read a paper, now being printed; apart from papers for private discussion. In the meantime I have been working steadily on material for a volume on International Organization (theoretical, not descriptive); and in between also on additional material for an enlarged edition for which I am being asked, of an essay published years ago on "Marx v. the Peasant". The booklet on "A Working Peace System" has, for something of its kind, had a remarkable circulation. What people think of these essays is not for me to say, but I can say that none of them is merely critical or descriptive - but each tries to break new ground. And whatever one may think of it, my approach has started a school of thought, and my writings are quoted as such in books of readings published since the war (as in that of Prof. Ebenstein, of Princeton, or the recent work of Prof. Morgenthau, of Chicago).

Finally, as I said, there was also a financial reason. When I was visiting professor at Harvard in 1932-3 and was discussing with Dr. Flexner my coming here, he asked my view about salaries, in general. I replied urging him not to offer higher salaries than those paid by the main universities, not to appear to be "buying" people from elsewhere - and also, so that the Institute's attraction should be the chance for quiet fork and not high salaries. When he offered me the appointment he said that we would all get equal salaries (mentioning Einstein and Weill as likely exceptions because they had lost all their possessions); and when he urged me to build a house (which I consequently arranged to do), he said that he had no funds to increase my salary but that for people like myself who had to start a new life here, there was no question of having to retire at 65. The first undertaking was broken as soon as it was made. With Dr. Aydelotte's retirement it was also a shock to hear that the second also had been ruled against by the Trustees. Because of my wife's long illness and the salary scale given me here, I have no property or reserve of any kind whatever; and especially because when I went to Unilever I refused to take more than what I was getting here (Dr. Aydelotte had a copy of the formal letter acknowledging this); and I also insisted in paying my own expenses though invited to charge them to the concern. So that all these years, though connected with a big business concern, in fact I have been getting less than my colleagues here (since 1943 I have also paid both parts of the superanuation). One reason was obviously that I took it for granted that I would be coming back here. It was only when the nature of relations and of means of living here appeared so bad, because of old attitudes and new rulings, that I naturally hesitated.

D Mitrany

May 10, 1949



WE NOMINATE

The members of the Boards of Education of Princeton Borough and Township, the administrative officers of the two municipalities' closely allied school systems and representatives of Princeton University and the Educational Testing Service who are making it possible for teachers of mathematics to take a fresh look at their vitally important subject. This week—and every Monday afternoon until the end of the school year—nearly 50 mathematics teachers, drawn from Hopewell, Montgomery Township and West Windsor as well as Borough and Township—are going back to class *on their own time* for sessions which are designed to give them added insight into the nature of the subject they are teaching and to show how their individual courses dovetail with new conceptions in mathematics.

Based upon nearly a year of discussions, the far-reaching orientation program, calling for a total of 15 classes this spring, is divided into two phases—advanced ("algebra and above") and elementary (Grades IV through VII). Next fall it will be followed by a more extensive, year-long "curriculum" that will be concerned with course-material (e.g., arithmetic, algebra, geometry) in special areas. The whole undertaking, as outlined by B. Woodhull Davis, 59-year-old superintendent of the Borough's Schools, is not in any sense a "crash program" but is closely related to an "overall new approach to mathematics" that probably means in the near future an added year of advanced mathematics at the high-school level for qualified students.

A pre-Sputnik meeting of the Curriculum Revision Committee, originally a Borough-Township venture but now involving five municipalities, struck the spark for the present organization of the mathematics program. Attending as expert advisers to the committee, and aptly described by one school authority as "parent expert reactors," were two able mathematicians, Marion G. Epstein, associated with the Mathematics Section in ETS Test Development, and Albert W. Tucker, Chairman of Princeton University's Department of Mathematics. Sensing the possibilities here, in what has often been termed "The Mathematics Capital of the Western World," the two advisers assumed responsibility for tapping the kind of human resources seldom available to public-school systems.

When the orientation classes met for the first time in late February, the 52-year-old Tucker, the father of three children in the Borough Schools and now Dod Professor of Mathematics in the University, was one of the three teachers for the "advanced program." Associated with him are two of his university colleagues, Emil Artin, 60-year-old Henry Burchard Fine Professor of Mathematics, two of whose children are graduates of local schools, and Norman Steenrod, father of two and internationally known 47-year-old topologist. The direction of the "elementary phase" has been assumed by a 40-year-old Ohio-born, and Ohio-trained, bachelor, Sheldon S. Myers, head of the mathematics section in ETS Test Development.

For undertaking a cooperative, purely voluntary program that may be without parallel in these United States; for strengthening the structure of an already excellent "school system"; for anticipating the educational needs of present and future; these men and women are TOWN TOPICS' nominees for

MEN AND WOMEN OF THE WEEK

Vert. file MM

WE NOMINATE

Kunihiko Kodaira, shy, unassuming 42-year old mathematician, who has been singled out for one of the highest honors that can be conferred upon a Japanese-born scholar—the Prize of the Japan Academy. Indicative of the regard the Japanese have for this award, which is reserved for individuals making distinctive contributions to the advancement of mathematics and is bestowed at no regular intervals, was the method of presentation. In the absence of Kodaira, a full-time Princetonian since 1949, it was recently presented in his native Tokyo to his mother, Mrs. Gonichi Kodaira, by the Emperor of Japan, Hirohito, "the 124th of his line."

The ceremonies in the Nipponese capital marked the second time in the past three years that Kodaira's achievements in the realm of pure mathematics have been recognized by a reigning sovereign. In 1954, when Kodaira and the brilliant and equally young French mathematician, Jean-Pierre Serre, were named co-recipients of the J. C. Fields Medal, the equivalent of the Nobel Prize in mathematics, they were specially received in Amsterdam by Queen Juliana of the Netherlands during the sessions of the International Congress of Mathematicians. Three years ago, and again this summer, Princeton learned of the tributes paid to Kodaira through his associates at the University and the Institute for Advanced Study.

The son of a distinguished Japanese agriculturist, who in post-World War II years held a cabinet post in the Japanese government, Kodaira is a product of a Westernized educational system. He took his advanced degrees at the University of Tokyo in mathematics and mathematical physics and served as a member of the Tokyo Faculty until he came to the United States in 1949 at the invitation of the Institute. Following two years at the Institute and a year as a visiting professor at Johns Hopkins University, he joined the University's Department of Mathematics in the fall of 1952 and for the past five years has divided his time on a "half-and-half" basis between the University and Institute.

Kodaira, holding professorial rank in the University and a membership at the Institute, is working on the far frontiers of mathematics—in a kind of transcendental "outer space" that only a few can now hope to penetrate. Over the past two decades his researches, which have been documented by 40 major articles in professional publications, have cemented his reputation as one of the profound and original thinkers of his time. In a sense, this adopted Princetonian, an increasingly influential teacher on the graduate level and, like other eminent mathematicians, a gifted musician, can be compared to late greats in his field, whose impact on the world has only been fully understood long years after they had initiated their tireless search for new knowledge.

For strengthening Princeton's position as the "Mathematics Capital" of the Western World; for demonstrating the effectiveness of the working relationships that exist between two sister institutions, the University and the Institute; for once again proving that man-made boundaries mean nothing in the quest for truth; he is TOWN TOPICS' nominee for

PRINCETON'S MAN OF THE WEEK

Vert M

[illegible] - Mbs Lists

Göttel 2
2
Weitzman 2

Yrs 1933-42 S.M. Mbs 2 yrs or more

2
2
2
2

2
2
2 9 2s
2
2
3 1 3
15 2s

2
3
2
2
2
3
2
2
2
2
2
2
2
9
2
2
2
2

(2) 9	18
1	3
(2) 15	30
(2) 15	30
(3) 2	6
1	9
43	96

Check 42 89

Up to ~~[illegible]~~ 1942 there were 43 indiv. who had two or more consecutive terms or years totalling in all 96 term yrs - in SM -

Excl. assts + years spent as assts in [illegible].
(exc. for [illegible], never listed as asst.)

There were 39 who had 2 yrs successively, 3 who had 3, 1 who had 9 (Mayer)

SHS, 1935-42

Cursec. mbships 2 yrs or more

Omitting assts -

1 @ 4					
1	7				
1	3				
1	6				
1	6				
1	4				
1	2	4 @	2 yrs		8
1	5	2 @	3 "		6
1	4	6	4		24
1	3	2	5		10
1	2	4	6		24
1	4	1	7		7
1	4 Tedesco	19			~~82~~ 79
1	2				
1	6				
1	5				
1	2				
1	4				
1	6				
19	82 mbship yrs				

In 1942 Mbships still cont.

Heitzman
Swarzenski
~~Stierwalt until 1940~~
de Tolnay
Swann
Bronner
Clement
Tedesco 9
Frankl
Campbell

SEP. 1933 - 4 [illegible]

[illegible] [illegible] 2 or more yrs -

x 1 0 2 yrs [illegible]
1 3 Gilbert
2 [illegible]
x 1 2 [illegible]
x 1 2 Possony
x 1 2 Durand
x 1 2
1 3 Vagts

~~1 2~~
~~1 2~~

1 2 Hery
1 2 [illegible]

~~1 2~~
~~1 2~~
~~1 2~~

9 10 yrs

~~10 0 [illegible] 24~~

7	0	2	14
2	0	3	6
			20

1943-54 [illegible]

Mbs - Consec. terms. Jobs? Thru 1945-6

Sm.			SHS			SEP?		
1933-5 Cameron	2	NRC	35-9 Stern	4	nj	36-8 Tungi	2	nj
1934-5 Clifford	2.5 (asst [illegible] yrs.)	nj.	35-44 Weitzmann	35-42 4		39-43 Gilbert	3 + 1	(war)
33-5 Scholes	2	nj.	36-9 Wilber	3 yrs	nj.	39-41 Lockwood	2	Amer. Cin. Int'l St.
33-5 Hull	4 2	NRC	36-48 Swarzenski	1936-47 6 + 6 yrs	nj	39-41 Weinberg	2	lecturer [illegible] nj.
33-35 Schoenberg	4 2	nj.	36-42 Stillwell	6 yrs	Job Petr.	41-45 Mitchell	(1) + 3	nj
33-5 Stafford	14 on runs 2	Job.	36-40 Downey	4 yrs.		40-42 Possony	2	war.
34-36 Clarkson	2	NRC 2nd yr.	39-41 Breasted	2	nj	40-2 Durand	3 2	nj
34-36 Myers	2	asst Hud U. NRC 2nd yr	39-44 Brunner	5	nj (Passed off by ASCS)			
34-36 Rosen	2	N.J.	38-49 Clement	4 + 7	ASCS	~~Leigh~~	~~2 yrs~~	~~Birmingham~~ Fmr Pres
34-37 Stobbe	3	nj.	39-48 de Dolmay	3 + 6	nj	39-42 Voigts	3	nj
35-37 Baer	2	nj	39-41 Hoag	2	nj.	41-3 Weiller	1 + 1	R. Fellow
36-37 Bouckaert	2	CRB 2nd yrs. nj	38-42 Rinkitschek	4	nj. (war?)	41-3 ~~Long~~	~~1 + 1~~	~~Jobs Guggenheim~~
34-36 Carlson	2	nj	38-45 Tellisco	4 + 3	gov job war	41-3 ~~Mantoux~~	~~1 + 1~~	Rockefeller 41-3
35-37 Commenetz	2	nj.	40-54 Frankel	2 + 12		45-8 Wilmerding	3	R. Fellow?
35-37 Holtman	2	nj.	~~Weltzen~~	~~2~~	~~nj~~ AAU fellow	43-6 Lentz	3	[illegible]
35-37 Levinson	2	NRC	43-45 Levi	~~2~~ 3		42-44 Gottmann	2	j
35-37 Pryce	2	CRF	~~Tung Yui~~	~~5~~	~~nj war~~	43-8 Schiffer	5	Guggenheim fell
35-37 Tagg	2	CRF	42-45 Lee	3	j	45-7 Andelotti jr.	2	nj
~~38-39 Drettmann~~	asst 1936-8 ~~4~~	~~nj~~	~~44-45 Forsyth~~	~~2~~	~~j~~	44-6 ~~Bledsoe~~	2	j
~~36-37 Teenberg~~	~~2~~	~~nj~~ asst 38-39	45-8 Baron	3	war.	46-50 Goldenweiser	4	Ret'd
36-38 Hinrewicz	2	(war)	36-43 Campbell	6 + 1	j	38-40 Henry	2	
36-38 Inpeli	2	nj war) 1/2 as asst	36-41 Capps	5		38-40 Rumney	2	
36-38 Kitchen	2	Jobs	38-40 Day	2		42-44 Silkeman	2	
36-38 Randolph	2	Job 1 st yr. nj	45-8 Grace	3				
36-38 Richardson	2	Jobs	36-40 51-53 Heckscher	4 + 2				
36-38 Smithies	2	nj	~~36-41~~ 45-7 Pritchett	~~6~~ + 2	(asst 36-42)			
Schilling 35-37	2		36-48 Swann	6 + 6	3			
no job.			45-49 Segall	4				

27 26 ~~33~~ 79 27

1934-46

Mbs -

38-1939	46; 8 Mbs who had been here in 1937-8 ~~4 mathe~~	8/46	1/6
~~1937~~ 1938	40 Mbs, of whom 15 were here yr before	15/40	1/3 +
1936-37	59 mbs 12 of whom here 1935-6	12/59	1/5 +
1935-6	45 Mbs 5 repeats	5/45	1/9
34-35	35 mbs 5 repeats	5/35	1/7
1941-2 -			
1942-5	14/52 (2/26) (see sep. list for 1944-5)		1/4 +
~~14~~			1/5 +
1939-40 - 1940-41	15/52		1/4 +
1942-5 - 1945-6	17/56		1/4 +

Rosen 1934-6 2 articles 1936 + 7

This shows number of those listed in Mbs from one year to next but does not reflect the numerous cases in which members enjoyed many annual appts. Thus the Peltz DAA group: Stein, Stilwell, Downey, Fors, the Swarzenski, Weitzmann. Nor the number in Math - Busemann, Σm. Sm

36-38 Tompkins 2 NRC — 38-40 Erdös 2 NY
37-40 Mbr 40-44 asst. 45-6 Mbr.
37-40 Bargmann 3 NJ — 45-47 Fan, Ky 2 NY
37-39 Nakayama 2 Job War
37-39 Serbin 2 Got job.
39-41 Ambrose 2 NJ
39-43 Fubini 3 + 1 (War)
1940-53 Gödel 2 + 10 Consec. from 1940-47 — Prof 1954 — periodic before
1940 45 Siegel 2 + 3 (War)
40-46 Pauli 2 + 4 (War)
40-42 Allen 2 3 War
Kai-Lai Chung 3 NY. (Pch PhD 1938 not in Biblio no publ.) — Omitted from Biblio.
40-42 Kakutani 2 War
40-42 Mohr 2 NJ.
~~Herr~~
44-46 Schatten 2 NRC
Alexander ?
~~45-47 Arens 2 Asst 45-6~~
~~Asst pair Asst. 37-40~~
~~36-41 Bargmann 6 yrs. O~~
46-54 Bigelow 9
46-54 Goldstine 9
45-58 PT Bochner 3 Princeton P-T
43-45 Chern 2
~~Cohen~~
51-53 Curtis 2
52-54 Davis 2
53-54 Dresden 2
~~39-42 Halmos 3~~ Asst 40-42
38-40 De Witt 2
-48 Mayer 3 9 + 6 63

Sm.
Alt. 3 43-46
Murray 2 34-36
~~Segal 2 45-47~~ Asst 45-6
Thrall 2 40-42
~~Walkman 2 38-40~~ Asst
~~Wilcox 3 35-38~~ Asst
~~Zippin 3 33-36~~ Asst

More than 60 ~~63~~ MBs Sm. appearing here first in period 1933-1946 enjoyed more than 1 year successively. Of these 39 attended for 3 successive years; 8 for 4 successive years, 3 for 5, and the others for periods in excess of 5 consec. years in excess of 5 (4 attended for 2 successive years)

37
4
8
2
51

22
27
~~49~~
48
47
46
45 20

20
63
83
~~16~~6
162
2
160

160
− 4
156
− 4
152
3
149

Sm

after 1945-6.

53-54 Ahzar 2
~~Arens~~
53-54 Bagemihl 2
52-54 Birnbaum 3
38-40 Barkas 3 N.J.
48-50 Bateman 3
49-51 Bers 3
52-54 Beurling 3
49-54 Bohm 6
52-54 Borel 3
47-49 Borges 3
49-52 Bott 3
53-54 Calderon 2
52-54 Carnap 3
48-50 Case 3
46-49 Chandrasekharan 4
48-54 Cherny 7
51-53 Cohen 3
52-54 Derwidz 3
48-50 Dvoretzky 3
50-53 Eilam 4 ECP
51-53 Finn 3
49-50 Fjortoft 2
51-2 Fomes 2
51-2 Fomes 2
49-50 Freeman 2
51-52 Frei 2
50-52 Gal 3

SHS.

Farber 2
Lowinsky 3

52-54 Gildhurst 3
49-51 Glauber 3
52-54 Goto 3
47-49 Harish-Chandra 3
47-48 Hildebrandt 2
52-54 Hirzebruch 3
50-52 Hu 3
48-58 Hua 3
47-49 Hunt 3
50-52 Iwasawa 3
49-54 Jost 6
50-52 Kadison 3
52-3 Kampen 2
48-50 Kaplan 3
47-50 Kaufmann 4 + 4
52-4 Kawada 3
52-3 Kent 2
52-4 Kinoshita 3
53-4 Kodama 2
49-50 Kodaira 2
53-4 Kostant 2
~~Kuiper 3~~
51-3 Lee 3
46-8 Leibler 3
48-50 Leipnik 3
48-9 Lepore 2
50-52 Lepson 3
52-4 Leray 4

Hu
SJ

SEP

Crabe 3
Fox 3
Guerlac 3
Harward 3
Kennon 3+2
Kreezer 2
Ladner 3
Levy 3
Lindberg 3
Marx 2
Nurkse 3
Palmer 3
Stamires 1
Vries 9
Wedgwood 3
Woodward

Dent Kent
Bar

Sm Post 1945-6

Levy 2 50-2
Lido 2 52-4
Low 2 50-2
Ma 2 46-7
Masani 2 46-8
Michel 2 53-4
Minakshisundaram 46-8 3
Morse 2 37-9
Mostow 2 47-9
~~Nambu 1 53-4~~
Newburgh 2 49-51
~~Newton 2 53-4~~
~~Nijenhuis 2 53-4~~
Pais 3 46-49
Palfrey 2 50-2 Math or HS?
Peck 2 46-8
Pekeris 2 46-8
Scp Phillips 3 51-4
Pitcher 2 47-9
Placzek 48-54
Pleijel 2 47-8
Alexander 3 47-50

Pomerene Scp 8 46-54
Protter 2 51-3
Ramanathan 3 48-51
~~Richtmyer 2 47-8~~
Rosenberg 47-51 4 ? [illegible]
Rubinoff 3 47-50
~~Sabidussi 2 53-54~~
Sario 2 50-52
Schafer 2 46-8
~~Schoenberg 2 53-4~~
~~Segal 3~~
~~Shapiro 2 53-4~~
Sitz 2 46-8
Smagorinsky 3 50-3
~~Strauss 2 53-4~~
~~Thompson 2 47-8~~
Tinderman 2 52-4
~~Ulucay 2 47-8~~
Ware 5 46-51
Whiteman 2 52-4
~~Whitney 3~~
~~Wong 2 53-4~~
Yamabe 2 52-4
Yang 49-54 5
Zelinsky 2 47-49

46
55
101

1950 vert. file August-September

MATHEMATICS Academic Activities

The International Congress of Mathematic ians pamphlet.

Filed in Vertical file under "m" for mathematics.

D, International Congress of Mathematic s

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS

CAMBRIDGE, MASSACHUSETTS, U.S.A.
AUGUST 30 - SEPTEMBER 6, 1950

An International Congress of Mathematicians will be held in Cambridge, Massachusetts, in 1950 under the auspices of the American Mathematical Society. The Society had hoped to be host to a Congress in September, 1940. However, the outbreak of World War II made it necessary to postpone the Congress and, consequently, there has been no international gathering of mathematicians since 1936. It is the sincere hope of the American Mathematical Society that the gathering in 1950 will be a truly international one, with all countries well represented.

Former Congresses

In connection with the World's Columbian Exposition in Chicago in 1893 there was held the first International Congress of Mathematicians. Except for omissions necessitated by the two World Wars, there have been similar gatherings about once every four years; all have been held in Europe except that of 1924 which was at Toronto. The most recent Congress was held at Oslo in 1936.

At the most recent Congresses, the number of countries represented has been about 40, the number of participants about 600, and the number of short papers presented about 250.

Time and Place

The dates of the Congress have been fixed as August 30 - September 6, 1950. The American Mathematical Society, the Mathematical Association of America, and the Institute of Mathematical Statistics, which usually meet jointly in the summer, will omit their summer meetings in 1950 so that their members may more easily participate in the Congress. Harvard University will be the principal host institution. Other institutions in metropolitan Boston will also participate by arranging special entertainments. Mathematicians so desiring will be housed at a modest charge in the Harvard University dormitories and meals will be served in the University dining rooms. There will be accommodations for members of families, special provision being made for the care of children. Those who prefer to live in hotels can be comfortably provided for in Cambridge or Boston.

Organization

The Organizing Committee has invited more than a score of outstanding mathematicians to deliver stated addresses. There will be Conferences in four different fields; these are more fully described below. There will be seven Sections for the presentation of short contributed papers and, by invitation of the Section Chairmen, there will be a small number of half-hour addresses as part of the Section programs.

In recent years mathematicians have been much impressed by the success of the conference method for presenting research in fields in which vigorous advances have just been made or are in progress. There will accordingly be a coordinated program of formal lectures and informal open discussion, and the stated addresses will be integrated as far as possible with the work of the Conferences. The following list of topics gives an indication of the nature of each of the Conferences:

Algebra (Chairman, A. A. Albert): 1, Groups and universal algebra; 2, Structure theory of rings and algebras; 3, Arithmetic algebra; 4, Algebraic geometry.

Analysis (Chairman, Marston Morse): 1, Algebraic tendencies in analysis; 2, Analysis and geometry in the large; 3, Extremal methods and geometric theory of functions of a complex variable.

Applied Mathematics (Chairman, John von Neumann): 1, Partial differential equations; 2, Statistical mechanics; 3, Random processes in physics and communication.

Topology (Chairman, Hassler Whitney): 1, Homology and homotopy theory; 2, Fibre bundles and obstructions; 3, Differentiable manifolds; 4, Topological groups.

The Sections for the presentation of short contributed papers will be as follows: I, Algebra and Theory of Numbers; II, Analysis; III, Geometry and Topology; IV, Probability and Statistics, Actuarial Science, Economics; V, Mathematical Physics and Applied Mathematics; VI, Logic and Philosophy; VII, History and Education. Each member of the Congress may present only one contributed paper, the time allotted for each paper will be ten minutes and there will be no presentation by title. Abstracts for such papers should not exceed 400 words in length and must be submitted on blanks which may be secured from the Secretary of the Congress. Abstracts must be in the hands of the Secretary of the Congress not later than May 15, 1950.

The official languages of the Congress are English, French, German, Italian, and Russian.

Entertainment

There will be many interesting entertainment features, including a reception, a concert in Symphony Hall, and a banquet. There will probably be a number of automobile excursions. Members and associate members of the Congress will be admitted to all social features of the Congress.

Membership in the Congress

Membership in the Congress will be open to all qualified persons, whether they are able to be present in person or not. For regular members of the Congress the fee is $15.00; these persons will receive the Proceedings of the Congress and be entitled to participate in the scientific and social features of the Congress. Members of families, accompanying Congress members and not participating in the scientific meetings, may become associate members, for whom the fee is $7.50; they will not present papers or receive the Proceedings, but will be entitled to many of the other privileges of membership. Only members and associate members of the Congress will have the privilege of residing in the Harvard dormitories.

Financial Support

Besides the support from Harvard University, generous subventions have been subscribed for the Congress by Bell Telephone Laboratories, Carnegie Corporation, General Electric Company, Institute for Advanced Study, Massachusetts Institute of Technology, National Research Council, Rockefeller Foundation, Standard Oil Development Company, UNESCO and several private donors.

Information

Persons who are interested in attending the Congress are requested to fill out and return the enclosed card as soon as possible. *Only those who return this card will receive further communications concerning the Congress.*

Communications should be addressed to:

INTERNATIONAL CONGRESS OF MATHEMATICIANS
Low Memorial Library
531 West 116th Street
New York City 27, U.S.A.

COMMITTEES OF THE INTERNATIONAL CONGRESS OF MATHEMATICIANS

Organizing Committee: Garrett Birkhoff (chairman), W. T. Martin (vice chairman), A. A. Albert, J. L. Doob, G. C. Evans, T. H. Hildebrandt, Einar Hille, J. R. Kline, Solomon Lefschetz, Saunders MacLane, Marston Morse, John von Neumann, Oswald Veblen, J. L. Walsh, Hassler Whitney, D. V. Widder, R. L. Wilder.

Financial Committee: John von Neumann (chairman), W. L. G. Williams (vice chairman), J. L. Coolidge, B. P. Gill, M. H. Ingraham, A. E. Meder, Jr.

Editorial Committee: L. M. Graves (chairman), Einar Hille, P. A. Smith, Oscar Zariski.

Secretariat: J. R. Kline (secretary), R. P. Boas (associate secretary).

Subcommittees of the Organizing Committee

Budget Committee: W. T. Martin (chairman), J. R. Kline, A. E. Meder, Jr., G. B. Price, Oswald Veblen, Oscar Zariski.

Cooperation Committee: Samuel Eilenberg (chairman), E. F. Beckenbach, Hassler Whitney, S. S. Wilks, J. W. T. Youngs.

Entertainment Committee: L. H. Loomis (chairman), C. R. Adams, Mrs. L. V. Ahlfors, Mrs. G. D. Birkhoff, J. A. Clarkson, Mrs. W. C. Graustein, F. B. Hildebrand, J. R. Kline, E. R. Lorch, Mrs. W. T. Martin, E. B. Mode, G. A. O'Donnell, Mrs. H. B. Phillips, Helen G. Russell, J. H. Van Vleck, Mrs. J. L. Walsh, Mrs. D. V. Widder, Mrs. Norbert Wiener.

Program Committee: E. G. Begle (chairman), A. A. Albert, Garrett Birkhoff, R. P. Boas, Richard Courant, J. L. Doob, Samuel Eilenberg, G. C. Evans, J. R. Kline, L. H. Loomis, Marston Morse, John von Neumann, C. V. Newsom, H. A. Rademacher, Alfred Tarski, Hassler Whitney.

Publicity Committee: R. P. Boas and G. W. Mackey (co-chairmen), A. A. Bennett, J. A. Clarkson, C. O. Oakley, R. M. Thrall.

Committee on Transportation Grants: Garrett Birkhoff (chairman), Samuel Eilenberg, J. R. Kline, W. T. Martin, J. L. Walsh.

Committee on Conference in Algebra: A. A. Albert (chairman), Richard Brauer, Nathan Jacobson, Saunders MacLane, Oscar Zariski.

Committee on Conference in Analysis: Marston Morse (chairman), L. V. Ahlfors, Salomon Bochner, G. C. Evans, Einar Hille.

Committee on Conference in Applied Mathematics: John von Neumann (chairman), Richard Courant (vice-chairman), Walter Bartky, R. V. Churchill, G. C. Evans, William Prager, Mina Rees.

Committee on Conference in Topology: Hassler Whitney (chairman), Deane Montgomery, N. E. Steenrod.

Chairmen of Sections:

Section I	Algebra and Theory of Numbers: H. A. Rademacher.
Section II	Analysis: G. C. Evans.
Section III	Geometry and Topology: Samuel Eilenberg.
Section IV	Probability and Statistics, Actuarial Science, Economics: J. L. Doob.
Section V	Mathematical Physics and Applied Mathematics: Richard Courant.
Section VI	Logic and Philosophy: Alfred Tarski.
Section VII	History and Education: C. V. Newsom.

E. A. WRIGHT COMPANY, PHILA.

File in Vertical File under "M" for School of Mathematics.

Article from The New York Times, Monday, June 4, 1956.

TEACHERS CHIDED ON MATHEMATICS

Study Finds Them Deficient, Curriculum Outmoded and Pupils Hostile or Bored

By BENJAMIN FINE

The teaching of mathematics is in a deplorable state, according to a year-long survey sponsored by the Carnegie Corporation.

The survey found that a large number of mathematics teachers not only did not know how to teach the subject effectively, but also were barely able to keep ahead of their students.

As a result, it was noted that mathematics was one of the poorest taught subjects on the elementary and secondary levels and that the students voted mathematics as their "most hated" course.

The survey, conducted by the Educational Testing Service of Princeton, made a first-hand study of sixty classrooms in five states. Thirty-six of these were at the elementary level, and twenty-four at the secondary.

The study was under the direction of six educators, headed by Prof. Samuel S. Wilks of the Princeton University Mathematics Department. The Carnegie Corporation gave $21,000 for the project.

Among the findings were these:

¶Of the sixty mathematics teachers reached in the study, only ten were competent; the other fifty were "confused" and unable to teach the subject.

¶The mathematics curriculum is outmoded and must be brought up to date if mathematics is to take its rightful place in the public schools.

¶Most students are not only

Continued on Page 22, Column 4

THE NEW YORK TIMES, MONDAY, JUNE 4, 1956.

TEACHERS SCORED ON MATHEMATICS

Continued From Page 1

indifferent, they are downright hostile to the teaching of the subject.

¶Most of the teachers do not like mathematics and teach it only under compulsion or under protest.

These conclusions are particularly serious, the survey suggests, because of the need for trained engineers, scientists and technicians in the atomic era. Mathematics is the basis of engineering.

The study notes that most students "back away" from mathematics at an early year. Even superior or gifted students are indifferent. It has the dubious honor of being the least popular subject in the curriculum.

The study lays much of the fault at the feet of the teacher. A sampling of 211 prospective elementary school teachers showed that 150 had a long-standing hatred of arithmetic.

The survey found that half of a random sampling of 370 candidates for elementary school positions failed to solve a simple problem in fractions.

"It seems pretty clear that many elementary school teachers have a hard time keeping even half a jump ahead of their pupils," the report stated.

The survey continues: "Future teachers pass through the elementary schools learning to detest mathematics. They drop it in high school as early as possible. They avoid it in teachers colleges because it is not required. They return to the elementary school to teach a new generation to detest it."

Toughening up requirements for professional certification would be only half a solution, the survey says.

The Princeton survey proposes the creation of a Remedial Mathematics Course for Teachers of Mathematics, designed to unravel the teacher's numerical neurosis.

Not the Entire Solution

But, the survey concedes, not all the trouble can be eliminated by retraining teachers.

"When our observer visited sixty classrooms to verify at first hand what the books and the experts were saying about the deplorable state of mathematics teaching," the survey says, "he found ten in which the teaching was reasonably effective.

"In the other fifty the instruction was so confused that learning of any kind seemed to be largely accidental and unilluminated by any learning theory whatever."

The survey is quick to add that the teachers themselves could not be censured for the conditions under which they work. Most of them were struggling with classes of 35 to 40 pupils who sometimes spread over two different grade levels and almost always ranged widely from the bright but bored to the dull and bewildered.

The curriculum is taken to task, too. The survey notes that it has changed very little during the past century.

"The high school curriculum today shows few, if any, signs of the important developments that have taken place in mathematical science since the seventeenth century," the report says.

The results have been devastating. An engineering school reports that 72 per cent of its students entering last September were found so inadequate mathematically that they had to take a review of high school mathematics before they could qualify for the regular freshman course. Similar complaints are frequently heard.

"Many things will have to be done and discovered before the general population can achieve literacy in mathematics comparable to its literacy in the mother tongue," the survey says.

The importance of research is stressed. However, the survey agrees that "the suggestion that the way out of the mathematica mess is through educational research is likely to try the patience of those who want immediate action."

The "big need" then becomes a comprehensive study of the whole problem of how to improve the teaching of mathematics.

It will take a generation or two to make a sizable dent in the problems of mathematical education, the survey warns. But, it maintains, the issues should be examined immediately.

V.N.
Letter, not sent
S.M.
11/14/46
K

November 7, 1946

Dear John:

I have thought over this proposal for a mathematical computing center as it might possibly effect the Institute, and must say that it seems to me the housing difficulty which has deterred Princeton University would of course be the same for us.

So far as a building is concerned, I think it might be possible to build something which would in the long run serve our own purposes and which we might rent to the Government for 15% of its cost for say a period of ten years. Whether our Trustees would see this or not, I have no idea.

The greatest difficulty which I see is the question of whether such a center, if established here, would be of scientific value to you in the work which you are doing, or whether it would on the whole be a distraction. I can see a real possibility that it might be a hinderance rather than a help.

I should like to talk that over with you when there is a chance.

Yours sincerely,

FA:kr

Frank Aydelotte

Mr. John von Neumann
Institute for Advanced Study
Princeton, N. J.

A bit late – Computer being built – Meteorology?
To stop R.O.?

1950 vert. file "M" 10/8

MATHEMATICS Academic ~~Paxx~~ Activities

MORSE, MARSTON Biographical

A paper, "Mathematics and the Arts," by Marston Morse, read at a conference in honor of the American Poet, Robert Frost at Kenyon College, October 8, 1950.

Filed in Vertical File under "M" for Mathematics.

Please return to BMS

MATHEMATICS AND THE ARTS*

by

Marston Morse

To talk about art other than in the impersonal sense of history, is to talk about the moments when one has been confronted with beauty. Every essay on art that lights a hidden niche has its source in the life of the writer. You will then perhaps understand why I start with the mood of my childhood.

One hundred miles northeast of Derry, New Hampshire, lie the Belgrade Lakes, and out of the last and longest of these lakes flows the Messalonskee. I was born in its valley, "north of Boston" in the land of Robert Frost. The "Thawing Wind" was there, the "Snow," the "Birches," and the "Wall" that had to be mended: I was born on a sprawling farm cut by a pattern of brooks that went nowhere -- and then somewhere. A hundred acres of triangles of timothy and clover, and twisted quadrilaterals of golden wire grass, good to look at, and good riddance. At ten I combed it all with horse and rake, while watching the traffic of mice beneath the horse's feet.

All that Frost has described was there -- the meanness and generosity of men and women. A neighbor's house burned down in a wind, and everyone knew who held the grudge. The woman who must have killed her lover (so everyone thought) stood up in prayer meeting and testified, and there was no more judgment against her than was proper. The autumn winds were the prelude to the loon's strange song. There was time to think in the winter, to like some things better than others.

My mother's world was the world of music, and her world became mine. At thirteen I was playing the organ in church and wished the time in summer to study and practice. Somewhat reluctantly my father conceded me the mornings. He said that the grass was too wet to rake in the morning, and that I could walk the three miles from church to farm. And so I learned some of the Bach Fugues for the organ, and the moving Sonatas which Mendelssohn had written to honor the memory of Bach.

Grecian art first became real to me in the shop of an old cabinet maker. I began to learn from him about cabinet making, and the history of his art.

---

*Read at a conference in honor of the American poet Robert Frost at Kenyon College October 8, 1950.

**Yale Review, Vol. 40 (1951) pp. 604-612

Sheraton chairs and tables were scattered about his shop, with their fluted columns and acanthus leaves. It came to me, of a sudden, that these were fragments of Grecian temples.

There was a copy of the Cabinet Maker of Sheraton in a remote library. It started with descriptive geometry and continued with a theory of ornaments. Cornices were constructed with ruler and compass; symmetry and perfection reigned throughout. Here was a meeting of mathematics and art, something final and universal, as it seemed to me then. It was very alive, because it was so new. But it was not mathematics as I know it today, and as it should be known; it was matter without the spirit. I made the same mistake that artists have made since the time of the Greeks, and placed mathematics alongside of the arts as their handmaiden. It is a humble and honorable position and very necessary; for one must begin with exactness in all the arts. But mathematics is the sister, as well as the servant of the arts and is touched with the same madness and genius. This must be known.

There was a German painter and engraver born in the 15th century with the name of Albrecht Dürer who wanted mathematics to be more than a handmaiden of art. His discontent on this account was unique among artists of all time. More completely than any other artist he formulated the rules of symmetry, perspective and proportion, and used them in his art. But any one who thinks Dürer's spirit is bound by rules is mistaken. There is almost a shock in passing from his rugged, first engravings to the radiant classical beauty and slender proportions of his Adam and Eve of 1507.

Dürer was a creative mathematician as well as an artist. He wanted his geometric theories to measure up to his art. His great engraving Melencolia I is a psychological self-portrait. The perplexed and thoughtful heroine is the figure of geometry. Everything I have to say today is hidden in this engraving or may be derived from it by projection into the future. Let me quote from my colleague Erwin Panofsky:

The engraving Melencolia I, he says, "...typifies the artist of the Renaissance who respects practical skill, but longs all the more fervently for mathematical theory -- who feels 'inspired' by celestial influences and eternal ideas, but suffers all the more deeply from his human frailty and intellectual finiteness...Dürer was an artist-geometer, and one who suffered from the very limitations of the discipline he loved. In his younger days, when he prepared the engraving Adam and Eve, he had hoped to capture absolute beauty by means of a ruler and a compass. Shortly before he composed the Melencolia I he was forced to admit: 'But what absolute beauty is, I know not. Nobody knows it except God.'"

In his dependence upon geometry Dürer was inspired by Leonardo but repudiated by Michael Angelo. Later artists followed Dürer only half way or not at all; it is indeed hard to follow an inspiration. Leonardo himself had little of Dürer's divine discontent.

Back of Dürer and Leonardo in the distant past stands the Roman architect and geometer Vitruvius. The Mesopotamian artists also looked on geometry as an aid to art and this was well known to the prophet Isaiah. Chapter 44 of Isaiah is written against idolatry; it is also an essay on aesthetics. The thirteenth verse reads: "The carpenter stretcheth out his rule; he marketh it out with a line; he fitteth it with planes, and he marketh it out with the compass, and maketh it after the figure of a man, according to the beauty of a man; that it may remain in the house."

Isaiah would minimize geometry in the arts, Dürer would maximize it. Neither Isaiah nor Dürer was content.

Let us turn to the relation between mathematics and music. The evolution of the scales from the archaic sequences of tones of Euripedes to the whole tone scale of Debussy shows that mathematics and music have much in common. And there is also the arithmetical basis for harmony. It is not too difficult to compose in the technical scheme of Debussy and thereby to get some of his naturalistic effects, but no one can explain the profound difference between the opera, Péléas et Mélisande, on the one hand, and Tristan and Isolde, on the other, by reference to whole tone scales or any other part of musical theory.

Geometric form imposed on music can have a null effect. As an example, I shall compare the First Prelude of Bach as found in the Well-Tempered Clavichord, with the First Prelude of Chopin. The First Prelude of Bach is without melody, and consists of repeating ascending arpeggios with similar form and length. It is intended that the effect shall be harp-like. The musical text as a whole exhibits a design that appears in no one of the other forty-eight preludes. Looked at geometrically, the First Prelude of Chopin has a very similar geometric design, and if the Chopin prelude is played an octave higher than written, with perfect evenness of tone and tempo, the actual musical similarity of the two preludes is most striking. If, however, the Chopin prelude is played with the colour and pulsating rhythm which it demands all similarity to the Bach disappears.

Most convincing to me of the spiritual relations between mathematics and music, is my own very personal experience. Composing a little in an amateurish way I get exactly the same elevation from a prelude that has come to me at the piano, as I do from a new idea that has come to me in mathematics.

My thesis is prepared. It is that the basic affinity between mathematics and the arts is psychological and spiritual and not metrical or geometrical.

The first essential bond between mathematics and the arts is found in the fact that discovery in mathematics is not a matter of logic. It is rather the result of mysterious powers which no one understands, and in which the unconscious recognition of beauty must play an important part. Out of an infinity of designs a mathematician chooses one pattern for beauty's sake, and pulls it down to earth, no one knows how. Afterwards the logic of words and of forms sets the pattern right. Only then can one tell someone else. The first pattern remains in the shadows of the mind.

All this is like Robert Frost's "Figure a poem makes." The poet writes "I tell how there may be a better wildness of logic, than of inconsequence. But the logic is backward, in retrospect after the act. It must be more felt, than seen ahead like prophecy." Or again, "For me the initial delight is in the surprise of remembering something I didn't know I knew. I am in a place, in a situation, as if I had materialized from cloud, or risen out of the ground."

Compare this with the account of how the French mathematician Henri Poincaré came to make one of his greatest discoveries. While on a geologic excursion a mathematical idea came to him. As he says it came "without anything in my former thoughts seeming to have paved the way." He did not then have the time to follow up this idea. On returning from his geologic excursion he sought to verify the idea. He had no immediate success, and turned to certain other questions which interested him, and which seemed at the time to have no connection with the idea which he wished to verify. Here again he was unsuccessful. Disgusted with his failure he spent a few days at the seaside and thought of something else. One morning while walking on the bluff the final solution came to him with the same characteristics of brevity and suddenness as he had experienced on sensing the initial idea, and quite remarkably he had a sense of complete certainty. He had made his great discovery.

An account of Gauss is similar. He tells how he came to establish a theorem which had baffled him for two years. Gauss writes: "Finally, two days ago, I succeeded, not on account of my painful efforts, but by the grace of God. Like a sudden flash of lightning, the riddle happened to be solved. I myself cannot say, what was the conducting thread, which connected what I previously knew, with what made my success possible."

These words of Frost, Poincaré and Gauss show how much artists are in agreement as to the psychology of creation.

A second affinity between mathematicians and other artists lies in a psychological necessity under which both labor. Artists are distinguished from their fellows who are not artists by their overriding instinct of self-preservation as creators of art. This is not an economic urge as everyone knows who has a variety of artist friends. I shall illustrate this by the case of Johann Sebastian Bach and his son Philipp Emanuel.

Johann Sebastian's work culminates and closes a religious and musical epoch. It is inconceivable that Philipp Emanuel could have continued as a composer in the same sense as his father and have lived as an artist. He did in fact reject his father's musical canons. There is considerable evidence that his environment called for a new musical spirit. History justifies Philipp Emanuel; Mozart said of him, "He is the father, we are the children;" Haydn was inspired by him and Beethoven admired him. With all this to his credit posterity can perhaps forgive him for calling his father an old wig.

Quite analogous to the son's turning away from his father is the story of the relation of mathematician Henri Poincaré to his younger colleague, Lebesgue. Poincaré had used the materials of the 19th century mathematics to revolutionize much of mathematics. He had gone so far in mathematics that it is doubtful whether his younger colleagues in France could go on in the same sense without introducing essentially new techniques. This was in fact what several of them did. One of the new fields was what is called "set theory," and one of the innovators Lebesgue.

Poincaré criticized the members of the new school rather severely. It is on record that at a Congress in Rome he made this prediction. "Later generations will regard set theory as a malady from which one has recovered." (One may remark parenthetically that the history of art records many maladies from which art has recovered.)

The response of Lebesgue to Poincaré was given on his elevation to a Professorship at the Collège de France. An older eminent colleague had praised the school of Lebesgue. Lebesgue made public reference to the "precious encouragement which had largely compensated for the reproaches" which his school had had to suffer.

I regard the reactions of both Poincaré and Lebesgue as dictated by instincts of self-preservation, typical of the artist. Such self-preservation was clearly to the advantage of mathematics as well. I am also one of the few mathematicians who think that Poincaré as well as Lebesgue was right, in that mathematics will return more completely to the great ideas of Poincaré with full appreciation of the innovations of Lebesgue, but with a truer understanding of the relation of mathematical technique to mathematical art.

Before coming to the third type of evidence of the affinity of mathematics with the rest of the arts it might be well to ask what is it that a mathematician wants as an artist. I believe that he wishes merely to understand and to create. He wishes to understand, simply, if possible, -- but in any case to understand; and to create, beautifully, if possible, -- but in any case to create. The urge to understand is the urge to embrace the world as a unit, to be a man of integrity in the latin meaning of the word. A world which values great works of art, music, poetry, or mathematics, can only approve and honor the urge to create of any man capable of such activities.

The third type of evidence of the affinity of mathematics with the arts is found in the comparative history of the arts. The history of the arts is the history of recurring cycles and sharp antitheses. These antitheses set pure art against mixed art, restraint against lack of restraint, the transient against the permanent, the abstract against the non-abstract. These antitheses are found in all of the arts, including mathematics.

In particular the antithesis of pure art and mixed art is very much in evidence in the relations between poetry and music. There have been those who wished to keep poetry and music separate at all times. Plato took sides when he said, "Poetry is the Lord of the Lyre," and music had to fight a long battle to obtain complete autonomy.

Quite analogously in mathematics there are those who would like to keep algebra and geometry apart, or would like to subordinate one to the other. The battle became acute when the discovery of analytic geometry by Descartes made it finally possible to represent all geometry by algebra. The battle between algebra and geometry has been waged from antiquity to the present day.

Grecian art was of course restrained and a departure from restraint has always brought a reaction. Berlioz gave an example of extreme lack of restraint. To get the maximum effect of Doomsday trumpets in The Last Day of the World Berlioz devised four full-fledged brass bands to play high in the four corners of St. Peters. One American composer even wanted to fire cannon on the beat.

Mathematicians too, are often unrestrained. In this direction are the grandiose cosmologies with more generality than reality. These fantasies are sometimes based neither on nature or logic. Mathematicians of today are perhaps too exuberant in their desire to build new logical foundations for everything. Forever the foundation and never the cathedral. Logic is now so well understood that the laying of foundations is not very difficult. The thing has gone so far that one of my Polish colleagues recently suggested that the right to lay foundations should be rationed, or put on the basis of the right to build one foundation for every genuine classical effort.

The antithesis between logic and intuition manifested itself in the days of the Greeks. Pythagoras had a mystical preference for whole numbers. The irrational numbers were not understood by the Greeks and hence avoided as much as possible. History has made a full turn and the nineteenth century saw the meteoric rise of a more sophisticated Pythagoras by the name of Kronecker. Kronecker laid down the rule "all results of mathematical analysis must ultimately be expressible in properties of integers."

This proclamation cut deeply into the life and work of Kronecker's colleague Weierstrass. Here are a few lines from Weierstrass's reproach.

> "But the worst of it is that Kronecker uses his authority to proclaim, that all those who up to now have labored to establish the theory of functions, are sinners before the Lord -- truly it is sad, and it fills me with a bitter grief, to see a man, whose glory is without flaw, let himself be driven by the well-justified feeling of his own worth, to utterances whose injurious effect upon others he seems not to perceive."

The human documents which I have put before you are not concerned with processes which a machine can duplicate. One cannot decide between Kronecker and Weierstrass by a calculation. Were that the case many of us would turn to another and truer art. As Dürer knew full well there is a center and final substance in mathematics whose perfect beauty is rational, but rational "in retrospect." The discovery which comes before, those rare moments which elevate man, and the searchings of the heart which come after are not rational. They are gropings filled with wonder and sometimes sorrow.

Often, as I listen to students as they discuss art and science, I am startled to see that the "science" they speak of and the world of science in which I live are different things. The science that they speak of is the science of cold newsprint, the crater-marked logical core, the page that dares not be wrong, the monstrosity of machines, grotesque deifications of men who have dropped God, the small pieces of temples whose plans have been lost and are not desired, bids for power by the bribe of power secretly held and not understood. It is science without its penumbra or its radiance, science after birth, without intimations of immortality.

The creative scientist lives in "the wildness of logic" where reason is the handmaiden and not the master. I shun all monuments that are coldly legible. I prefer the world where the images turn their faces in every direction, like the masques of Picasso. It is the hour before the break of day when science turns in the womb, and, waiting, I am sorry that there is between us no sign and no language except by mirrors of necessity. I am grateful for the poets who suspect the twilight zone.

The more I study the interrelations of the arts the more I am convinced that every man is in part an artist. Certainly as an artist he shapes his own life, and moves and touches other lives. I believe that it is only as an artist that man knows reality. Reality is what he loves, and if his love is lost it is his sorrow.

REFERENCES

(1) Erwin Panofsky. Albrecht Dürer. Vol. I, pp. 157-171. Princeton University Press.

(2) Erwin Panofsky. The Codex Huygens and Leonardo da Vinci's Art Theory. See page 107, The Warburg Institute, London.

(3) Curt Sachs. The Commonwealth of Art. See page 244 for Berlioz. W. W. Norton and Co., Inc., New York.

(4) Jacques Hadamard. The Psychology of Invention in the Mathematical Field. Princeton University Press.

(5) E. T. Bell. Men of Mathematics. See chapter on Kronecker. Simon and Schuster, New York.

1941 vert. file M September (?)

SCHOOL OF MATHEMATICS Academic Organization

MORSE Biographical

VON NEUMANN

Their report on mathematics for Aydelotte's report to Board of Trustees.

Filed in Vertical File under "M" for School of Mathematics.

F. A., 1/8/57

Only Copy

REPORT ON SCHOOL OF MATHEMATICS

by

Marston Morse and John von Neumann

The great difficulties of describing adequately the work of the mathematical group are obvious. Apart from being a highly technical and finely differentiated science, mathematics is among other things a language differing no little in its words, considerably in its grammar, and absolutely in its syntax, from any other language used by men. And from its very nature -- in fact this is the main reason why mathematical language was invented -- its contents cannot be translated into any other language. It is only fair to expect that any attempt to describe the contents of mathematical research cannot convey essentially more of the essence of the subject than would an attempt to describe the "contents" of a Chinese poem.

The only thing one may reasonably try to describe is the general tendency and purpose of such research, and the spirit, the atmosphere, in which it is undertaken.

One must realize, above all, that there is a very particular double character which pervades all mathematical work. It is perfectly true that mathematics has practical applications. These are sometimes very indirect -- for example, applications to mathematical physics, which in turn are justified by applications to experimental physics, which in turn are justified by applications to engineering, etc. -- but they are applications nevertheless. It is even true that much, if not most, of the best mathematical inspiration has been directly or indirectly derived from "applied" problems. Nevertheless most mathematical research is usually undertaken without any regard to such applications, and it is strongly to be suspected that its quality could only suffer if the mathematician kept the applications constantly in mind. As matters stand, they sometimes never enter his mind, and it is by no means established that this is always a loss. It is very difficult to do justice, in any finite number of words, to this situation and to all its nuances, but it is necessary to keep it in mind when visualizing the nature of mathematical research.

Thus when dealing with mathematics it is probably more useful to judge it by the same standards by which a creative art is judged,- that is, by esthetic standards. The esthetic angle may escape the layman who does not speak the "foreign language" in which the intellectual effort goes on. It may also seem strangely disconnected with the application which may ultimately be made of mathematical results. But it is there nevertheless, and ignoring it would lead to a complete misunderstanding of mathematics.

The above indications give probably a less complete picture than some lines written by Dr. Abraham Flexner in "I Remember", which were intended to convey an idea of the purpose and nature of the Institute for Advanced Study, but their validity applies to the study of mathematics. Dr. Flexner writes as follows:

> "The Institute for Advanced Study was intended, by reason of its constitution and conception, to be mainly a research institute. From an unknown source I quote the following:
>
> The deepest joy in life is to be creative. To find an undeveloped situation, to see the possibilities, to identify yourself with something worth while doing, put yourself into it, and stand for it -- that is a satisfaction in comparison with which superficial pleasures are trivial."

Referring to teaching:

"Persons who require to be drilled or taught hard do not belong within

> the Institute for Advanced Study. The level of the teaching and its form mark it off sharply from college teaching, from most university teaching, from technological or professional teaching. This granted, the professor himself benefits, if for an hour or two weekly, in addition to his own research and the supervision of a few investigations, he discusses a larger theme with a small, thoroughly competent, body. He is thus assisted in preserving his own perspective, and he has a stimulus to wide reading and broader contacts."

With reference to scholars in the Institute:

> "These men presumably know their own minds; they have their own individual ways; the men who have, throughout human history, meant most to themselves and to human progress have usually followed their own inner light; no organizer, no administrator, no institution can do more than furnish conditions favorable to the restless prowling of an enlightened and informed human spirit, seeking its intellectual and spiritual prey. Standardization, organization, making trifles seem important, do not aid: they are simply irksome and wasteful."

The members of the School of Mathematics believe in these principles so clearly stated by Dr. Flexner, and as far as they are able have endeavored to embody them in their research and in their contacts with fellow scholars. We are concerned with the foundations of mathematics and mathematical physics, with the discovery and development of those principles of mathematics which will give deeper harmony to mathematics as an art, and greater power as a science. It is true that some of us are concerned at the moment with important applications of mathematics to ballistics, aviation, and other aspects of engineering. We regard these activities as temporary,- although inevitable and necessary as the need to live. The long-term conception of our true functions would relegate these diversions to a secondary place. The order in the world which we desire and the peace which we seek, will make technological studies the servant and not the master of our lives. The path to knowledge for its own sake will still be open, the creative artist or scientist will still be free, and objective truth will still be revered.

Was this what I [illegible]?

The limitation of the value of any specific statement of the contents of mathematical research should be clear from what was said above. It may nevertheless be useful to append descriptions of the work of the permanent members of the Institute as they see it:

James W. Alexander

For the last years Alexander has been working on a presentation of topology from an algebraic-combinatorial point of view. The entire development of topology in the last decade seems to indicate that an important task of generalization and unification can and must be performed in this direction. Work is progressing and it is hoped that eventually a combinatory analogue will be developed to tensor theory, which will be applicable to an arbitrary topological space. Certain recent developments in connectivity theory seem to indicate that the desired theory is just around the corner.

Albert Einstein

Einstein has for the last fifteen years worked on a unification of the theories of relativity and gravitation. This is to be achieved in the form of a general field theory as much as possible in the spirit of the existing general theory of relativity. It is hoped to reach thereby a new understanding of various phenomena which so far could be described only on an entirely different basis,- in the first place, of the quantum phenomena and of the electric nature of elementary particles. Many geometrical and field-theoretical avenues had to be explored, and while the work is not completed the results obtained so far indicate interesting possibilities. In the last years the collaboration of his assistants, Drs. Bergmann and Bargmann, has proved valuable.

Marston Morse

Morse had devoted the major part of the last ten years to the development of a "variational theory in the large". This theory originated largely with him although built on the ancient subject of the calculus of variations. The principal difficulties and major objectives for the theory of simple integrals were developed at Harvard prior to his coming to Princeton, and were published in his Colloquium Lectures before the American Mathematical Society. After coming to Princeton the theory was put on a somewhat more abstract basis preparatory to attempting the very difficult extension to multiple integrals. In the last few years this extension has been achieved. The results obtained have recently been confirmed in part by others, working independently or in collaboration with Morse. The general understanding of the scope of the theory was greatly enhanced by the publication of a book on the subject by two German authors shortly before the war. This book consists of expositions of the simpler parts of Morse's papers on the subject prior to 1937. Papers in press include three papers written jointly by Morse and Charles Tompkins of Princeton University.

? See 90B's Instrument - p299. Morse "generalized" B's work calc of variations & study dynamical systems

Morse has also collaborated with Professor Hedlund of the University of Virginia in giving a proof of new conditions for topological transitivity, and is engaged at the moment in writing a joint paper with George Ewing, one of the professors visiting the Institute this year.

Morse was recently elected President of the American Mathematical Society. About a year ago he organised and has since directed the work of the War Preparedness Committee of the American Mathematical Society and the Mathematical Association of America. These societies have a joint membership of more than 5000 mathematicians. This Committee has various subcommittees dealing with questions of technical aid to the Army or Navy, with secondary school education in its bearing on national defense, with the proper use of draftees possessing scientific qualifications. A recently added subcommittee will investigate the supply of and demand for applied mathematicians and teachers in relation to the national defense.*

John von Neumann

In the last years von Neumann's interest in mathematics proper has been mainly in the theory of functional operators and the theory of integration in groups. The former subject is closely connected with quantum mechanics, i.e. the form of atomic physics developed since 1926. But it also has bearing on various disciplines in pure mathematics, in particular on group theory, algebra, and the theory of higher spaces. He has also worked on the logical and philosophical implications of the indeterministic point of view necessitated by modern quantum physics. Partly in collaboration with Garrett Birkhoff of Harvard, a system of logic based purely on probability and modifying some of the traditional postulates of logic has been developed. It is hoped that this system will be found to do fuller justice to the empirical situation which the new atomic theory has disclosed. In the course of the last year he has also taken up again and continued earlier work on various questions in mathematical economics, in particular in connection with the mathematical theory of production and of the "oligopoly" which is closely connected with the theory of games.

Professors Lefschetz, Bohnenblust and von Neumann form the editorial board of the Annals of Mathematics. Von Neumann is also co-editor of two international journals. Outside of purely mathematical research, he is engaged

* For further details see "Mathematics in the defense program", The Mathematics Teacher, May 1941. A copy is appended.

in some projects of national defense: chief consultant on ballistics of the War Preparedness Committee of the American Mathematical Society and the Mathematical Association of America, member of the Scientific Advisory Board of the Ballistic Research Laboratory at Aberdeen Proving Ground, and consultant to one of the sections of the National Defense Research Committee now part of the Office of Scientific Research and Development.

In his scientific work von Neumann has been closely collaborating with Professors Francis J. Murray of Columbia and Garrett Birkhoff of Harvard, and at Princeton with Drs. Ambrose and Halmos and Professor Kakutani of Osaka. He has been joined in his defense research work by Professor William W. Flexner of Cornell, who is in Princeton for this summer.

Oswald Veblen

Veblen has been working for several years on a book which will probably be called "Spinors in Projective Geometry", in which an attempt will be made to do justice to the various branches of algebra and geometry as well as theoretical physics, which combine to form this particular body of doctrine. He is collaborating with Dr. Givens and Professor Taub, who were his assistants at the time the work started. Professor Taub returned to the Institute for this year from the University of Washington at Seattle, where he has a permanent position, in order to make this collaboration more effective by personal contact. For the same purpose, both Taub and Givens (until now at Cornell University, but going to Northwestern) are working with Veblen this summer, and there is good reason to expect that the book will be actually finished by fall. Several other men, as van Stockum (now at Baltimore) and deWet (now at Cape Town) have worked with Veblen's group on this subject, and particularly on its applications to theoretical physics. In accordance with

1940/1941

never published? Not in bibliography

the general policy of the Institute, all of these men are mature scientists rather than beginners. They came from widely separated parts of the world. Presumably this bringing together of such men to work on a common program for a while and then depart to their several stations with renewed enthusiasm, is about as much as the Institute can profitably attempt to do in mathematics.

During the last two years Veblen has devoted a good deal of effort of one sort or another to the founding of the "Mathematical Reviews". This must of course be considered as completely extra curricular. It is particularly fortunate that it was possible to locate this journal (which, like all journals, is an auxiliary to scientific work and not to be confused with scientific work itself) at another place than Princeton.

Hermann Weyl

Although Weyl cannot and should not be pinned down as an algebraist only, his major interest in the last years has been in that field, and he has made it a particular subject of his endeavor to see that the two important disciplines of algebra and group theory are adequately represented in the School of Mathematics. He has also attempted to break the ground for number theory, a branch of mathematics which does not seem to have met so far with as much interest in this country as it deserves. A book on "The Classical Groups, Their Invariants and Representations", the first in the "Princeton Mathematical Series", for which he enjoyed the close cooperation of such gifted assistants as Richard Brauer and Alfred H. Clifford, and the opening volume of the "Annals of Mathematics Studies", on "Algebraic Theory of Numbers", are fruits of his endeavors in this direction. During the present year the theory of reduction under arithmetical equivalence has received much attention because Siegel has just arrived at a wealth of new profound results concerning these problems, Gordon Pall (who came to the Institute as a Guggenheim Fellow) is writing a book on the subject, and some of Weyl's own latest research has been in this field.

(1941) Weyl considers an important part of his mathematical activities to be a seminar on current literature, which thie year he continued jointly with Professor Chevalley of Princeton University. The idea is to have the members of the seminar report on recent papers of outstanding interest, and thus to counteract the dangerous tendency toward a too-narrow specialization, by covering in the same seminar all fields of mathematics. Next term Weyl hopes to be able to do something in the direction of applied mathematics, particularly in hydro- and aero-dynamics.

The building up of our new mathematical library has required much of Weyl's attention during the last year. He believes we can be justly proud of what has so far been accomplished under difficult circumstances. The credit for it should go to Weyl's present assistant, Alfred Brauer, who is an expert librarian in the field of mathematics and has given as much of his time and energy to this job as he could give without unduly neglecting his own research work.

For years Weyl has been busy with helping European mathematical refugees, either directly, or through correspondence with the Friends Service Committee and other interested scientists and committees. During the last months he has given considerable time to his job as co-editor of the American Journal of Mathematics.

Insert (i) →

The picture of work going on in the Institute would be utterly in-

Walter Mayer

While still in Vienna Mayer did significant work in topology with particular reference to its group-theoretic aspects. He has continued his work in this field while at the Institute. Mayer has the greatest interest in simplifying the foundations of various branches of mathematics. Because of this interest he has given expository courses in topology, differential geometry, and the calculus of variations. Through such courses he sometimes reaches students who would not be reached by more ambitious courses. Professor Alan D. Campbell of Syracuse is an example of a worker at the Institute who has been stimulated by Mayer and has collaborated with him. His interests have been reflected in a number of papers in the last years.

The picture of work going on in the Institute would be utterly incomplete if the work of the temporary members were not referred to. It will not be attempted, however, to give here a detailed elaboration like the above. This omission should, of course, not be taken at all as a judgment of value or importance. It is merely that such a compilation would be technically difficult, and the main tendencies represented in the Institute are probably indicated essentially by the above. It should be said, however, that among the temporary members of the Institute are absolute leaders in their fields, whose recent work has been of exceptional importance:

Kurt Gödel

He established a decade ago the impossibility of certain proofs in logic and -- for the first time in the history of mathematics -- the impossibility of deciding certain problems in arithmetic and analysis. In the last years he found the (negative) solution of the famous "continuum problem" which had resisted all efforts for over forty years.

Carl L. Siegel

He had previously done outstanding work in the analytic theory of numbers and the theory of quadratic forms, which he has continued and extended during his stay at the Institute. Recently he has also made important contributions to celestial mechanics.

Some statistics concerning the temporary members who participated in the work of the School of Mathematics are appended.

REPORT ON SCHOOL OF MATHEMATICS

by

Marston Morse and John von Neumann

The great difficulties of describing adequately the work of the mathematical group are obvious. Apart from being a highly technical and finely differentiated science, mathematics is among other things a language differing no little in its words, considerably in its grammar, and absolutely in its syntax, from any other language used by men. And from its very nature - in fact this is the main reason why mathematical language was invented - its contents cannot be translated into any other language. It is only fair to expect that any attempt to describe the contents of mathematical research cannot convey essentially more of the essence of the subject than would an attempt to describe the "contents" of a Chinese poem.

The only thing one may reasonably try to describe is the general tendency and purpose of such research, and the spirit, the atmosphere, in which it is undertaken.

One must realize, above all, that there is a very particular double character which pervades all mathematical work. It is perfectly true that mathematics has practical applications. These are sometimes very indirect - for example, applications to mathematical physics, which in turn are justified by applications to experimental physics, which in turn are justified by applications to engineering, etc. - but they are applications nevertheless. It is even true that much, if not most, of the best mathematical inspiration has been directly or indirectly derived from "applied" problems. Nevertheless most mathematical research is usually undertaken without any regard to such applications, and it is strongly to be suspected that its quality could only suffer if the mathematician kept the applications constantly in mind. As matters stand, they sometimes never enter his mind, and it is by no means established that this is always a loss. It is very difficult to do justice, in any finite number of words, to this situation and to all its nuances, but it is necessary to keep it in mind when visualizing the nature of mathematical research.

Thus when dealing with mathematics it is probably more useful to judge it by the same standards by which a creative <u>art</u> is judged, - that is, by esthetic standards. The esthetic angle may escape the layman who does not speak the "foreign language" in which the intellectual effort goes on. It may also seem strangely disconnected with the application which may ultimately be made of mathematical results. But it is there nevertheless, and ignoring it would lead to a complete misunderstanding of mathematics.

The above indications give probably a less complete picture than some lines written by Dr. Abraham Flexner in "I Remember," which were intended to convey an idea of the purpose and nature of the Institute for Advanced Study, but their validity applies to the study of mathematics. Dr. Flexner writes as follows:

> "The Institute for Advanced Study was intended, by reason of its constitution and conception, to be mainly a research institute. From an unknown source I quote the following:

> 'The deepest joy in life is to be creative. To find an undeveloped situation, to see the possibilities, to identify yourself with something worth while doing, put yourself into it, and stand for it - that is a satisfaction in comparison with which superficial pleasures are trivial.'"

Referring to teaching:

> "Persons who require to be drilled or taught hard do not belong within the Institute for Advanced Study. The level of the teaching and its form mark it off sharply from college teaching, from most university teaching, from technological or professional teaching. This granted, the professor himself benefits, if for an hour or two weekly, in addition to his own research and the supervision of a few investigations, he discusses a larger theme with a small, thoroughly competent, body. He is thus assisted in preserving his own perspective, and he has a stimulus to wide reading and broader contacts."

With reference to scholars in the Institute:

> "These men presumably know their own minds; they have their own individual ways; the men who have, throughout human history, meant most to themselves and to human progress have usually followed their own inner light; no organizer, no administrator, no institution can do more than furnish conditions favorable to the restless prowling of an enlightened and informed human spirit, seeking its intellectual and spiritual prey. Standardization, organization, making trifles seem important, do not aid: they are simply irksome and wasteful."

The members of the School of Mathematics believe in these principles so clearly stated by Dr. Flexner, and as far as they are able have endeavored to embody them in their research and in their contacts with fellow scholars. We are concerned with the foundations of mathematics and mathematical physics, with the discovery and development of those principles of mathematics which will give deeper harmony to mathematics as an art, and greater power as a science. It is true that some of us are concerned at the moment with important applicaions of mathematics to ballistics, aviation, and other aspects of engineering. We regard these activities as temporary, - although inevitable and necessary as the need to live. The long-term conception of our true functions would relegate these diversions to a secondary place. The order in the world which we desire and the peace which we seek, will make tehnological studies the servant and not the master of our lives. The path to knowledge for its own sake will still be open, the creative artist or scientist will still be free, and objective truth will still be revered.

The limitation of the value of any specific statement of the contents of mathematical research should be clear from what was said above. It may nevertheless be useful to append descriptions of the work of the permanent members of the Institute as they see it:

Walter Mayer

While still in Vienna Mayer did significant work in topology with particular reference to its group-theoretic aspects. He has continued his work in this field while at the Institute. Mayer has the greatest interest in simplifying the foundations of various branches of mathematics. Because of this interest he has given expository courses in topology, differential geometry, and the calculus of variations. Through such courses he sometimes reaches students who would not be reached by more ambitious courses. Professor Alan D. Campbell of Syracuse is an example of a worker at the Institute who has been stimulated by Mayer and has collaborated with him. His interests have been reflected in a number of papers in the last years.

The picture of work going on in the Institute would be utterly incomplete if the work of the temporary members were not referred to. It will not be attempted, however, to give here a detailed elaboration like the above. This omission should, of course, not be taken at all as a judgment of value or importance. It is merely that such a compilation would be technically difficult, and the main tendencies represented in the Institute are probably indicated essentially by the above. It should be said, however, that among the temporary members of the Institute are absolute leaders in their fields, whose recent work has been of exceptional importance:

<u>Kurt Gödel</u>

He established a decade ago the impossibility of certain proofs in logic and - for the first time in the history of mathematics - the impossibility of deciding certain problems in arithmetic and analysis. In the last years he found the (negative) solution of the famous "continuum problem" which had resisted all efforts for over forty years.

<u>Carl L. Siegel</u>

He had previously done outstanding work in the analytic theory of numbers and the theory of quadratic forms, which he has continued and extended during his stay at the Institute. Recently he has also made important contributions to celestial mechanics.

Some statistics concerning the temporary members who participated in the work of the School of Mathematics are appended.

The greatest need of the Institute in its relation to mathematics is an increase of funds for stipends to workers. The total amount available each year for this purpose is now considerably less than the amount available during the first years of the Institute. An examination of the table on the following pages shows that the number of candidates for stipends has remained sensibly constant (excepting next year for obvious reasons), while the number of those receiving stipends from the Institute in mathematics has diminished from 25 and 21 in 1935-36 and 1936-37 to 11 and 9 respectively in 1940-41 and 1941-42.

That the Institute's aid to workers in mathematics is appreciated by the mathematical world at large is shown by the remarkable degree of collaboration which exists between its professors of mathematics and visiting scholars. Moreover, outside foundations have indicated their approval of work here by increasing their aid to men proposing to work in mathematics until the number of those aided by the foundations next year, for the first time, will equal those aided by the Institute. However, the number of mathematical scholars of established reputations who would like to work at the Institute, but who are prevented by financial reasons, remains deplorably large.

The need for greater stipend funds is heightened by the necessity of restoring young men now in the draft army to their rightful places in the scientific world. Some of these young men were starting on promising careers in mathematics. They will return with a keener and more realistic appreciation of science. A year of study at the Institute would serve to remove the feeling that they have been handicapped and enable them to continue their work with even greater vigor and enthusiasm.

Math.

Report to Board Ap 20, 1943

Years work - Financial problems - pensions - oil shortage - war work - all covered in previous reports -

Today intellectual work - review of research by faculty members

Refer back to my 3 comprehensive reports of 1941 - advances since those were written

Math - Econ - Human studies - League

1. Math. - Rock Found report on Göttingen 30-32

Weyl - Siegel

like Cyclotron - no moving parts - effects not immediately visible - no less imp. and profound - Power.

NY Times "The Great clock of civilization ticks on, now as always."

JAMES W. ALEXANDER

is writing a book on topology. For the last one or two decades Princeton and Moscow have been the centers of topology, Princeton mainly through the work of Lefschetz and Alexander. The classical scheme for the topological analysis of the continuum is based on dissection into elements deformable into spheres. The resulting "complex" is accessible to purely algebraic combinatorial methods. Although this theory is satisfactory in itself, its application to the many forms under which continua appear in mathematics and physics, is often very cumbersome. During the last years Alexander has worked incessantly on a new much more flexible scheme for topology. He has now brought this work to a successful conclusion.

April 5, 1943

ALBERT EINSTEIN

wrote a joint paper with Professor Pauli in which they prove that under certain restrictions there is no solution of Einstein's classical equations for the gravitational field without singularities. This is important because otherwise such a field could exist without being generated by masses. But Einstein's main endeavor was, as it has been during the last twenty years, directed toward the unification of electromagnetism and gravitation, the two primary forces of nature. The gap between facts and theory is so wide here that the facts give practically no hint how to proceed in building up an adequate theory; the existing field theories, and a sense of mathematical harmony are the only guides. If a theoretical possibility seems to hold out some promise, the working out of its consequences to the point where they can be confronted with factual experience is a difficult and laborious mathematical task. In this way Professor Einstein has developed, and afterwards given up, a number of theories. This work has been by no means in vain, because it has definitely excluded possibilities which sooner or later had to be examined. He is now following a new promising and highly interesting approach by which he hopes not only to unify gravitation and electromagnetism, but also to account for the discontinuous structure of matter; but whether it will lead to the goal he cannot yet say. If anybody has earned the right to attack such a long-range problem, and if anybody has a chance to find its solution at the present state of physics, it is of course Professor Einstein.

April 5, 1943

Isolation from Schrödinger
mystic approach to same problem

VALENTIN BARGMANN (Ph.D. Univ. Zürich 1936), arrived N.Y.C. June 23/37 with visa from Kaunas, Lithuania, and has been at IAS ever since: stipends 1937-40; Asst. to Prof. Einstein 1940-

finished an important paper on the representations of the Lorentz group; it answers the question what kind of physical quantities are possible in quantum mechanics that satisfy the postulates of special relativity. (This work was inspired by Prof. Pauli.) Moreover Dr. Bargmann assisted Prof. Einstein in working out Einstein's new type of unified field theory.

April 6, 1943

THE INSTITUTE FOR ADVANCED STUDY
SCHOOL OF MATHEMATICS
PRINCETON, NEW JERSEY

April 5, 1943

Dear Doctor Aydelotte:

This letter is in response to your call for a report on current work of members of the Institute. As you know, I have been working off and on for the last two years for the N.D.R.C., and more recently, since November, for the Ordnance Department in the Army, spending four or five days a week in Washington. In spite of this diversion, by working night and day I have been able to carry on some of my researches in pure mathematics.

Two papers by me came out last year. This year there will appear three papers beginning a fascinating program which I hope will culminate during my life. I have good reasons to believe that the planetary orbits exist for topological causes. That is, the possible closed paths which a planet might follow form a kind of space so twisted and tied up that the planets have no way of escaping except by forming closed orbits. The second and third of these papers, on which Ewing collaborated with me after he left here, will appear this spring in the Annals of Mathematics. My colleagues here are largely unaware of these developments partly because they are outside their fields and partly because I have not had the chance to talk about them here. I am thinking about this work nights and on trains.

Transue

Dr. William R. Transue [Ph.D. Lehigh 1941; fellowship from Inst.Internatl. Ed. 1935-6 for study at Univ.Bordeaux; Asst. Yale 1936-7, Lehigh 1937-42; Asst. to Prof. Morse 1942-3, resigned Mar.1/43 for work with ? Prof. Morse in Technical Division of Office of Chief of Ordnance, U.S.Army], who was my assistant for six months, began an intensive study of elasticity and related problems. We had two things in mind,- to help Adams of the Geophysical Laboratory, and to relate the vibration theory to my own work. The first objective was realized and the second will be realized sometime later. Transue is now Junior Physicist in the Ordnance Department, doing valuable work.

As you know, I have been loath to leave my own research here for war work. I recently declined to represent mathematics at Washington with the Man Power Commission. My present task involves scientific investigations for which no one else is properly available. While this work is not likely to stand out through the years as does pure research, I cannot in good conscience refuse to do it. It does require originality and judgment, which are not available in anything like the degree needed. I have now finished my sixth published report for the Ordnance Department. One of these reports is of real scientific value involving a new and systematic analysis of bomb fragmentation and power. Another report is being distributed (1000 copies) to the aviation headquarters in England. If this work ever becomes mediocre or ineffective I shall quit it at once. At the present time I have drawn up the principal plans for a $100,000 bomb experiment program at Aberdeen and the modes of analysis exist unfortunately only in my head. I am grateful to the Institute for the generous and patriotic attitude they have taken in making it possible for me to do this work. They are making a sacrifice. I too am making a heavy sacrifice in being away from my family, and in existing as one must in Washington. I believe the need and the results justify this.

Sincerely yours,

Marston Morse G.B.

Marston Morse

Dr. Frank Aydelotte
MM:GB

OSWALD VEBLEN

has continued work on his book on spinors, which has occupied him and a number of collaborators for the last years. The manuscript is now nearing completion. Spinors are a new sort of geometric quantities which first showed up in quantum physics, and there account for the fundamental difference between a spinning electron and a spinning top. The notion has its purely algebraic and geometric side, and Veblen's book is devoted to developing the theory of spinors in detail by direct geometric methods and incorporating it organically into the whole of geometry.

never published

Givens
Taub

introduction, tensor theory
Development

April 5, 1943

JOHN VON NEUMANN - England - for Navy

is a man who never seems to be satisfied with one job only. While working for the Navy in Washington and for the Army at Aberdeen Proving Ground, and the N.D.R.C., he also completed several papers on pure mathematics and wrote a book on mathematical economics with Professor Oskar Morgenstern. The most important of his recent papers -- among them one large paper written jointly with Professor Francis J. Murray, who in previous years had worked under von Neumann at the Institute -- deal with so-called rings of linear operators in Hilbert space. These investigations had their origin in the formalism of quantum mechanics, and have occupied von Neumann for more than ten years. The corresponding theory for spaces of finite dimensionality constitutes one of the most beautiful and fruitful parts of modern algebra. Naturally the situation in spaces of infinitely many dimensions is more complicated. Two other papers written by von Neumann jointly with S. Chandrasekhar, and recently published, investigate the statistics of the gravitational field arising from a random distribution of stars.

A great enterprise is the book by von Neumann and Morgenstern on mathematical economics. The science of physics owes its great success in the last three centuries to Galileo's method of isolating simple phenomena accessible to mathematical analysis in terms of a number of variable parameters. The analysis leads to universal laws which ultimately make it possible to understand even the most complicated phenomena. Von Neumann and Morgenstern attempt to apply a similar method to economics. They axiomatize the economic process under the scheme of an association game. Such a game consists of a series of moves the outcome of each of which is determined either by chance according to certain *a priori* probabilities, or by an act of one of the players based on a knowledge of the outcome of certain (previous) moves. Does the series ~~Each player faces the~~ of events take a uniquely determined course if every player acts according

~~problem how to act~~ to his own best advantage.[2] The theoretical solution of such problems depends on a branch of algebra and geometry of which comparatively little is known, and which von Neumann had to develop for this purpose. It may be that for a future theoretical economics this book will play a role similar to that played by Galileo's Discorsi delle nuove Scienze for mechanics ~~in~~ and physics.

MS, about 1000 pages, just went to the printer

April 6, 1943

T h e o r y o f G a m e s

and its application to Economics and Sociology.

by

John von Neumann

and

Oskar Morgenstern

The book is going to the printer within the next 10 days. The MS has app. 1050 pp. It has 12 Chapters, 103 graphs and Figures. It may be a volume of app. 650 printed pages or more.

April 4, 1943.

Read Preface

Preface.

This book contains an exposition and various applications of a mathematical theory of games. The theory has been developed by one of us since 1928 and is now published for the first time in its entirety. The applications are of two kinds: On the one hand to games in the proper sense, on the other hand to economic and sociologic problems which, as we hope to show, are best approached from this direction.

The applications which we shall make to games serve at least as much to corroborate the theory as to investigate these games. The nature of this reciprocal relationship will become clear as the investigation proceeds. Our major interest is, of course, in the economic and sociological direction. Here we can approach only the simplest questions. However, these questions are of a fundamental character. Furthermore our aim is primarily to show that there is a rigorous approach to these subjects, involving, as they do, questions of parallel or opposite interest, perfect or imperfect information, free rational decision or chance influecnes.

Princeton, N.J.

Janurary 1943.

John von Neumann

Oskar Morgenstern

Technical Note:

The nature of the problems investigated and the techniques employed in this book necessitate a procedure which in many instances is thoroughly mathematical. The mathematical devices used are elementary in the sense that no advanced algebra, or calculus etc. occurs. (With one exception: Part of the discussion of an example in 19.7. et sequ. makes use of a simple integral.) Concepts originating in set theory, linear geometry and group theory play an important role, but they are invariably taken from the early chapters of those disciplines and are moreover analyzed and explained in special expository sections. Nevertheless the book is not truly elementary because the mathematical deductions are frequently intricate and the logical possibilities are extensively exploited.

Thus no specific knowledge of any particular body of advanced mathematics is required. However the reader who wants to acquaint himself more thoroughly with the subject expounded here will have to familiarize himself with the mathematical way of reasoning definitely beyond its routine, primitive phases. The character of the procedures will be mostly that of mathematical logics, set theory and functional analysis.

We have attempted to present the subject in such a form that a reader who is moderately versed in mathematics can acquire the necessary practice in the course of this study. We hope that we have not entirely failed in this endeavour.

In accordance with this, the presentation is not what it would be in a strictly mathematical treatise. All definitions and deductions are considerably broader than they would be there. Besides, purely verbal discussions and analyses take up a considerable amount of space. We have, in particular, tried to give, whenever possible, a parallel, verbal exposition for every major mathematical deduction. It is hoped that this procedure will elucidate in unmathematical langugage what the mathematical technique signifies — and will also show where it achieves more than can be done without it. In this, as well as in our methodological stand, we are trying to follow the best examples of theoretical physics.

(These are the opening paragraphs of the book).

The purpose of this book is to present a discussion of some fundamental questions of economic theory which require a treatment different from that which they have found thus far in the literature. The analysis is concerned with some basic problems arising from a study of economic behavior which have been the center of attention of economists for a long time. They have their origin in the attempts to find an exact description of the endeavor of the individual to obtain a maximum of utility, or, in the case of the entrepreneur, a maximum of profit. It is well known what considerable -- and in fact unsurmounted -- difficulties this task involves given even a limited number of typical situations, as, for example, in the case of the exchange of goods, direct or indirect, between two or more persons, of bilateral monopoly, of duopoly, or oligopoly, and of free competition. It will be made clear that the structure of these problems, familiar to every student of economics, is in many respects quite different from the way in which they are conceived at the present time. It will appear, furthermore, that their exact positing and subsequent solution can only be achieved with the aid of mathematical methods which diverge considerably from the techniques applied by older or by contemporary mathematical economists.

Our considerations will lead to the application of the mathematical theory of "games of strategy" developed by one of the authors in several successive stages in 1928 and 1940-1942. After the presentation of this theory, its application to economic problems in the sense indicated above will be undertaken. It will appear that it provides a new approach to a number of economic questions as yet unsettled.

We shall first have to find in which way this theory of games can be brought into relationship with economic theory, and what their common elements are. This can be done best by stating briefly the nature of some fundamental economic theorems so that the common elements will be seen clearly. It will then become apparent that there is not only nothing artificial in establishing this relationship but that on the contrary this theory of games of strategy is the proper instrument with which to develop a theory of economic behavior.

One would misunderstand the intent of our discussions by interpreting them as merely pointing out an analogy between these two spheres. We hope to establish satisfactorily, after developing a few plausible schematizations, that the typical problems of economic behavior become strictly identical with the mathematical notions of suitable games of strategy.

proved a basic theorem on harmonic integrals. In 1941 Hodge in England published a book on this subject, the fruit of fifteen years labor, which aroused widespread interest in the mathematical world. Last year Professor Chevalley of Princeton University conducted a full year's seminar in Fuld Hall on this book, with six professors and almost all the younger mathematicians in Princeton attending; but in the middle of the second term the seminar exploded because it was discovered that the proof of the central theorem on which everything hinges was hopelessly wrong. But two months later, Professor Weyl succeeded in finding the correct proof. During the first term of the current year Weyl lectured on meromorphic functions and analytic curves. This course forms the basis of a monograph on the subject which he has prepared jointly with his son Joachim, and the manuscript of which has just been completed. Moreover Weyl conducted a seminar in which the younger members of the School reported on their own research work; Siegel and Professor Chevalley attended.

April 5, 1943

modest
value as coordinator
range

MISS AUDREY WISHARD (MRS. BROCKWAY McMILLAN)

(Ph.D. Radcliffe 1938) - Grad. Fellowships at Radcliffe 1935-8; Instr. Vassar 1938-42; Asst. to Prof. Weyl 1942- resigned Mar.1/43 for research on fire control instruments in Princeton Surveys statistical office)

came to the Institute from Vassar College where she held an Instructorship, and married a Princeton mathematician, Dr. Brockway McMillan. She acted as Prof. Weyl's assistant until March 1, when she resigned in order to devote her whole time to essential war work in the Princeton Surveys statistical office. Her field, analytic theory of functions, along the lines of the great Finnish school of Lindelöf and Nevanlinna, is closely related to the subject of analytic curves with which Prof. Weyl was occupied; thus she could render him very valuable assistance. During the year she published one and finished another paper on analytic functions.

April 5, 1943.

WALTHER MAYER

also works in topology. He has pursued his way independently of both Lefschetz and Alexander. His point of departure is the classical scheme of complexes, and he endeavors to isolate the purely algebraic aspect. Last year he discovered in this way some new topological invariants, and during this year his research has made further headway but has not yet reached a definite goal.

April 5, 1943

Gödel

Siegel

Pauli

Rect F – 4 yrs

1943-4 last

---

all in Profship caliber

KURT GÖDEL

had visited the Institute several times before (full year 1933-34, first term 1935-36, first term 1938-39) and has now been with us continuously since March 1940. Mathematical logic and the foundations of mathematics are his fields, wherein he occupies a unique position. Since the Greeks, mathematicians have attempted to base their science on axioms, so that once these axioms are admitted everything proceeds by pure reasoning and no uncertainties and doubts can creep in. As a matter of fact the axioms have to be formulated in symbols rather than language, and the reasoning is done by manipulating such formulas according to definite rules. But Gödel shook the belief that reason can ever be completely axiomatized, by showing that whatever axioms you start with, there are always evidently true number-theoretic propositions which you cannot prove on their basis. From these more or less artificial examples of undemonstrable propositions constructed ad hoc, he has now proceeded to investigate a controversial principle, the so-called axiom of choice, on which depends much of modern set-theory and analysis. After proving that this principle is not in contradiction to the other axioms of mathematics, he has now nearly completed the proof of its independence. But he interrupted this study in order to write an account of Bertrand Russell's work in mathematical logic for the collection, "Living Philosophers". The critical analysis of Russell's epoch-making "Principia Mathematica", published some forty years ago, and the subsequent development by the outstanding modern logician, will undoubtedly be of great interest. The manuscript is about completed.

Axioms

Russell

April 3, 1943

CHARLES LUDWIG SIEGEL

who had been with the Institute before, in 1935, succeeded in getting out of Germany via Denmark and Norway the last minute before the Nazi invasion of Norway. He is living through a particularly productive period of his mathematical career. Two papers of his on stability of analytic mappings, which straddle the fields of mechanics (in particular celestial mechanics) and function theory, have just been published. He has continued, and is still continuing, his research on fundamental domains for arithmetically defined groups, their volumes, and the corresponding automorphic functions. For the special group of linear transformations with integral coefficients this subject has been of central importance in the theory of numbers for the whole last century, and for ~~its purpose~~ this special instance, the great mathematician Minkowski more than forty years ago created the so-called geometry of numbers. Siegel has gone far beyond Minkowski. As a matter of fact, after Siegel's work, all that has been done before looks like a hill in a vast mountainous landscape. His latest paper in this field is entitled "Symplectic Geometry", but it actually deals with problems on the borderline of group, function and number theories, and opens up a very original and promising approach to the unexploited domain of analytic functions of several variables. He submitted the paper, in the form of a beautiful handwritten manuscript, to the American Journal of Mathematics, but the referee suggested that we have a typewritten copy made for the printer in order to preserve the original manuscript as a treasure in the library of the Institute for future generations to admire. INSERT A It is probably not too much to say that if the School of Mathematics had accomplished nothing in the ten years of its existence but to enable Siegel to produce these works, it would have fully demonstrated its usefulness to the scientific world.

April 3, 1943

Insertion A

Moreover Siegel made an interesting contribution to the study of the zeta function, that analytic function on which depends our knowledge of the erratic distribution of the prime numbers. (Riemann's conjecture about the zeros of the zeta function, which has now challenged mathematicians for nearly a century, remains still unproved, but Siegel's result throws some light on this question.) Finally, Siegel succeeded in settling Waring's problem for arbitrary algebraic number fields, a problem which had withstood his efforts twenty years ago, forcing him at that time to limit himself to quadratic fields; now he has won through.

WOLFGANG PAULI

is working on the most mysterious of the several elementary particles or waves discovered by atomic physics, the mesotron, which occupies an intermediate position between the particles known for a long time,- electron and proton on one hand, and the photon (i.e. light or electromagnetic field) on the other hand. The experimental evidence concerning the mesotron comes from the study of cosmic rays and is scanty, but the mesotron plays an important part for the constitution of the atomic nuclei. Its law of motion is not as well known as that of the electron and the light, and Professor Pauli has pursued two different hypotheses concerning this law. In doing so he has collaborated with several younger physicists,- namely with Dr. Dancoff, who was at the Institute last year; with Dr. Kusaka, who is with us now; with Dr. Bargmann, Einstein's assistant; and Dr. Jauch of Princeton University. Theoretical physics is at present in an awkward position. The theory of the outer shell of electrons of the atom is practically complete; the experimental evidence concerning the heavy nucleus far from being conclusive. But there is no doubt that Pauli makes the best possible of this bad situation, and that he and his collaborators are doing pioneer work of first importance.

Pauli also wrote a joint paper with Einstein concerning Einstein's equations of the gravitational field, and a critical report for the Reviews of Modern Physics on some new ideas by which Dirac hopes to overcome the difficulties connected with the quantization of the field equations of photon and electron.

During both terms he has conducted a seminar in Fuld Hall on quantum electrodynamics and meson theory.

April 6, 1943

IRVIN S. COHEN

(Ph.D. Hopkins 1942), Jr. Instructor in Math. at Hopkins 1936-42, and Instructor in Math., Night School for Technology 1939-42. Instructor at Univ. of North Carolina since Jan.1/43)

got his degree at Johns Hopkins under Zariski. He stayed for the first term only, and then resigned because he had received an appointment as Instructor at the University of North Carolina. His field is abstract algebra; in particular, the development of those highly intricate algebraic instruments which the theory of algebraic surfaces necessitates. While working here he found a number of surprising and profound results, and in Weyl's seminar he gave an exposition of his research which aroused universal admiration. Dr. Cohen is a first-rate mathematician, and it would be particularly desirable to have him return to the Institute for a longer time after the war is over.

April 5, 1943

SHUICHI KUSAKA (Ph.D. Univ. Calif. 1942) - held Grad.Scholarship 1937 (B.A./37) at Univ.Brit.Columbia; Tuition Scholarship 1937-8 (M.S./38) at M.I.T.; and at Univ.Calif., Univ. Fellowship 1938-9 and fall of 1941, and Teaching Asst. 1939-41 and spring of 1942

worked in close collaboration with Prof. Pauli. They have just finished the manuscript of a joint paper on the theory of the mesotron. Dr. Kusaka has also helped in the final editing of Professors von Neumann and Morgenstern's book on mathematical economics, and with the manuscript of Prof. Veblen's book on spinors.

April 6, 1943

Suicide at Berkeley - Sproul's new office entire day - Oppenheimer

Possibility at Sw -

LUTHER I. WADE, JR.

(Ph.D. Duke 1941. Grad. Asst. 1938-9, Grad. Fellow 1939-41 at Duke; Instr. Hopkins, 1941-2. NRC Fellow at IAS 1942-3)

is a National Research Council Fellow (in Mathematics). Two of the three NRC Fellows selected for this year had chosen to join the Institute, but one of them, Dr. Howard Levi, resigned before the beginning of the year because of war duties (Ground School Instructor under the Navy Department).

Dr. Wade comes from Duke University. His work is on transcendency problems. The most famous transcendental number is π and the fact that it is transcendental proves that the quadrature of the circle is impossible. After Hermite and Lindemann had proved the transcendency of π in the 19th century, the greatest contributions to this line of ideas were made by Siegel some ten to fifteen years ago. Wade has continued his research during the year, with singular success. In Weyl's seminar he gave several talks on his research.

Negro - Rosenwald

J. ERNEST WILKINS, Jr.

(S.B. 1940, S.M. 1941, Ph.D. Dec.1942, all at Univ. of Chicago) - held Alva K. Brown Fellowship at Univ. of Chicago 1941-42; and Julius Rosenwald Fellowship at I.A.S for 1942-43, but resigned after 1st term to take teaching position at Tuskegee Inst. Age - 19.

is a very young mathematician of great talents. He stayed with the Institute for one term only, and then accepted an instructorship at Tuskegee Institute. While at the I.A.S. he presented four papers to the American Mathematical Society; they deal with maxima and minima problems for multiple integrals, and are closely related to ~~the problems discussed in~~ his thesis. These papers will be published in several journals. Besides, he studied algebraic geometry under Professor Chevalley, and made notable contributions to Professor Lefschetz's seminar on non-linear differential equations.

April 16, 1943

FUMIO YAGI (M.S. Univ.Washington 1941; Ph.D. M.I.T. June 1943) - Fellowship at Univ.Washington 1940-1, Grad.Scholarship at M.I.T. 1941-2. American citizen.

an able young American mathematician of Japanese descent, joined the Institute less than two months ago. He had just finished his thesis for the Doctor's degree, on integral equations, written at the M.I.T. under Professors W.T.Martin and Cameron. Since Mrs. McMillan resigned he has assisted Prof. Weyl in completing his book on analytic curves. He plans future research on integral equations and theory of analytic functions.

April 6, 1943

GUIDO FUBINI

now a non-resident (honorary?) member of the Institute, finished, or is about to finish, a book, "The Mathematics of the Engineer", on which he has worked for many years and which covers the whole field from quadratic equations to advanced electrodynamics and thermodynamics. As far as we know, it will be published in South America.

April 12, 1943

vert. file "M"

1941 October

MATHEMATICS Academic Activities

MORSE Biographical

VON NEUMANN

Their report to Aydelotte for Board.

Filed in Vertical File under "M" for ~~School of~~ Mathematics.

F. A., 1/8/57

[1941]

REPORT ON SCHOOL OF MATHEMATICS

by

Marston Morse and John von Neumann

The great difficulties of describing adequately the work of the mathematical group are obvious. Apart from being a highly technical and finely differentiated science, mathematics is among other things a language differing no little in its words, considerably in its grammar, and absolutely in its syntax, from any other language used by men. And from its very nature - in fact this is the main reason why mathematical language was invented - its contents cannot be translated into any other language. It is only fair to expect that any attempt to describe the contents of mathematical research cannot convey essentially more of the essence of the subject than would an attempt to describe the "contents" of a Chinese poem.

The only thing one may reasonably try to describe is the general tendency and purpose of such research, and the spirit, the atmosphere, in which it is undertaken.

One must realize, above all, that there is a very particular double character which pervades all mathematical work. It is perfectly true that mathematics has practical applications. These are sometimes very indirect - for example, applications to mathematical physics, which in turn are justified by applications to experimental physics, which in turn are justified by applications to engineering, etc. - but they are applications nevertheless. It is even true that much, if not most, of the best mathematical inspiration has been directly or indirectly derived from "applied" problems. Nevertheless most mathematical research is usually undertaken without any regard to such applications, and it is strongly to be suspected that its quality could only suffer if the mathematician kept the applications constantly in mind. As matters stand, they sometimes never enter his mind, and it is by no means established that this is always a loss. It is very difficult to do justice, in any finite number of words, to this situation and to all its nuances, but it is necessary to keep it in mind when visualizing the nature of mathematical research.

Thus when dealing with mathematics it is probably more useful to judge it by the same standards by which a creative art is judged, - that is, by esthetic standards. The esthetic angle may escape the layman who does not speak the "foreign language" in which the intellectual effort goes on. It may also seem strangely disconnected with the application which may ultimately be made of mathematical results. But it is there nevertheless, and ignoring it would lead to a complete misunderstanding of mathematics.

The above indications give probably a less complete picture than some lines written by Dr. Abraham Flexner in "I Remember," which were intended to convey an idea of the purpose and nature of the Institute for Advanced Study, but their validity applies to the study of mathematics. Dr. Flexner writes as follows:

> "The Institute for Advanced Study was intended, by reason of its constitution and conception, to be mainly a research institute. From an unknown source I quote the following:

> 'The deepest joy in life is to be creative. To find an undeveloped situation, to see the possibilities, to identify yourself with something worth while doing, put yourself into it, and stand for it - that is a satisfaction in comparison with which superficial pleasures are trivial.'"

Referring to teaching:

> "Persons who require to be drilled or taught hard do not belong within the Institute for Advanced Study. The level of the teaching and its form mark it off sharply from college teaching, from most university teaching, from technological or professional teaching. This granted, the professor himself benefits, if for an hour or two weekly, in addition to his own research and the supervision of a few investigations, he discusses a larger theme with a small, thoroughly competent, body. He is thus assisted in preserving his own perspective, and he has a stimulus to wide reading and broader contacts."

With reference to scholars in the Institute:

> "These men presumably know their own minds; they have their own individual ways; the men who have, throughout human history, meant most to themselves and to human progress have usually followed their own inner light; no organizer, no administrator, no institution can do more than furnish conditions favorable to the restless prowling of an enlightened and informed human spirit, seeking its intellectual and spiritual prey. Standardization, organization, making trifles seem important, do not aid: they are simply irksome and wasteful."

The members of the School of Mathematics believe in these principles so clearly stated by Dr. Flexner, and as far as they are able have endeavored to embody them in their research and in their contacts with fellow scholars. We are concerned with the foundations of mathematics and mathematical physics, with the discovery and development of those principles of mathematics which will give deeper harmony to mathematics as an art, and greater power as a science. It is true that some of us are concerned at the moment with important applicaions of mathematics to ballistics, aviation, and other aspects of engineering. We regard these activities as temporary, - although inevitable and necessary as the need to live. The long-term conception of our true functions would relegate these diversions to a secondary place. The order in the world which we desire and the peace which we seek, will make tehnological studies the servant and not the master of our lives. The path to knowledge for its own sake will still be open, the creative artist or scientist will still be free, and objective truth will still be revered.

The limitation of the value of any specific statement of the contents of mathematical research should be clear from what was said above. It may nevertheless be useful to append descriptions of the work of the permanent members of the Institute as they see it:

Walter Mayer

While still in Vienna Mayer did significant work in topology with particular reference to its group-theoretic aspects. He has continued his work in this field while at the Institute. Mayer has the greatest interest in simplifying the foundations of various branches of mathematics. Because of this interest he has given expository courses in topology, differential geometry, and the calculus of variations. Through such courses he sometimes reaches students who would not be reached by more ambitious courses. Professor Alan D. Campbell of Syracuse is an example of a worker at the Institute who has been stimulated by Mayer and has collaborated with him. His interests have been reflected in a number of papers in the last years.

The picture of work going on in the Institute would be utterly incomplete if the work of the temporary members were not referred to. It will not be attempted, however, to give here a detailed elaboration like the above. This omission should, of course, not be taken at all as a judgment of value or importance. It is merely that such a compilation would be technically difficult, and the main tendencies represented in the Institute are probably indicated essentially by the above. It should be said, however, that among the temporary members of the Institute are absolute leaders in their fields, whose recent work has been of exceptional importance:

Kurt Gödel

He established a decade ago the impossibility of certain proofs in logic and - for the first time in the history of mathematics - the impossibility of deciding certain problems in arithmetic and analysis. In the last years he found the (negative) solution of the famous "continuum problem" which had resisted all efforts for over forty years.

Carl L. Siegel

He had previously done outstanding work in the analytic theory of numbers and the theory of quadratic forms, which he has continued and extended during his stay at the Institute. Recently he has also made important contributions to celestial mechanics.

Some statistics concerning the temporary members who participated in the work of the School of Mathematics are appended.

The greatest need of the Institute in its relation to mathematics is an increase of funds for stipends to workers. The total amount available each year for this purpose is now considerably less than the amount available during the first years of the Institute. An examination of the table on the following pages shows that the number of candidates for stipends has remained sensibly constant (excepting next year for obvious reasons), while the number of those receiving stipends from the Institute in mathematics has diminished from 25 and 21 in 1935-36 and 1936-37 to 11 and 9 respectively in 1940-41 and 1941-42.

That the Institute's aid to workers in mathematics is appreciated by the mathematical world at large is shown by the remarkable degree of collaboration which exists between its professors of mathematics and visiting scholars. Moreover, outside foundations have indicated their approval of work here by increasing their aid to men proposing to work in mathematics until the number of those aided by the foundations next year, for the first time, will equal those aided by the Institute. However, the number of mathematical scholars of established reputations who would like to work at the Institute, but who are prevented by financial reasons, remains deplorably large.

The need for greater stipend funds is heightened by the necessity of restoring young men now in the draft army to their rightful places in the scientific world. Some of these young men were starting on promising careers in mathematics. They will return with a keener and more realistic appreciation of science. A year of study at the Institute would serve to remove the feeling that they have been handicapped and enable them to continue their work with even greater vigor and enthusiasm.