

### The Scientific Work of Hassler Whitney

Whitney was a pioneer in many areas which have contributed enormously to the growth of mathematics during the past forty years. The following discussion can cover only a few of the highlights of his work.

The field of Differential Topology began with Whitney's work in the period 1936-1944. The concept of a "differentiable manifold" defined by overlapping coordinate neighborhoods had recently been introduced by Veblen and Whitehead. Whitney laid the groundwork for further development by showing that every such manifold could be smoothly embedded in a high dimensional euclidean space. In fact, he showed that an  $r$ -times differentiable manifold could be embedded as a real analytic submanifold of euclidean space. Later he showed that an  $n$ -dimensional manifold could actually be embedded in  $2n$ -dimensional space, and immersed in  $(2n-1)$ -dimensional space. The geometric techniques involved in proving these results were of great interest, and continue to be very important in current research.

The 1944 paper on immersions was also the beginning of the systematic study of singularities of differentiable mappings. He returned to this subject in 1955, and helped to initiate an extremely rich theory which potentially has great importance, not only for pure mathematics, but also for fluid dynamics, biology, and indeed for all areas of applied mathematics. These potentialities are now being intensely developed by R. Thom, J. Mather, and others.

Throughout his career, Whitney has made many contributions to the local study of differentiable functions. This has been of decisive importance in later work by B. Malgrange and many others. To cite one example, L. Hörmander's solution of the division problem for distribution (a basic result in the modern theory of partial differential equations) made essential use of Whitney's work.

In 1937 and 1938 Whitney helped create Cohomology and the theory of cup products. He showed, for example, that duality in manifolds, and the Hopf classification for mappings from an  $n$ -complex to an  $n$ -sphere, both gain greatly in clarity when formulated in terms of Cohomology. Cohomology Theory is now a basic tool, essential to many branches of mathematics. The key concept of "tensor product" for abelian groups is also due to Whitney.

In roughly the same period, 1935-1941, Whitney was founding another important branch of topology, the theory of Fiber Bundles. The tangent bundle of a differentiable manifold, and the normal bundle associated with any embedding in euclidean space, are its most fundamental invariants. Whitney was the first to introduce these basic concepts, and to relate them through what we now call the "Whitney sum" construction. Together with E. Stiefel he defined the characteristic classes associated with any sphere bundle. Whitney showed that these classes were properly described in terms of cohomology theory, and he discovered the formula for the characteristic classes of a Whitney sum. Also, he proved the basic classification theory for sphere bundles, in terms of maps into a Grassmann manifold.

Closely related is the field of Obstruction Theory, which began with Whitney's work on Fiber Bundles, and which he did much to develop. (See, for example, his 1949 paper on mappings of a 3-complex into a simply connected space.) Obstruction theory has become one of the most basic tools of homotopy theory, and has great influence in other branches of mathematics.

One relatively minor paper, dating from 1937, has had an extremely large impact in recent years. Whitney's classification of immersions of the circle in the plane, by means of the "rotation number" has led directly to the classification of all immersions by S. Smale and M. Hirsch and to important developments in foliation theory by A. Phillips and M. L. Gromov.

After all this talk of Whitney's successes it is perhaps only fair to mention one field in which he (and the rest of the mathematical world) has so far been unsuccessful. From his first published papers in 1931 down to the present day, Whitney has maintained a lively and active interest in the four color problem, and related topics in graph theory. No solution of the four color problem has yet been found.

Conclusion. At the beginnings of the most fruitful branches of recent mathematics: Algebraic Topology, Differential Analysis and Topology, one finds the name of Whitney associated with the key concepts, those with which the theories were launched. Deeply original, completely indifferent to mathematical fads and fashions, Whitney has been a germinal spirit. Into vague and half-formed theories he brought the basic ideas which permitted its elaboration and development. He is surely one of the most creative and influential of contemporary mathematicians.

SELECTED BIBLIOGRAPHY OF HASSLER WHITNEY

1. The coloring of graphs, Proc. Nat. Acad. Sci. 17 (1931), 122-125.
2. Analytic extensions of differentiable functions defined in closed sets, Trans. of Amer. Math. Soc. 36 (1934), 63-89.
3. Sphere-spaces, Proc. Nat. Acad. Sci. 21 (1935), 464-468.
4. A function not constant on a connected set of critical points, Duke Math. Jour. 1 (1935), 514-517.
5. Differentiable manifolds, Annals of Math. 37 (1936), 645-680.
6. On regular closed curves in the plane, Compositio Math. 4 (1937), 276-284.
7. The maps of an  $n$ -complex into an  $n$ -sphere, Duke Math. Jour. 3 (1937), 51-55.
8. Topological properties of differentiable manifolds, Bull. Amer. Math. Soc. 43 (1937), 785-805.
9. On products in a complex, Annals of Math. 39 (1938), 397-432.
10. Tensor products of abelian groups, Duke Math. Jour. 4 (1938), 495-528.
11. On the theory of sphere-bundles, Proc. Nat. Acad. Sci. 26 (1940), 148-153.
12. On the topology of differentiable manifolds, Lectures in Topology, Univ. of Michigan Press (1941), 101-141.
13. The self-intersections of a smooth  $n$ -manifold in  $2n$ -space, Annals of Math. 45 (1944), 220-246.
14. The singularities of a smooth  $n$ -manifold in  $(2n-1)$ -space, Annals of Math. 45 (1944), 247-293.
15. On ideals of differentiable functions, Amer. Jour. Math. 70 (1948), 635-658.

16. Classification of the mappings of a 3-complex into a simply-connected space, *Annals of Math.* 50 (1949), 270-284.
17. On singularities of mappings of Euclidean spaces, I. Mappings of the plane into the plane, *Annals of Math.* 62 (1955), 374-410.
18. Elementary structure of real algebraic varieties, *Annals of Math.* 60 (1957), 545-556.
19. *Geometric Integration Theory*, Princeton University Press, Princeton, N. J. (1957), xv + 397 pp. (Princeton Mathematical Series, 21)
20. Singularities of mappings of Euclidean spaces, *Symposium Internacional de Topologia Algebraica*, Mexico, 1956 (1958), 285-301.
21. (with F. Bruhat) Quelques propriétés fondamentales des ensembles analytiques-réels, *Comm. Math. Helv.* 33 (1959), 132-160.
22. Local properties of analytic varieties, in: *Differential and Combinatorial Topology (Symposium in Honor of Marston Morse)*, Princeton University Press, Princeton, N. J. (1965), pp. 205-244.
23. Tangents to an analytic variety, *Annals of Math.* 81 (1965), 496-549.

July 20, 1970

Memorandum to Mr. Morgan:

This will authorize you to pay up to \$600 to a Princeton graduate student who has been working with Professor Whitney. The check is to be drawn to the student's order and sent to Professor Whitney at his request. The amount should be charged to Professor Whitney's Assistants Fund.

Professor Whitney will be in touch with you directly about the recipient and the amount.

Carl Kaysen

cc: Professor Whitney

May 14, 1970

Dear Hassler:

Here is the material that Professor  
Wirszup sent me after talking to Adrian Albert.  
Anything you want please keep. Anything you  
don't want you may return at your convenience.

Cordially,

Carl Kaysen

Professor Hassler Whitney  
Institute for Advanced Study

Material as indicated in Prof. Wirszup's letter of May 5, 1970

THE UNIVERSITY OF CHICAGO

DEPARTMENT OF MATHEMATICS

5734 UNIVERSITY AVENUE

CHICAGO · ILLINOIS 60637

May 5, 1970

Dr. Carl Kaysen, Director  
Institute for Advanced Study  
Princeton, New Jersey 08540

Dear Dr. Kaysen,

I was extremely pleased to hear from Dean A. A. Albert about the interest you expressed in the work of the Survey of Recent East European Mathematical Literature. At Professor Albert's suggestion, I am sending you some SURVEY publications, as well as information on the SURVEY, its programs and activities. A general description of the SURVEY and lists of its publications are given in Appendix I.

SURVEY programs currently in progress are as follows:

1. The SURVEY, in cooperation with the School Mathematics Study Group (SMSG) of Stanford University, has been studying the extensive literature on research and experiments in the psychology of learning and teaching mathematics, which have been conducted in the Soviet Union over the past twenty-five years. As a result of this effort, SMSG and the SURVEY are jointly publishing a fifteen volume series comprising translations of selected Russian research papers and monographs. The series is entitled Soviet Studies in the Psychology of Learning and Teaching Mathematics.

I am sending you the first three volumes of the series. A detailed listing of the contents of all 15 volumes (which will be published during 1970-71) is given in Appendix II. The series will not end with volume 15, however, but will be continued. Among the monographs currently being prepared for inclusion in subsequent volumes are the following:

M. M. Bongard, The Problem of Learning, Moscow, 1967, 320pp.

Psychological Abilities of the Youngest Schoolchildren in Mastering Mathematics, Editor: V. V. Davydov, Moscow, 1969, 288pp.

Dr. Carl Kaysen  
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May 5, 1970

Learning Capacity and Age Level, Editors: D. B. El'konin and V. V. Davydov, Moscow, 1966, 235pp.

L. B. Itel'son, Mathematical and Cybernetic Methods in Teaching, Moscow, 1964, 249pp.

E. N. Kabanova-Meller, The Formation of Methods of Mental Activity and the Mental Development of Schoolchildren, Moscow, 1968, 288pp.

V. A. Krutetskii, The Psychology of Schoolchildren's Mathematical Abilities, Moscow, 1968, 431pp.

L. N. Landa, Algorithms and Teaching, Moscow, 1966, 523pp.

Foundations of Methods of Elementary Mathematics Instruction, Editor: A. S. Pchelko, Moscow, 1963, 376pp.

N. F. Talyzina, Theoretical Problems of Programmed Instruction, Moscow, 1969, 134pp.

2. The SURVEY has already published 33 books, which are translations and adaptations of Soviet books in extracurricular mathematics for secondary school students and their teachers, or of monographs and texts for the training of mathematics teachers. These publications are listed in Appendix I, and excerpts from reviews of the SURVEY editions are given in Appendix III. This program, too, will be continued. I am sending you some of the SURVEY publications in this area.

Additional programs of study and publications which I am now developing are:

3. Texts and monographs designed for the Soviet Secondary Schools for Computer-Programmers and for their other schools for mathematically gifted youngsters. (Please see Appendix IV). As part of this program the SURVEY is currently publishing the series Library of School Mathematics with the M.I.T. Press. The Russian originals were prepared by Professor I. M. Gel'fand of Moscow University and the staff of the Mathematics Correspondence School for talented secondary school students. I am sending you the first three volumes of this series.

Dr. Carl Kaysen  
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May 5, 1970

4. Texts and experimental materials currently appearing in connection with the new mathematics curriculum for the Soviet general schools. (Please see Appendix V).

5. Books and monographs on the methods of teaching mathematics. Literature of this type is almost completely missing in the United States. (Please see Appendix VI).

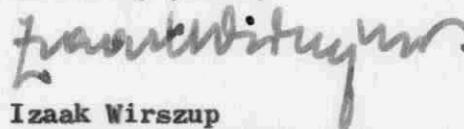
6. A series in the psychology and methodology of teaching mathematics and other subjects to handicapped children. The Soviet Union, unfortunately, is many years ahead of us in this area as well as in the psychology of learning and teaching so-called "normal" children. The one exception is in research on emotionally disturbed children, in which the United States has far surpassed the Russians.

Research at the Institute of Defectology of the U.S.S.R. Academy of Pedagogical Sciences has been outstanding for a long time. The fact that their research on handicapped children proved to be of tremendous value in analyzing the learning processes in "normal" children, has resulted in an even greater emphasis during the last ten years on the development of special education in Russia. An excellent example of the above is the research done by the renowned neuropsychologist A. R. Luriya and reported by him and L. S. Tsvetkova in the monograph, Neuropsychological Analysis of the Solving of [Arithmetic] Problems, Moscow, 1966, 291pp.

In the United States special education only recently achieved significance - and that primarily through the attention and resources devoted to socially disadvantaged and mentally retarded children. The aim of the planned SURVEY series in special education is to acquaint American specialists with Soviet achievements and thus prevent the repetition here of similar research with its concomitant expenditures of time and effort. A sampling of titles that are being considered for inclusion in this series is given in Appendix VII.

If I can be of any assistance to you, I would be very happy to do so. If you or any member of the Institute would like to visit the SURVEY, Dean Albert and I would be delighted to receive you at the University and to show and discuss with you in detail the many monographs, books and periodicals on Soviet education research.

Sincerely yours,



Izaak Wirszup  
Professor of Mathematics

IW:he  
c.: Dean A. A. Albert

THE INSTITUTE FOR ADVANCED STUDY  
PRINCETON, NEW JERSEY 08540

SCHOOL OF MATHEMATICS

With the changed  
circumstances, I naturally  
cancel my letter concerning  
Gardner.

HSW.

THE INSTITUTE FOR ADVANCED STUDY  
PRINCETON, NEW JERSEY 08540

SCHOOL OF MATHEMATICS

April 13, 1970

Mr. Carl Kaysen  
Institute for Advanced Study

Dear Carl,

I would like to have Robert B. Gardner  
of Columbia University as my assistant  
during the academic year 1970-71.

Sincerely yours,

*Hassler*

Hassler Whitney

*T. K. Gardner  
per CW 4-14-70*

January 29, 1970

Dear Hassler:

I am sorry I didn't have a chance to catch you at the end of the meeting yesterday. In any event, there is a meeting this morning at 11:00 a.m. in my office with Messrs. Short and Widmer who are representing a Princeton citizens group on the battlefield matter. If you have time and wish to come, I would be glad to have you join us.

Cordially,

Carl Kaysen

Professor Hassler Whitney  
Institute for Advanced Study

October 2, 1969

Dear Hassler:

Thanks very much for the gift of  
forty shares of General Motors.

Is there some particular use you  
would like it to be put to or do you simply  
wish it to be added to the Institute's general  
funds?

Cordially,

Carl Kaysen

Professor Hassler Whitney  
Institute for Advanced Study

THE INSTITUTE FOR ADVANCED STUDY  
PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

Oct 2, 1969

Mr. D. C. Dilts  
Laidlaw and Co.  
Princeton, N. J.

Dear Mr. Dilts:

Would you please transfer from my account with Laidlaw to the  
Institute for Advanced Study, Princeton, N. J., forty (40) shares of  
General Motors stock. (This is a gift.)

Please let me know the value when received.

Very truly yours,

Hassler Whitney

COPY

Memorandum for the file

February 3, 1969

Hassler Whitney telephoned the Director today and confirmed the note of November 22 to Mr. Morgan from Dr. Kaysen; Professor Whitney will be away the last two weeks in March for school examination trips in Europe.

  
Ruth Bortell

November 27, 1968

Dear Hassler:

I have read with interest about the National Academy Survey Committee's report on mathematics. If you have a copy that you can spare, I would very much appreciate seeing it as well as the companion volume on undergraduate education in mathematics.

Cordially,

Carl Kaysen

Professor Hassler Whitney  
Institute for Advanced Study

October 3, 1968

Memorandum for Mr. Morgan

Would you please add to Hassler Whitney's salary \$1,200 between the period September 30 to 31 December. Charge this to the Contingency Fund. This reflects a small cutback in his NSF grant, and I see no reason why he should bear the burden of this.

We might have to make a similar adjustment next year, but we will wait and see.

Carl Kaysen

November 22, 1968

Memorandum to Mr. Morgan

Owing to NSF funding problems Professor Whitney would like to get back on the payroll for full time 1 January to 30 June. He hopes that the NSF money will become available again and he will therefore have a corresponding reduction to half time 1 July to 30 December next year, but that remains to be seen.

C.K.

Note for file: Professor Whitney will be on leave  
10 days in March for a trip to Switzerland.

April 29, 1968

Dear Hassler:

I am glad to be able to tell you that the Trustees approved, in accordance with the arrangement which you and I had discussed, half time leave without pay, extending during the next academic year, to permit you to work for the Educational Development Corporation in Cambridge.

This means you will get half your pay, but the Institute will continue to make its full contribution to your benefits.

Cordially,

Carl Kaysen

Professor Hassler Whitney  
Institute for Advanced Study

cc: Mr. Morgan

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY 08540

Telephone-609-924-4400

THE DIRECTOR

March 25, 1968

Memorandum for File

Conversation with Professor Whitney in the Director's Office  
at 3:30 p.m. Monday, March 25, 1968

Hassler Whitney's arrangement with <sup>EDC</sup>~~ESI~~ is now  
fairly firm. He would like to go on leave for half time  
with half his pay from the Institute and with the Institute  
continuing to pay its contribution to all the benefits, etc.  
and to withhold at the level of full salary.

CK  
C. K.

## INSTITUTE FOR ADVANCED STUDY

Professor Hassler Whitney will give a lecture entitled HOLOMORPHIC MULTIFUNCTIONS on Thursday, February 15, 1968, at 2:45 p.m. in the Library Wing. Elementary applications to analytic varieties will be given.

INSTITUTE FOR ADVANCED STUDY

Professor Hassler Whitney will give a set of two or three lectures entitled ELEMENTARY STUDY OF ANALYTIC VARIETIES on Thursdays at 2:00 p.m. in Fuld Hall Lecture Room 119 starting March 9, 1967.

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY 08540

Telephone-609-924-4400

THE DIRECTOR

December 15, 1967

Memorandum for File

Conversation with Professor Whitney in the Director's  
Office Thursday, December 14, 1967 - Dr. Kaysen

Professor Whitney, reflecting an earlier conversation between us, continued discussion of his interest in working on mathematics teaching. I indicated that in my own judgment it was up to each member of the faculty to decide how profitably to spend his time and that I saw nothing in principle wrong with a decision by Professor Whitney to devote a good deal of energy in the near future to working on the problems of teaching mathematics. Should it appear to him that these interests took so much of his time and effort as to preclude his continued attention to mathematics at the Institute, this would be a matter which we could review at a later date.

Professor Whitney expressed his desire to take half time leave next year, the other half of his time to be paid for by Educational Development Corporation in Cambridge. I agreed that I would recommend this to the Trustees and expected that they would concur. I suggested to Professor Whitney that he notify his colleagues of his intention, and requested that he continue to serve on the Committee on Logic. He agreed to do this and said he expected to be able to attend most meetings of the Faculty on the selection of members and the like.

CK  
C.K.

April 20, 1967

Dear Mary:

I have now found out a little more about the road that aroused your concern. This is a private road that Princeton University is building that will connect the next stage of their apartment project to Alexander Street. It begins on Alexander Street north of the brook and curves around to parallel our north-south boundary line. It will stop several hundred feet south of the intersection of Springdale and Hardin Roads. The University has no intention of pushing for the extension of Springdale Road until after December, 1970. As you know, we hope to get work on the southwest portion of the loop road started by then in the hope that this will obviate the necessity for extending Springdale Road.

Cordially,

Carl Kaysen

Mrs. Hassler Whitney  
56 Maxwell Lane  
Princeton, New Jersey

December 15, 1967

Memorandum for File

Conversation with Professor Whitney in the Director's  
Office Thursday, December 14, 1967 - Dr. Kaysen

Professor Whitney, reflecting an earlier conversation between us, continued discussion of his interest in working on mathematics teaching. I indicated that in my own judgment it was up to each member of the faculty to decide how profitably to spend his time and that I saw nothing in principle wrong with a decision by Professor Whitney to devote a good deal of energy in the near future to working on the problems of teaching mathematics. Should it appear to him that these interests took so much of his time and effort as to preclude his continued attention to mathematics at the Institute, this would be a matter which we could review at a later date.

Professor Whitney expressed his desire to take half time leave next year, the other half of his time to be paid for by Educational Development Corporation in Cambridge. I agreed that I would recommend this to the Trustees and expected that they would concur. (Hugh Bradley of EDC will some day get in touch with me about the mechanics of the arrangement.) I suggested to Professor Whitney that he notify his colleagues of his intention, and requested that he continue to serve on the Committee on Logic. He agreed to do this and said he expected to be able to attend most meetings of the Faculty on the selection of members and the like.

C.K.

Note: Professor Whitney will be a week late for the opening of the second term.

C O P Y

CONFERENCE BOARD OF ASSOCIATED RESEARCH COUNCILS  
Committee on International Exchange of Persons

Confidential Report on Applicant for a Government Grant  
Under Public Law 584, The Fulbright Act

Applicant: Hassler Whitney  
Concise Statement of Proposal To lecture at the College de France, Paris, on the  
general subject of Singularities of Mappings of Euclidean Spaces; also, continuing  
research on the subject.  
Lecturing X  
Country: France

Information requested from:  
Dr. Robbert Oppenheimer, Director  
Institute for Advanced Study  
Princeton, New Jersey

It is a pleasure to support the application of Professor Hassler Whitney of the Institute for Advanced Study for help in his project lecturing at the College de France. Professor Whitney is probably the most imaginative and certainly one of the foremost topologists in the world. He is a lucid and luminous lecturer, and I believe that his lectures at the College de France will be a great event in mathematical history and in the cultural ties between this country and Europe. Professor Whitney is also a man of the greatest charm, diffidence, and humor. With many ardent cultural and even athletic avocations and a great purity of selflessness in his approach to other scientists, he is sure to win affection as well as admiration by his visit to Paris.

The Institute for Advanced Study has continuing relations with two eminent mathematicians on the faculty of the College de France, Jean Leray and Jean-Pierre Serre. It seems most suitable that we take advantage of this opportunity to reciprocate. I hope very much that Professor Whitney's application will be favorably considered.

Robert Oppenheimer

19 July 1956

CONFERENCE BOARD OF ASSOCIATED RESEARCH COUNCILS  
COMMITTEE ON INTERNATIONAL EXCHANGE OF PERSONS

Mailing address: 2101 Constitution Avenue, N.W., Washington 25, D. C.

Office address: 1785 Massachusetts Avenue, N.W., Washington 6, D. C.

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AMERICAN COUNCIL ON EDUCATION  
AMERICAN COUNCIL OF LEARNED SOCIETIES  
NATIONAL RESEARCH COUNCIL  
SOCIAL SCIENCE RESEARCH COUNCIL

Instructions  
for  
References

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JAMES S. EARLEY	BRYCE WOOD

FRANCIS A. YOUNG  
*Executive Secretary*

These instructions and a confidential report form are forwarded to you by an applicant, personally known to you, who is making application for a Fulbright Award. Please type or write in black ink on only one side of the report form and, if necessary, use a second sheet of approximately the same weight of paper.

It would be appreciated if you would provide the Committee with your appraisal of the applicant's personal character, his professional qualifications, and his ability to accomplish the purpose for which the grant has been requested. Your comments will be used only in connection with a review of the candidate's application.

The Committee has found that comments from references on the following points are particularly helpful in reviewing applications: What have been the achievements of the applicant, and what is his promise as a scholar or teacher considering his age and present stage of professional development? If the candidate is applying for an award as a visiting lecturer, does he possess sufficient maturity and experience to undertake teaching responsibilities in a foreign university and to represent creditably his American colleagues? If the applicant requests an award for advanced research, does he have the necessary preparation in his special field, as well as the intellectual qualifications, to undertake independent and productive research? How would his candidacy be viewed by his colleagues in regard to his professional standing? Would he be an effective representative abroad of American academic and cultural life? Would he and the members of his family who might accompany him be likely to adapt successfully to foreign cultures and conditions of life?

As the objective of the Fulbright program is to foster international understanding as well as to assist individuals in furthering their professional development, the Committee is especially interested in evidences of the applicant's adaptability, interest in human relations, and capacity for constructive leadership. It is hoped that you will refer to any other factors which you feel the Committee should consider in reviewing the application.

FAY:rgb  
Jan54

CLASS OF SERVICE

This is a fast message unless its deferred character is indicated by the proper symbol.

# WESTERN UNION TELEGRAM

W. P. MARSHALL, PRESIDENT

1201

SYMBOLS

DL=Day Letter

NL=Night Letter

LT=International Letter Telegram

The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

Prof. Hassler Whitney  
c/o National Academy of Science  
2101 Constitution Avenue  
Washington, D. C.

*sent 4/22/63*

We shall have a short faculty meeting at noon Friday 26th. I very much hope that you can attend. Best wishes,

Robert Oppenheimer

June 13, 1962

Professor Hassler Whitney  
The Institute for Advanced Study

Dear Professor Whitney:

Dr. Oppenheimer has asked me to write you about your pension arrangements. At the meeting of the Board of Trustees held in Princeton on April 6 and 7, the Board voted to increase faculty salaries to \$25,000 and increase the minimum guaranteed pension through TIAA-CREF to \$15,000.

The standard 5% contribution by the professor matched by a 5% contribution by the Institute for the balance of your tenure as an active professor will not produce the minimum guarantee, and the Institute is therefore adding \$133.17 to the monthly payments in your behalf to TIAA-CREF.

You should know also that the Major Medical contract with TIAA has been modified to reduce the deductible after Blue Cross from \$200 to \$100.

Cordially yours,

Minot C. Morgan, Jr.  
General Manager

MCM:lw

Whitney

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

July 12, '60

Dear Robert,

I was one of the two members of the organizing comm., representing the International Math. Union. The colloquium was in conjunction with the 50th anniversary of the Swiss Math. Society, at this time, G. de Khan, J. Leray and I were made honorary members of the Swiss Math. Society.

HW

cc Mr. Morgan

20 April 1959

Dear Professor Whitney:

The Trustees of the Institute, meeting on April 18th, have fixed your salary, and that of your colleagues, at \$22,500 a year, starting July 1, 1959.

I am glad to tell you the good news.

Very sincerely,

Robert Oppenheimer

Professor Hassler Whitney  
The Institute for Advanced Study

20 April 1959

Dear Professor Whitney:

The Trustees of the Institute, meeting on April 18th, have by formal action asked me to express to you their appreciation and gratitude for your discussion with them. I should like to add my own.

Very sincerely,

Robert Oppenheimer

Professor Hassler Whitney  
The Institute for Advanced Study

*Whitney*

3 June 1957

Dear Professor Whitney:

As you know, the Trustees of the Institute for Advanced Study have been considering the adequacy of retirement and pension arrangements, both for the Faculty and for others who are in the employ of the Institute. Their deliberations have led to some changes in policy, all of which should be favorable for the employee, and some of which affect you.

1. The mandatory age for retirement for members of the Faculty has been advanced to the June 30th following their 70th birthday.

2. The Institute will allocate the maximum that it may, which is fifty per cent of the total annual contribution that you and the Institute make toward your retirement, to College Retirement Equities Fund. This fund has been established in order that beneficiaries may be provided with a hedge against inflation, through investment in equities whose value and whose income have increased with the years in the past, and are expected to increase in the future. The Trustees are aware of the fact that benefits from C.R.E.F. vary as provided in C.R.E.F. contracts, and are not guaranteed as those accruing under T.I.A.A.; but they believe that, under the C.R.E.F.-T.I.A.A. arrangement, your total pension is far more likely to exceed that provided by T.I.A.A. alone than to fall below this sum.

Within the next months you will receive a new contract from T.I.A.A. describing the provisions under which your retirement benefits will be paid. Should you have any questions about that contract or this letter, or the matters touched upon in it, please do not hesitate to let me know.

Very sincerely,

Robert Oppenheimer

Professor H. Whitney  
Institute for Advanced Study

*Whitney*

ANNOUNCEMENT OF  
UNITED STATES EDUCATIONAL EXCHANGE GRANT

The Department of State has announced the awarding of a grant to

Name: Hassler Whitney, Ph.D.  
Title: Professor of Mathematics  
Institution in U.S.: Institute for Advanced Study  
Purpose of Grant: To lecture in Mathematics  
Institution Abroad: College of France  
Paris, France

The award is made under the provisions of Public Law 584, 79th Congress, the Fulbright Act. It is one of approximately 400 grants for lecturing and research abroad included in the program for the academic year 1956-57. As provided by the Act, all candidates are selected by the Board of Foreign Scholarships, the members of which are appointed by the President. Lecturers and research scholars are recommended for the Board's consideration by the Conference Board of Associated Research Councils, which has been designated to receive and review the applications of candidates in these categories.

The funds used for carrying out the program under the Fulbright Act are certain foreign currencies or credits owed to or owned by the Treasury of the United States. Under executive agreements with foreign governments, programs are currently in effect in the following countries: Australia, Austria, Belgium and Luxembourg, Burma, Ceylon, Denmark, Finland, France, Germany, Greece, India, Iraq, Italy, Japan, the Netherlands, New Zealand, Norway, Pakistan, the Philippines, Thailand, and the United Kingdom.

*Whitney*

ADDRESS OFFICIAL COMMUNICATIONS TO  
THE SECRETARY OF STATE  
WASHINGTON 25, D. C.



DEPARTMENT OF STATE  
WASHINGTON

In reply refer to  
IES

January 16, 1957

Dear Dr. Oppenheimer:

It is a pleasure to inform you that a member of your staff, Hassler Whitney, has been selected by the Board of Foreign Scholarships to receive an award to participate in the International Educational Exchange Program under the Fulbright Act. Enclosed is a copy of an announcement giving details of this award.

A copy of this letter and three copies of the announcement are being sent to the Fulbright representative on your campus with the request that he publicize this award in a suitable manner.

From time to time you may receive announcements of similar grants to other individuals connected with your institution. Applicants for lecturing and research grants who have not yet been notified of the outcome of their candidacies may be assured that applications are being processed as rapidly as possible and that they may expect to be informed of decisions within the near future.

The cooperation of the colleges and universities in the educational exchange program is appreciated.

Sincerely yours,

For the Secretary of State:

*J. Manuel Espinosa*

J. Manuel Espinosa, Chief  
Professional Activities Division  
International Educational Exchange Service

Enclosure:

Announcement of United States  
Educational Exchange Grant.

Dr. J. Robert Oppenheimer,  
Director, Institute for Advanced Study,  
Princeton, New Jersey.

Whitney

THE INSTITUTE FOR ADVANCED STUDY  
PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

Jan 5, 1956

Dear Robert,

During the fall I was asked by Leray and Lichnerowicz if I would care to lecture at the Collège de France in April-June of 1957. A formal invitation is probably now in process. I had in mind that I might obtain Fulbright aid.

It was then too late to apply for a Fulbright grant in the normal fashion, and I have recently learned that there is a considerable excess of strong candidates for France for the next academic year. If I cannot lecture that year, they would like to have me the following year. On the other hand, I think that for several reasons next year might be considerably better for me than the following.

Since a visit in Paris would be to my benefit mathematically also, perhaps aid from the Institute should be considered. I am writing to ask your advice in this matter.

Sincerely yours,

Hassler

OK

settled

Whitney

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March 29, 1955

Dr. J. Robert Oppenheimer  
Institute for Advanced Study  
Princeton, New Jersey

Dear Dr. Oppenheimer:

I am returning herewith your copy of Hassler Whitney's notes for his course on "An Introduction to Pure Mathematics." Although I am no mathematician, I read the first 50 pages with considerable interest, and I am certain that when they are revised the notes will make a very exciting and useful little book. I spoke with Professor Whitney about them, and he apparently has made a promise to another publisher to let him have the revised manuscript. Of course I was disappointed, but at least it is good to know that the book will some day be published. Meanwhile, I want to thank you for making this suggestion, and I hope you will not hesitate to suggest other possibilities of books which would be appropriate for us.

It was pleasant to talk with you the other day, and I believe such conversations from time to time may help us to continue the fruitful cooperation of the Institute and the Press.

Sincerely yours,

*Herbert S. Bailey, Jr.*  
Herbert S. Bailey, Jr.

HSB-B

THE INSTITUTE FOR ADVANCED STUDY  
PRINCETON, NEW JERSEY

SCHOOL OF MATHEMATICS

March 30

Dear Robert,

I am very sorry the faculty meeting completely slipped my mind yesterday.

If I may record my favorable vote for the appointment of Herlert Block, please let me do so.

Sincerely,  
Hassler

copy to Miss Trinterud

April 6, 1953

Dear Professor Whitney:

At a regular meeting of the Board of Trustees of the Institute for Advanced Study on April 3, 1953, it was voted:

(1) To make available to you, as to all members of the Faculty, \$1,000 a year as a fund for your professional travel. This fund, if not required by you in any one year, may accumulate, but will not at any time exceed \$3,000. It is to be available to you only for these purposes, and only as long as you are a member of the Faculty of the Institute;

(2) To alter the provisions for your retirement--as for all members of the Faculty--in that retirement, which has until now been mandatory as of the June 30th following your 65th Birthday, will now become optional with you from your 65th Birthday on, and will be mandatory only as of the June 30th following your 68th Birthday.

Yours sincerely,

Robert Oppenheimer

Professor Hassler Whitney  
Institute for Advanced Study  
Princeton, N. J.

M E M O R A N D U M

*F. Whitney*

TO: Dr. Oppenheimer

FROM: L. Trinterud

SUBJECT: Professor Whitney

DATE Aug. 8, 1952

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When making arrangements about his salary Professor Whitney asked me to pay \$600 out of his check each month to a bank in Boston as alimony to his former wife. I agreed to do this, but when Mr. White, our auditor, noticed it, he objected to my doing so, saying he thought it inadvisable for the Institute to undertake this responsibility. I have no doubt Prof. Whitney's own bank would do this for him for a very small fee.

Please advise whether or not I should continue to make these payments.

Reply to L. T. 8/11/52; RO suggested following advice of our auditors

copy to Miss Underwood  
Mrs. Barnett

*Jae  
Whitney*

March 20, 1952

Dear Professor Whitney:

Thank you for your good note of March 19th. I am enclosing a copy of our formal letter of appointment to Mr. Wolfsohn. We have offered him a salary of \$3,000, assuming that he is unmarried. I know that both Miss Underwood, our Secretary in the School of Mathematics, and Mrs. Barnett, who is handling our housekeeping problems, will be in touch with Wolfsohn to help with the arrangements of his coming to Princeton.

With warm good wishes,

Robert Oppenheimer

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Mass.

HARVARD UNIVERSITY

CAMBRIDGE 38, MASS.

3.520

DEPARTMENT OF  
MATHEMATICS

March 19, 1952

Prof. R. Oppenheimer  
Institute for Advanced Study  
Princeton, N. J.

Dear Prof. Oppenheimer:

I have written to Mr. Norman Wolfsohn, of the University of Maryland, asking him if he would care to be my assistant for the coming year at the Institute. He replies that he would. His address is:

4215 Sheridan st., University Park,  
Hyattsville, Md.

I would be glad if you would invite him officially, giving him any required information.

He should receive his Ph. D. degree from Harvard this June.

Sincerely yours,

*Hassler Whitney*  
Hassler Whitney

HARVARD UNIVERSITY  
CAMBRIDGE 38, MASS.

*Joe  
Whitney*

DEPARTMENT OF  
MATHEMATICS

July 19, 1951

Prof. R. Oppenheimer  
Fuld Hall  
Institute for Advanced Study  
Princeton, N. J.

Dear Prof. Oppenheimer:

I am glad to say that I accept with pleasure the offer to become a permanent member of the Institute. Since I am committed to Harvard for the coming academic year, and Harvard's fiscal year starts July 1, I accept as of July 1, 1952. I suppose this is all right with the Institute.

As you may know, I will be lecturing in France next fall, as Exchange Professor from Harvard. My addresses will be: \*

Aug.-Sept: American Express, Lausanne, Switzerland.

Till Oct. 20: American Express, London.

Till about Jan. 20: Institut Henri Poincaré, 11 rue Pierre Curie, Paris (5).

Sincerely yours,

*Hassler Whitney*  
Hassler Whitney

\* I leave here July 25.

copy to Mr. Fleming  
Miss Trinterud  
Miss Underwood

July 23, 1951

*For  
Whitney*

Dear Professor Whitney:

Thank you for your note of the 19th, welcome because it came so early, and multiply welcome because of the good news. I am delighted and look forward to the time when you will be here.

With warm good wishes,

Robert Oppenheimer

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge, Mass.

copy for Professor Morse

*For  
Whitney*

June 7, 1951

Dear Professor Whitney:

It was very good to have your letter of May 31st. We are all content that you should be thinking with some seriousness of joining us at the Institute.

You will have had a note from Marston Morse about your visit. Perhaps you ought to know that a good many people will be away, not only those who are in Europe for the summer, but von Neumann and I as well, just for next week. It is probable that that will not make you wish to postpone your visit; but I thought you would want to know. I believe that von Neumann and I will both be here in early July; but I do not know Morse, Selberg and Montgomery's plans in enough detail to urge you to wait.

With every good wish,

Robert Oppenheimer

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Mass.

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

Copy: ✓ Mrs. Russell

June 4, 1951

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Massachusetts

Dear Hassler:

I am delighted that you are coming down around June 13. Let me know when you are coming and I will meet you at the train and will also make reservations for you at the Nassau Tavern.

You will have a fine time in France next year, and I hope you will come back to the Institute.

As ever,

Marston Morse

MMcdu

*Shelby  
Montgomery  
Morse*

*V. Newman - away 1974*

HARVARD UNIVERSITY

CAMBRIDGE 38, MASS.

DEPARTMENT OF  
MATHEMATICS

Eliot House N-21

Cambridge 38, Mass.

May 31, 1951

Math  
✓ Prof. J. Neumann  
✓ Prof. Morse  
✓ Prof. Neustrom  
✓ Prof. Selberg  
H. R. to O. S.

Dear Prof. Oppenheimer:

I am of course greatly honored and pleased at the offer from the Institute of Advanced Study. I will think of this in terms of July 1, 1952. This fall I ~~be~~ will be Exchange Professor to France from Harvard, giving lectures at the Sorbonne; I have a course scheduled to teach here in the Spring term.

Since I think very highly of Harvard and have become attached to the region, it is difficult to make up my mind. I will plan to let you know by mid November, if that is all right.

Though I know Princeton fairly well, The prospect of moving there permanently puts a new light on the matter. I believe I will take a short trip down, so that I can picture the place with this in mind. About June 13 would probably be a good time for me. I would be glad to know if there will be any members of the Institute there at that time. Another possibility would be early July. I sail for Europe July 26th.

Sincerely yours,

Hassler Whitney  
Hassler Whitney

HARVARD UNIVERSITY

CAMBRIDGE 38, MASSACHUSETTS

*For  
Whitney*

OFFICE OF THE PROVOST

May 31, 1951

Dear Mr. Oppenheimer:

I very much appreciate your courtesy in letting me know about and giving me the details of your offer to Hassler Whitney.

The decision is, of course, Whitney's to make, and I am confident that he will make it almost entirely in terms of whether at the Institute or at Harvard he can better advance his scientific work.

He is very happy at Harvard. We consider him as one of our top professors, and he is given treatment as such. He likes the freedom which prevails in this Faculty and the colleagues with whom he is associated. He has, as you perhaps know, refused offers from Chicago and Yale. I doubt if he would ever leave Harvard for another university. But the Institute for Advanced Study is another story, and it may well be that being the type of person he is, he will decide that his work will advance better in Princeton than in Cambridge. If such is his decision, no one here will quarrel with it, painful as it would be to lose him.

Sincerely yours,

*Paul H. Buck*

Provost

Dr. J. Robert Oppenheimer  
Institute for Advanced Study  
Princeton, New Jersey

Copy to Mr. Fleming  
Miss Trinterud  
Miss Underwood

May 23, 1951

Dear Professor Whitney:

It gives me great pleasure to invite you to a Professorship at the Institute for Advanced Study in our School of Mathematics. This invitation I make with the unanimous approval of the Faculty of the Institute and of its Board of Trustees.

As you perhaps know, the formal duties of a Professorship here are not arduous; and its primary purpose is to enable you to continue your own beautiful researches and to collaborate with those of your colleagues whom you may wish to have associated with you at the Institute. The Professors of the Institute are, with me, responsible for formulating its academic policy; but since we are a very small institution, this obligation has never proved burdensome.

The appointment to a Professorship is of course a permanent one. At the present time, Professors retire at the end of the fiscal year following their 65th birthday, though some revision in this may be expected in the future. We think it improbable that should you accept this invitation you would be free to come before the academic year 1952-53; but we would be happy to have you assume the Professorship as soon as this can conveniently be arranged. The salary attached to the position is \$18,000.00 per year; and the Institute would be prepared to contribute 5% of this amount yearly toward the purchase of an annuity after your retirement, provided that you would be willing to make a like contribution. Professors at the Institute may have an assistant, if they so desire, to work with them on their own research problems. As I have indicated before, Professors participate in selecting the Institute's Members in the field in which they are concerned. We have as you perhaps know an adequate working library in mathematics, and have access to the Firestone Library at Princeton University.

This long account may not adequately answer the practical questions which will concern you in your reply to this invitation. Your many

- 2 -

friends here and I will be glad to try to answer those questions as they arise; but I do not want to make this letter an unduly complicated one. I do want to assure you that this invitation comes to you with the warm concurrence of all your colleagues, and with the admiration and high expectation of the mathematicians.

With every warm good wish,

Robert Oppenheimer

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Mass.

- 2 -

friends here and I will be glad to try to answer those questions as they arise; but I do not want to make this letter an unduly complicated one. I do want to assure you that this invitation comes to you as an expression <sup>of</sup> ~~the~~ admiration of your colleagues in mathematics, and with the warm concurrence and high expectation of all of us.

With every warm good wish,

Robert Oppenheimer

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Mass.

Copy for Provost Paul Buck  
Harvard University

May 23, 1951

Dear Provost Buck:

Since this is one of the rare occasions in which there is a conflict between my interests as an Overseer and my obligations as Director, I thought it right to let you know what we were up to. We are fully aware of the possibility that Whitney will not want to accept our offer. We did think you should know that we had made it.

With every good wish,

Robert Oppenheimer

Provost Paul Buck  
Harvard University  
Cambridge 38, Mass.

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY

Copy:  Mrs. Russell

May 23, 1951

Professor Hassler Whitney  
Department of Mathematics  
Harvard University  
Cambridge 38, Massachusetts

Dear Hassler:

In a few days you will receive a formal invitation to become Professor of Mathematics at the Institute for Advanced Study. It gives me great pleasure to know that there may be a possibility that you will cast your lot with us. Everyone in the School of Mathematics is most enthusiastic about the decision to tender you this invitation.

You doubtless know that Leray will be with us as Visiting Professor the first term for each of the next five years, and Professor Weyl will return in January for the second term for several more years. I am asking Miss Underwood to send you the list of mathematicians whom we are certain will be Members at the Institute next year.

You doubtless know how free we are here about work. You write, think or lecture, according to your need, and you can travel and speak in a long summer.

You know so much about Princeton I need tell you little more. The interest in your work has always been high around here. With your assistant, with our young Members whom you will help select, with the visiting Fellows, and Office of Naval Research members, you will find plenty of mathematical company.

We are all eager to get your answer.

As ever,

Marston Morse

Encdu  
Enclosure

THE INSTITUTE FOR ADVANCED STUDY

Princeton, New Jersey

SCHOOL OF MATHEMATICS

HASSLER WHITNEY

Hassler Whitney was born March 23, 1907 in New York City. His undergraduate studies were at Yale, and he received his Ph.D. degree from Harvard in 1932. He was a National Research Council Fellow at Princeton University in 1931-32 and at Harvard in 1932-33. At Harvard he was successively Instructor, 1933-35, Assistant Professor, 1935-40, Associate Professor, 1940-46, and Professor, 1946-52. He accepted the appointment as Professor of Mathematics at the Institute for Advanced Study in 1952.

Whitney's interest has been mainly in topology and its applications, especially applications to differentiable manifolds. His methods are geometric and intuitive and his work is marked by great originality and strength. He is regarded by mathematicians throughout the world as an outstanding scholar, a leader in his field, and in the front rank of mathematicians of his age. His lectures, writing and personal contacts have been of wide influence. Several mathematicians, including Chern, Eilenberg, and Steenrod have been greatly stimulated by him and the same is true of a number of younger people at Harvard and elsewhere.

A large part of his work has been on differentiable manifolds and it is on this subject that he gave the Colloquium Lectures before the American Mathematical Society at Cornell in 1946.

He helped develop the subject of cohomology and made some of its first applications. He has made important contributions to the problem of determining whether or not two given objects in a space can be continuously deformed so that they coincide.

Hassler Whitney

Born March 23, 1907

Ph. B. Yale 1928

Mus. B. Yale 1929

Ph. D. Harvard 1932

Hon. Sc. D. Yale 1947

National Research Council Fellow, Princeton 1931-2, Harvard 1932-3.

Instr. Harvard 33-35, Assistant Prof. 35-40, Assoc. Prof. 40-46, Prof. 46 --

Whitney's interest has been mainly in topology and its applications especially applications to differentiable manifolds. His methods are geometric and intuitive and his work is marked by great originality and strength. He is regarded by mathematicians throughout the world as an outstanding scholar, a leader in his field, and in the front rank of mathematicians of his age. His lectures, writings, and personal contacts have been of wide influence. Several mathematicians, including Chern, Eilenberg, and Steenrod have been greatly stimulated by him and the same is true of a number of younger people at Harvard and elsewhere.

This statement attempts to describe mainly in non-technical language some of his interests which can be most easily so described and it is not intended to be an exhaustive or well rounded account.

As mentioned above, a large part of his work has been on differentiable manifolds and it is on this subject that he gave the colloquium lectures before the American Mathematical Society at Cornell in 1946. A differentiable manifold is a smooth geometric figure of any number of dimensions, some examples in low dimensions being the circle, the surface of a sphere or the surface of a ring. These manifolds arise in many ways in algebra, geometry, and analysis. To take one illustration, each point of a manifold may represent

-2-

the state of a mechanical system, and the manifold as a whole is then the totality of possible states of the system. Changes in the system cause the points to move about on the manifold. These facts were largely the motivation for the original work in the subject by Poincare. Locally a manifold is like a euclidean space (euclidean space is the ordinary space of our experience or its counterpart in higher dimensions) of the same dimension but taken in its entirety there may be great differences and the study of these differences is one of the tasks of topology.

There are two different ways to give a precise definition of differentiable manifolds, the first by abstract postulates and the second by regarding the manifold as imbedded in euclidean space by means of equations. Whitney showed that these two points of view come to the same thing so that it is permissible to adopt whichever is more convenient. He showed first that an abstract  $n$ -dimensional manifold can be imbedded in euclidean space of  $2n+1$  dimensions and later that  $2n$  dimensions is sufficient. The question of how many dimensions are necessary to imbed a particular manifold is very difficult and almost all the information known has been obtained by Whitney. He has an example of a 4-dimensional manifold (the complex projective plane) which can not be imbedded in 7-dimensional space.

At each point of a manifold there is a collection of tangents which themselves form a space or a fibre, called the tangent space at the point. The totality of these tangent spaces or fibres forms a larger space called a fibre space, and an examination of this larger space has been fruitful. The idea of fibre spaces, that is spaces built up by layers of other spaces, had many origins but Whitney was one of the first, and most successful, to exploit it in this direction. He and others used these large spaces to find properties of the original manifold.

-3-

Many of his early papers were on one-dimensional complexes or graphs with some attention to the four color map problem. In another early paper he gave a characterization of a plane in the language of combinatorial topology. At about the same time he studied families of curves of the kind which are solutions of differential equations. His next papers were on properties of derivatives and were at least partly in preparation for his work on differentiable manifolds. He remarked in 1936 (in Scripta Mathematica) that he regarded his best papers up to that time as numbers 5, 10, 15, 18, 25, and 28 of the bibliography.

He helped develop the subject of cohomology and made some of its first applications. He has made important contributions to the problem of determining whether or not two given objects in a space can be continuously deformed so that they coincide.

Whitney has several hobbies including mountain climbing and music. It may be of interest that he is a descendent of Eli Whitney, inventor of the cotton gin, and of Simon Newcomb, the mathematical astronomer. His honorary degree from Yale came at the centennial celebration of the founding of the Sheffield scientific school. At about this time he was offered a Sterling professorship at Yale but did not accept. During the war he carried on mathematical research for the NDRC. He was invited to give an hour address at the International Congress of Mathematicians held at Harvard in 1950, and he was chairman of the conference on topology, held at the congress. He also addressed international meetings of topologists in Paris in 1948 and in Moscow in 1935. He has been vice president of the American Mathematical Society and is a member of the National Academy of Sciences and the Philosophical Society.

BIBLIOGRAPHY OF HASSLER WHITNEY

1. The coloring of graphs, NAS Proc., v. 17, 1931, 122-125.
2. Non-separable and planar graphs, NAS Proc., v. 17, 1931, 125-127.
3. A theorem on graphs, A.M., s.2, v. 32, 1931, 378-390.
4. Note on Perron's solution of the Dirichlet problem, NAS Proc., v. 18, 1932, 68-70.
5. Non-separable and planar graphs, AMS Trans., v. 34, 1932, 339-362.
6. Congruent graphs and the connectivity of graphs, A.J.M., v. 54, 1932, 150-168.
7. Regular families of curves I, NAS Proc., v. 18, 1932, 275-278.
8. Regular families of curves II, NAS Proc., v. 18, 1932, 340-342.
9. A logical expansion in mathematics, AMS Bull., v. 38, 1932, 572-579.
10. The coloring of graphs, A.M., v. 33, 1932, 688-718.
11. A characterization of the closed 2-cell, AMS Trans., v. 35, 1933, 261-273.
12. A set of topological invariants for graphs, A.J.M., v. 55, 1933, 231-235.
13. On the classification of graphs, A.J.M., v. 55, 1933, 236-244.
14. 2-Isomorphic graphs, A.J.M., v. 55, 1933, 245-254.
15. Regular families of curves, A.M. s.2, v. 34, 1933, 244-270.
16. Characteristic functions and the algebra of logic, A.M., s.2, v. 34, 1933, 405-414.
17. Planar graphs, Fundamenta Mathem., v. 21, 1933, 73-84.
18. Analytic extensions of differentiable functions defined in closed sets, AMS Trans., v. 36, 1934, 63-89.
19. Derivatives, difference quotients and Taylor's formula, AMS Bull., v. 40, 1934, 89-94.
20. Differentiable functions defined in closed sets I, AMS Trans., v. 36, 1934, 369-387.
21. Derivatives, difference quotients and Taylor's formula I, A.M., s.2, v. 35, 1934, 476-481.
22. Functions differentiable on the boundaries of regions, A.M., s.2, v. 35, 1934, 476-481.
23. On the abstract properties of linear dependence, A.J.M., v. 57, 1935, 509-533.
24. On the abstract properties of linear dependence in Euclidean space, NAS Proc., v. 20, 1935, 100-105.

24. Differentiable manifolds in Euclidean space, NAS Proc., v. 21, 1935, 462-464.
25. Sphere-spaces, NAS Proc., v. 21, 1935, 464-468.
26. A function not constant on a connected set of critical points, Duke Math. Journ., v. 1, 1935, 514-517.
27. Differentiable functions defined in arbitrary subsets of Euclidean space, AMS Trans., v. 40, 1936, 309-317.
28. Differentiable manifolds, A.M., s.2, v. 37, 1936, 645-680.
29. The imbedding of manifolds in families of analytic manifolds, A.M., s.2, v. 37, 1936, 865-878.
30. On regular closed curves in the plane, Compositia Math. 4, 1937, 276-284.
31. Matrices of integers and combinatorial topology, Duke Math. Journ., 3, 1937, 35-45.
32. On the maps of an  $n$ -sphere into another  $n$ -sphere, Duke Math. Journ., 3, 1937, 46-50.
33. The maps of an  $n$ -complex into an  $n$ -sphere, Duke Math. Journ., 3, 1937, 51-55.
34. On products in a complex, Proc. Nat. Acad. of Sci., 5, 1937, 285-291.
35. Analytic coordinate systems and arcs in a manifold, Annals of Math. 38, 1937, 809-818.
36. Topological properties of differentiable manifolds, Bull. Am. Math. Soc., 43, 1937, 785-805.
37. A numerical equivalent of the four color problem, Monatshefte fur Math. and Phys. 3, 1937, 207-213.
38. Cross sections of curves in 3-space, Duke, Math. Journ., 4, 1938, 222-226.
39. On products in a complex, Annals of Math. 39, 1938, 397-432.
40. Tensor products of abelian groups, Duke Math. Journ., 4, 1938, 495-528.
41. Some combinatorial properties of complexes, Proc. Nat. Acad. of Sci. 26, 1940, 143-148.
42. On the theory of sphere-bundles, Proc. Nat. Acad. Sci. U.S.A. 26, 1940, 148-153.
43. On regular families of curves, Bull. Amer. Math. Soc. 47, 1941, 145-147.
44. On the topology of differentiable manifolds, Lectures in Topology, U. of Michigan Press, 1941, 101-141.

45. Differentiability of the remainder term in Taylor's formula, *Duke Math. Journ.*, 10, 1943, 153-158.
46. Differentiable even functions, *Duke Math. J.*, 10, 1943, 159-160.
47. The general type of singularity of a set of  $2n-1$  smooth functions of  $n$  variables, *Duke Math. J.*, 10, 1943, 161-172.
48. Topics in the theory of Abelian groups. I. Divisibility of Homomorphisms, *Bull. Amer. Math. Soc.*, 50, 1944, 129-134.
49. On the extension of differentiable functions, *Bull. Amer. Math. Soc.*, 50, 1944, 76-81.
50. The self-intersections of a smooth  $n$ -manifold in  $2n$ -space, *Ann. of Math. (2)*, 45, 1944, 220-246.
51. The singularities of a smooth  $n$ -manifold in  $(2n-1)$ -space, *Ann. of Math. (2)*, 45, 1944, 247-293.
52. Algebraic topology and integration theory, *Proc. Nat. Acad. Sci. U.S.A.* 33, 1947, 1-6.
53. Geometric methods in cohomology theory, *Proc. Nat. Acad. Sci. U.S.A.* 33, 1947, 7-9.
54. Complexes of manifolds, *Proc. Nat. Acad. Sci. U.S.A.* 33, 1947, 10-11.
55. On ideals of differentiable functions, *Amer. J. Math.* 70, 1948, 635-658.
56. Relations between the second and third homotopy groups of a simply connected space, *Ann. of Math. (2)* 50, 1949, 180-202.
57. Classification of the mappings of a 3-complex into a simply connected space, *Ann. of Math. (2)* 50, 1949, 270-284.
58. An extension theorem for mappings into simply connected spaces, *Ann. of Math.*, (2) 50, 1949, 285-296.
59. La topologie algebrique et la theorie de l'integration, *Topologie algebrique*, 1949, 107-113.
60. With L. H. Loomis, An inequality related to the isoperimetric inequality, *Bull. Amer. Math. Soc.* 55, 1949, 961-962.