

PROPOSAL

ARMY MATHEMATICS CENTER

Engineering Research Institute
University of Michigan
Ann Arbor, Michigan

August 18, 1955

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ARMY MATHEMATICS CENTER

This proposal for an Army Mathematics Center at the University of Michigan has been prepared and is being presented on the basis of an invitation from Ivan R. Hershner, Jr., Chairman Ad Hoc Advisory Committee on the Army Mathematics Center, to President Harlan Hatcher. Consideration of the establishment of the Army Mathematics Center at the University of Michigan has demonstrated the important mutual advantages that could develop from a joint arrangement between the Department of the Army and the University. This proposal presents information and methods to accomplish desirable results for both the Army and the University in the field of Mathematics.

BACKGROUND AND RESOURCES

General Organization and Information about the University of Michigan:

The University of Michigan, as it is now called, was first organized in 1817. An act of the legislature of March 20, 1837 located the institution at Ann Arbor. The University has outgrown its original 40 acre campus and has expanded into additional area adjacent to and greater than the original campus. Approximately three years ago an additional 387 acres were acquired as a new campus area located two miles north and east of the present campus. Several new buildings have been completed on this campus (North Campus) and more are planned for construction in the immediate future.

At present, the University of Michigan is governed by the Regents of the University of Michigan, who are a constitutional corporation under the State of Michigan. The Regents are elected by popular vote for an eight-year term of office, as an honorary position.

The chief administrative officers of the University are the President (Dr. Harlan Hatcher), the Vice-President and Dean of Faculties (Dr. Marvin L. Niehuss), the Vice-President in charge of Business and Finance (Dr. W. K. Pierpont) and the Vice-President in charge of Student Affairs (Mr. J. A. Lewis).

The University of Michigan is a state-supported institution receiving funds as approved by the State Legislature, and from tuition, endowments, grants and gifts. The enrollment for the past semester was about 18,000 students.

Department of Mathematics:

The Department of Mathematics of the University of Michigan, with 51 regular staff members, and about 40 pre-doctoral students and teaching fellows, is one of the largest departments of mathematics in the country. In addition to size, it also ranks very high in stature and in the standing of its members; i.e., it provides a center of mathematical activity. The interests of its members are diverse, and every important field of mathematical endeavor is represented. In addition to having a high concentration of effort in the field of topology, there are nationally known figures in the field of analysis, algebra, linear spaces, applied mathematics, statistics and probability, and actuarial mathematics. In the last two fields the department did pioneer work.

Research is encouraged among the members of the staff, and there is considerable exchange of ideas and mutual stimulation on the parts of staff members. In addition to regular graduate instruction (there are about 140 graduate students registered in the department) there are numerous seminars, which are conducted not only for the benefit of graduate students, but also aid in enlarging the background of members of the staff. The Mathematics Colloquium offers opportunity for staff members to present their researches, and also for inviting visitors from this country and abroad, to present their recent results. The general departmental atmosphere is congenial.

There is every reason to believe that the members of an Army mathematical research center would be welcome in this depart-

ment, that they would be able to find staff members of similar interest with whom they could discuss their private mathematical problems, and possibly get help on programmatic material. They would be welcome to participate in departmental activities, and in turn contribute to the mathematical activities of the group.

Engineering Research Institute:

From the Regents Bylaws concerning the Engineering Research Institute:

"In the development and continuation of its research projects, the Institute shall have due regard for the integration of research with the educational programs of the departments of instruction. It shall carry on its research activities, insofar as possible with the assistance of members of the faculty and for this purpose shall work with and through the regularly constituted authorities of the schools and colleges concerned. The terms and conditions of employment shall be subject to the approval of the respective departments and in accord with general policies approved by the Engineering Research Council and the Board of Regents. Employment in the Institute shall be open to graduate and undergraduate students under conditions satisfactory to the Graduate School, the Department of instruction, and the Institute, respectively, provided that such employment shall not interfere with academic tasks."

At the present time, about 260 graduate students and 240 undergraduate students working for their degrees are employed

by the Engineering Research Institute. Men employed or on a visiting basis at the Center would be eligible to work toward advanced degrees. The University of Michigan practices permit a combination of work towards advanced degrees with employment on research projects, the amount of credit courses permitted being dependent on the percentage of time in employment.

Established procedures and experience have demonstrated the success of the arrangements. The appointment of research staff members is made by the Regents, subject to the availability of funds from outside sources (e.g., funds available for support of the Army Mathematics Center.) Thus, tenure of the research staff is contingent upon the availability of the support funds.

Appointments in the teaching staff originate in the teaching department concerned. The research worker on a part-time professorship appointment would be employed for a specified period, having all the rights and privileges except tenure. Over a thirty-five year period the University has developed an equitable method of salary adjustments to coordinate full-time research and nine-month teaching salaries. Experience has shown no difficulty from a salary standpoint of attracting highly-qualified research staff members.

The full-time research personnel are employed on a twelve-month basis with a one-month vacation and an equitable salary, so that they are not engaged in outside consulting activities. University policy prohibits outside consulting by twelve-month employees. There are approximately 400 full-time research people employed by Engineering Research Institute on this basis.

The University research personnel have a very favorable

University retirement plan. In addition to this, all University employees are eligible for the group insurance with the Prudential Company, available at a very reasonable rate.

A listing of all contracts in force between the University of Michigan and the Department of the Army from July 1, 1953 through July 1, 1955 is appended to this proposal.

Mathematical Research at the University:

In connection with the sponsored research programs, the University of Michigan has various over-all research mathematical activities in the Willow Run Laboratories and on the campus, some of which have a definite bearing on the present problems for the Army Mathematics Center, including data processing, systems analysis, analog simulation and control systems, turbulence, electromagnetic theory, wave propagation, surveillance communication, weapon-system accuracies, surveillance requirements and a study of the surveillance characteristics of military targets. These groups involve approximately 65 research people engaged in the mathematical problems associated with this work.

Some fundamental mathematics sponsored projects such as linear vector spaces of elliptic mappings, geometry of numbers, mathematical analysis, sub-harmonic, harmonic and analytic functions, and the topology of manifolds are supervised by faculty members. However, additional mathematical effort is connected with contracts of a larger scope such as those previously mentioned, in which the mathematics staff is participating on a consulting basis.

There are many University research programs being investigated by the Department of Mathematics faculty as part of

their regular University activities. The number of technical papers from this source is steadily increasing. To provide additional opportunities for publication, the Mathematics Department sponsors "The Michigan Mathematics Journal."

There are many other mathematical problems and investigations that are spread practically through the entire University. The Astronomy Department is using various statistical methods for studying Astrophysics. In the Philosophy Department, research investigations are being carried on in logic using the tools of mathematics. In the Engineering College, heat-transfer, fluid flow, chemical separations and plastic deformation problems are being studied.

The Graduate School confers the third largest number of Ph.D.'s in Mathematics of any school in the country, according to the data compiled in "The American Universities and Colleges" published by the American Council on Education, 1952.

Computer Facilities:

The wide range of the University's educational and research activities has led to the procurement and development of an extensive array of computer facilities, ranging from automatic desk calculators to electronic high-speed computers. These computer facilities present a significant research tool for the University's educational functions, including research, and for sponsored research on behalf of industry and government.

The most advanced electronic digital facility at the University is the University of Michigan Digital Automatic Computer.

(MIDAC) This is a general-purpose, high-speed, electronic digital computer and data processor. At present it has an acoustic memory storage of 512 words and a magnetic-drum storage capacity of 6,144 words. Two auxiliary systems have been developed for this computer, viz., an automatic programming system (MAGIC) and an easy programming procedure for the solution of many simple problems (EASIAC).

Several installations of standard IBM equipment in University laboratories are available including such units as tabulators, electronic calculators, electronic statistical machine, key punches, key verifiers, sorter, duplicator, and collator and other auxiliary equipment.

A general-purpose analog computing facility is maintained in connection with the research activities of the Engineering Research Institute. It is a consolidation of government-owned components procured and developed by Research Laboratories. The Aeronautical and Electrical Engineering Departments each operate electronic differential analyzers of small and medium size.

Library System:

The library system of the University includes the General Library, a number of divisional libraries operated as branches of the General Library, and several special libraries. The book collections total 2,300,000 catalogued or indexed volumes and pamphlets. The mathematical division libraries have complete sets of practically all mathematical journals of importance, and maintain subscriptions to practically all of the mathematical journals published at the present time. In addition, it

aims to have available all mathematical treatises of importance in the various branches of mathematical research. The Physics and Engineering divisional libraries likewise carry most publications in the respective technical and scientific fields. These specialized libraries, as well as the General Library, facilitate ease in specific reference material.

Raymond M. Hughes, President Emeritus of Iowa State College, prepared a study of American Graduate Schools conferring doctorate degrees, published in 1946, which rated the University of Michigan library facilities first in the country in its collection of mathematical periodicals and publications.

TECHNICAL STATEMENT OF WORK

The staff members of the Army Mathematics Center will devote approximately 1/2 time to programmatic research and 1/2 time to their own research interests, orientated principally to Army problems and fulfilling research requirements in the following areas:

1. Numerical analysis including engineering physics of high-speed computers.
2. Statistics and probability.
3. Applied mathematics and analysis.
4. Operations research including linear and non-linear programming, game theory and its applications, decision theory, information theory and optimizing problems.

(As general background material we would like to take this opportunity to mention a few men that have competence in these four fields, as listed in the Appendix.)

PROPOSAL

Organization:

The proposed Army Mathematics Center will be administered as a self-contained unit within the Engineering Research Institute of the University of Michigan.

1. The Director and Resident Staff will be employees of the University of Michigan appointed by the Regents of the University.
2. The work and program of the Army Mathematics Center will be determined by the Director, who in turn is responsible to the Administration of the University of Michigan through the Director of the Engineering Research Institute. The Director of the Army Mathematics Center will be aided by a policy and advisory committee composed of administrative officers and faculty members of the University of Michigan.
3. The program of the Center will be determined by the Director taking into consideration deliberations of the University committee and of a non-resident committee appointed by the Chief of Research and Development, Office of the Deputy Chief of Staff for Plans and Research, Department of the Army. (The non-resident committee is expected to be very helpful in coordinating the fundamental work of the Center with the mathematics research and development program of the Army.)
4. The support of the Center will be funds monitored by

the Research Division, Office of the Chief of Research and Development.

5. The Center will be created and operated by means of a contract between the University of Michigan and a designated contracting agency. It is proposed that the contract will be of a continuing nature with funds specified at least as follows:

First year: \$400,000

Second year: \$600,000

Third year: \$800,000

In the event that this project were to be terminated before completion of the contract period, a six-month phase-out period with funds will be provided to take care of the writing of final reports, disposition of property, and obtaining suitable employment for key personnel engaged at the Army Mathematics Center.

Objectives:

"The general objective in establishing the Center is to provide a nucleus of highly qualified mathematicians responsive to the Army, who will carry on investigations slanted toward general problems having Army relevance and who can be called upon for advice on specific problems which may be outside the specific capabilities of regular Army mathematics facilities. The goal of the Center should be the discovery, if possible, of techniques having direct applications to the Army's needs. The final measure of the success of this work will be its applicability."

The following are important functions which it is anticipated that this Center will perform:

1. Create a group of highly qualified mathematicians to work on long-range programmatic and non-programmatic problems of importance to the Army.
2. Supplement the mathematical research work of existing Army activities.
3. Serve as an educational and training facility for military and civilian Army research and development personnel.
4. Develop a reservoir of mathematicians experienced in Army requirements, the condition of vital significance in the event of hostilities.
5. Provide additional opportunities for University graduate students in mathematics.
6. Strengthen the University of Michigan's educational efforts in the field of Applied Mathematics.
7. Coordinate the activities of the Center with the educational program of the University.

The establishment of the Army Mathematics Center at the University of Michigan is considered by the administration and the faculty members concerned as an opportunity for the University to contribute to the solution of some of the basic mathematical problems of the Army and at the same time to the fundamental store of mathematical knowledge and to take an active part in the basic research education of qualified mathematicians.

Liaison with Army Centers:

The function of the Army Mathematics Center requires liaison with the various installations of the Army, especially on the part of the permanent staff of the Army Mathematics Center.

An important potential service of the Army Mathematics Center is the dissemination of information about new developments in mathematics and the applications in the work of the Army installations. One important possible use of the Army Mathematics Center in dissemination of information is through participation in short-term intensive programs. These programs can last anywhere from a few days to a few weeks and can be run with anywhere from two to ten lecturers. It is expected that staff members of the Army Mathematics Center would be available for participation in such programs both at the University and at various Army installations.

A second function of the liaison with Army installations is the discovery of problems in mathematics which may be suitable for further study by the Army Mathematics Center. Direct contact between the originating source and the Army Mathematics Center is important. To achieve this end, it is desirable that members of the Army Mathematics Center, especially permanent ones, devote a reasonable amount of time to visiting Army installations.

Director:

The Director of the Center should have the following qualifications:

1. Have a Ph.D. degree in Mathematics, Physics, or the equivalent.

2. Have a recognized record of contribution to at least two fields of the four of general interest to the Army Mathematics Center activities. This record may include publications, classified research reports, or special lectures.
3. Hold or have held the rank of Professor in a department of Mathematics, Physics, or equivalent in a recognized Institution.
4. Be at least 40 years of age.

As soon as the Army Mathematics Center is established, the first important operation will be the appointment of a suitable director. This may be a member of the present University staff, or someone from the outside having qualifications equal to or better than anyone available at the University of Michigan. In the event that the contract is awarded to the University of Michigan, a member of the University Mathematics Department may be designated to undertake the work of faculty supervisor for the initial phases of this program.

The heads of the four work areas included in the technical statement of the contract would be selected with the following qualifications in mind:

1. At least two men should have abilities equivalent to those required for appointment as an Associate Professor. The men being considered should have an established position in an appropriate scientific or technical society. For example, the man in Statistics and Probability might be a Fellow in the Institute for Mathematical Statistics, and the man in

Operations Research might be a Fellow in the Operations Research Society of America.

2. The category concerning Numerical Analysis should have two men, one on the mathematical side with actual experience in computation on modern machines; the other would have competence and experience in the design of machines. Even though it is contemplated that the machines used in this center may be rented from one of the large manufacturers, it is still desirable to have one permanent member of the staff whose interest is in the design and development of computing machines. He should be able to consider such questions as the possible simultaneous use of digital and analog computers and, in general, to serve as a consultant on questions of machine capabilities.
3. The man in Operations Research should have had experience in the applications of operational research in addition to theoretical knowledge of this particular field.

Housing of the Center:

During the initial phases of this program, space will be made available by the Mathematics Department to house the Director, and possibly two or three other research people. The MIDAC will be available on a limited basis for computing needs during the initial phases of the program. In the build-up to the proposed level of operation for the Army Mathematics Center, additional space facilities will have to be acquired.

Building space at the University is at a premium and the 15,000 to 20,000 sq. feet required for the Center are not available in presently constructed University buildings on the campus. There are three possibilities:

1. Recognizing the many advantages that will accrue by providing suitable housing for this project, it is proposed that consideration be given to having the University construct a North Campus building to be used exclusively for this research program. In such a case, the University would be reimbursed on an annual basis over a given period possibly six to ten years. It would be understood further that the Army would have exclusive use of this building during payment period unless, by mutual agreement between the Army and the University, other organizations would be allowed to occupy space, provided they assumed a pro-rated amount of the unrecovered costs.
2. Space requirements can also be met by utilizing local commercial rental property. There are currently available suitable facilities requiring only minor alterations, and located in the vicinity of the University.
3. The University has implemented an extensive new building program for the new North Campus (about \$8,000,000 has been spent in construction contracts during the last two years) and a modernization program on the

campus. It is probable that, at the appropriate time, housing for the Army Mathematics Center might be made available through one of the building programs.

Additional Notes:

The research staff, providing they are full-time employees of the University of Michigan, are allowed the same library privileges as a professor. In brief, these consist of stack privileges, and extended loan periods.

The Dean of the Graduate School issues a letter to guests of the University who hold a Ph.D. or equivalent. The privileges in this connection are:

1. Use of libraries.
2. Attendance at classes (without credit)
3. Work in laboratories without payment of fees. (The University asks reimbursement for laboratory supplies and destructible materials.)

APPENDIX I

SECURITY

The University of Michigan has signed a Security Agreement, Form DD441 dated March 22, 1954, with the Department of Defense, establishing security regulations and listing cleared buildings and facilities. Atomic Energy Commission facilities at the University of Michigan are essentially approved facilities only for the storage of classified information, as related to the Fission Products Laboratory, Phoenix project, Cooley Building, offices of University Atomic Energy Commission Consultants, and the University Research Security Office.

The following is the Armed Services Security Clearance Status of Regents, President, Executive and key Administrative Officers at the University of Michigan, Ann Arbor, Michigan.

Regents of the University

Vera B. Baits	SECRET, June 23, 1953, INM
Roscoe O. Bonisteel	SECRET, May 21, 1954, INM
Alfred B. Connable, Jr.	SECRET, May 21, 1953, INM
Leland I. Doan	SECRET, May 29, 1951
Otto E. Eckert	SECRET, May 21, 1953, INM
Charles S. Kennedy	SECRET, May 25, 1953, INM
Kenneth M. Stevens	SECRET, Oct. 20, 1953, USAF

Executive, Administrative and Key Personnel

Harlan Hatcher, President	SECRET, Jan. 5, 1953, INM
Marvin L. Niehuss, Vice Pres.	SECRET, Dec. 9, 1952, INM
Wilbur K. Pierpont, Vice Pres.	SECRET, May 14, 1953, Fifth Army
Herbert G. Watkins, Secretary	SECRET, June 18, 1953, INM
Arthur L. Brandon, Univ. Relations	SECRET, Sept. 11, 1952, USAF
Edmund A. Cummiskey, Att'y	SECRET, Mar. 16, 1953, Fifth Army
Gilbert L. Lee, Jr., Controller	SECRET, Feb. 14, 1952, AMC

Ralph A. Sawyer, Dean	SECRET, Mar. 4, 1954, USAF
Charles Odegaard, Dean	SECRET, Oct. 5, 1954, Fifth Army
George G. Brown, Dean	SECRET, Apr. 7, 1953, INM
Richard G. Folsom, Director, Eng. Res. Institute	TOP SECRET, Aug. 30, 1954, USAF
Harold A. Ohlgren, Asst. Director, Eng. Res. Inst.	SECRET, Mar. 8, 1954, Fifth Army
Aubrey B. Hicks, Fus. Mngr. Eng. Res. Institute	SECRET, Oct. 20, 1953, USAF
Frederick E. Oliver, Chief Accountant	SECRET, Apr. 7, 1953, INM
Laurel Z. Keene, Univ. Res. Security Officer	TOP SECRET, Apr. 13, 1953, USAF

The following is a list of the cleared professors and instructors on the teaching staff in the Department of Mathematics. Some of these clearances are old and will have to be brought up to date. The following cleared men represent about 1/4 of the staff of the Department of Mathematics.

H. C. Carver	SECRET, June 24, 1952
R. V. Churchill	SECRET, Feb. 24, 1947, AMC
A. H. Copeland, Sr.	SECRET, Feb. 12, 1954, USAF
C. C. Craig	SECRET, June 16, 1948, ONR
P. S. Dwyer	SECRET, Oct. 12, 1954, USAF
T. H. Hildebrandt	SECRET, Aug. 24, 1953, ONR
E. D. Rainville	SECRET, Dec. 8, 1950, AMC
C. L. Dolph	TS & SECRET, June 5, 1947 AMC & CFL, July 14, 1949, INM TS, Feb. 3, 1953, USAF
G. E. Hay	TS & SECRET, Jan. 9, 1950, AMC
E. H. Rothe	SECRET, June 6, 1950, INM
R. M. Thrall	SECRET, Feb. 12, 1954, USAF
C. J. Coe	TS & SECRET, Apr. 15, 1949, Fifth Army INM
F. Harary	CONFIDENTIAL, July 7, 1949, INM
A. J. Lohwater	SECRET, June 8, 1950, INM
C. J. Titus	SECRET, June 22, 1954, USAF
A. B. Clarke	SECRET, June 9, 1953, INM
R. L. Davis	SECRET, Oct. 15, 1952, INM
G. Livesay	SECRET, Jan. 12, 1953, ONR
D. A. Storvick	SECRET, Aug. 11, 1952, INM
J. O. Brooks	SECRET, Dec. 5, 1952, INM
R. T. Dames	SECRET, Aug. 19, 1952, ONR

APPENDIX II

CONTRACT INFORMATION

All University of Michigan Engineering Research Institute contracts are conducted on a cost-reimbursement basis with monthly billings. The following statements refer to the standard cost items and the policies regulating them.

1. Reimbursement to be made for salaries and wages of personnel and borrowed personnel directly engaged in the performance of the work and properly allocable thereto including salaries and wages for vacation and sick leave pay of its personnel pursuant to the established practice of the University.
2. Expenditures are to be made for the transportation of the persons directly engaged in the performance of the work and such reasonable actual subsistence expenses according to the conditions of the published University travel policy. University policy is to reimburse for actual reasonable costs incurred.
3. The purchase of capital equipment, building alterations, and purchase orders should be allowable costs up to \$2500 without prior approval of the contracting officer.
4. An overhead rate of 37% on personnel has been negotiated and established by the representatives of the Department of Defense and of the University of Michigan, effective for the period January 1, 1955 through December 31, 1956.

Other Direct Salaries and Wages* is the allocated portion of salary costs for project service personnel directly engaged

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in the administration of research activities. These salaries are classified as direct costs in the overhead calculation and are not included in the overhead expense pool. These salary charges are allocated to specific contracts on a percentage basis acceptable to the Resident Government Auditor. (Present practice indicates 10% on the direct salaries).

Other Direct Supplies and Expense* is the allocated portion of supplies and other non-salary costs incurred in direct support of research activities. These costs are classified as direct costs and are not included in the overhead expense pool. They are allocated to specific contracts on a percentage basis acceptable to the Resident Government Auditor. (Present practice indicates 2% on direct salaries).

* In most Institutions these charges are made on an actual hours-spent and actual materials-used charge.

APPENDIX III

DISCUSSION OF ANN ARBOR ENVIRONMENT

The city of Ann Arbor has a population of approximately 40,000 without the University students. There is a limited amount of industry carried on here such as Argus Camera Inc., Hoover Ball and Bearing Co., King Seeley Corp. (primarily producers of automobile instruments) and American Broach Co.

The following distances indicate that Ann Arbor is adjacent to, but not part of, the surrounding centers, in the event of hostilities:

38 miles west of Detroit

56 miles south of Flint

34 miles east of Jackson

58 miles north of Toledo

The New York Central Railroad passes directly through Ann Arbor; five trains run daily to Chicago and six to Detroit. The Willow Run Airport, serving Detroit and the metropolitan area is owned by the University of Michigan and located approximately 14 miles from the campus. Direct commercial flights are available to most important cities of the country.

Ann Arbor is close enough to the metropolitan area of Detroit to enjoy some of the large recreation areas, symphony orchestras, and other activities that are associated with a large city. On the other hand, Ann Arbor is pretty much self-contained.

Activities:

We enjoy the musical concerts throughout the winter months, and a concentrated May Festival, featuring the Philadelphia Symphony Orchestra, conducted by Eugene Ormandy, and several outstanding soloists, such as Lily Pons, Fritz Kreisler, Myra Hess, etc.

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During the spring months the University of Michigan Drama Festival presents actresses such as Helen Hayes, Eva LeGallienne, and Katherine Cornell. Nine noted personalities have been signed for the 101st Annual Lecture Course. Some of these will include Senator Alexander Wiley, Senator Wayne Morse and Norman Vincent Peale. We have local groups such as the Dramatic Arts Center and the Ann Arbor Civic Theatre where individuals can express their particular talents. The athletic facilities of the University have family nights for athletic events as recreational programs. Community square-dancing is enjoyed by several local groups. There are numerous lakes within a 25 mile area of Ann Arbor for summer cottages and swimming.

There are three private country clubs - Barton Hills, Washtenaw Country Club, and Ann Arbor Golf and Outing. This past June the Michigan Open Golf Championship was held at the Washtenaw course. The University of Michigan also maintains a good 18 hole golf course for students and faculty. In addition, the city of Ann Arbor maintains two municipal golf courses.

School System:

The Ann Arbor school system has been expanded and in the past two years has completed a new Junior High School for around 1,000 students and has added a wing on the other Junior High School for about 500 students. Both of these schools have standard swimming pools. Several new grade schools have been completed. The new Ann Arbor High School is under construction and will be completed next February. This new high school will have one of the finest plants in the country. The School of Education of the University of Michigan offers a complete training for students through the high school level. If desired, students can enroll

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in the kindergarten and complete their education through their high school diploma at the University school system.

Athletic Plant:

The University of Michigan has one of the most complete athletic plants in the country, both for intramural and extramural sports. Its teams participate in the following sports: baseball, basketball, football, golf, handball, ice hockey, swimming, tennis, track, wrestling, and others.

Employee Housing:

An increasingly large amount of building is going on in Ann Arbor. Several new housing developments are under construction. Privately owned housing projects such as Pittsfield Village and the Nob Hill Apartments are located in the surrounding area in addition to the University Terrace and the North Campus Apartments, which provide housing for full and part-time students.

Services are available through the University Rental Property Office to any employee of the University who has a full-time academic appointment. The Office publishes monthly listings of available housing including both University-owned housing and listings that are received from other sources.

The cost of living in the Ann Arbor vicinity is comparable to our larger cities and ranks fairly high with the index of cost of living in the country.

APPENDIX IV

Present faculty and staff engaged in specific problems listed
in technical statement of work:

1. Asst. Prof. John Carr, Ph.D., Mathematics
mathematical physics, computer programming, and operation,
network synthesis. Head of MIDAC Computer at the Willow
Run Laboratories.

Prof. Paul S. Dwyer, Ph.D., Mathematics
mathematics and educational statistics, use of Hollerith
machines in statistical work, statistical computation
techniques, specifically on fire control, matrix inversion,
and linear programming. Year's research program on statis-
tical analysis of Air Force personnel compatibility, devel-
oping generalized mathematical procedures for optimum assem-
bly of potentially effective combat crews.

Prof. H. H. Goode, MA, Electrical Engineering
pursuit curves, mathematical analysis applied to engineering
development, correlation in mathematical statistics, applica-
tion to educational psychology, mechanization of binomial
sequential analysis, automatic computation.

2. Prof. Arthur H. Copeland, Ph.D., Mathematics
theory of probability, mechanics, analysis

Prof. C. C. Craig, Ph.D., Mathematics
mathematical statistics; Director of the Statistical Research
Laboratory.

Asst. Prof. Donald A. Darling, Ph.D., Mathematics
mathematical statistics, probability and applications;
stochastic processes.

Prof. Paul S. Dwyer (see above)

3. Assoc. Prof. R. C. F. Bartels, Mathematics
hydrodynamics, aerodynamics, dynamics, mechanics of a
continuum potential theory.

Prof. R. V. Churchill, Ph.D., Mathematics
operational mathematics, mathematical theory of heat conduc-
tion and diffusion, boundary-value problems in partial dif-
ferential equations, vibration; published "Modern Operational
Mathematics in Engineering" McGraw-Hill, 1944; "Introduction
to Complex Variables and Applications", McGraw-Hill - 1948.

Assoc. Prof. Charles L. Dolph, Ph.D., Mathematics
electromagnetic theory, including propagation, scattering
antennas, network analysis, integral equation-theory of
linear prediction and aerodynamics, including turbulence,
vibrations analysis, guided missiles.

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Assoc. Prof. George E. Hay, Ph.D., Mathematics
mathematical theory of elasticity, mechanics.

Mr. Andrew L. Moffett, MA, Research Engineer
Former Prof. of Mathematics at Gettysburg College
group theoretical methods, modern algebraic techniques
and boundary-value problems.

Asst. Prof. Robert K. Ritt, Ph.D. Mathematics
electromagnetic theory, variational methods, boundary-
value problems involving differential and integral equa-
tion and general methods of operational calculus.

Professor Erich H. Rothe, Ph.D., Mathematics
boundary-value problems of partial differential equations,
integral equations, topology in function spaces and appli-
cations to analysis.

Mr. Keeve M. Siegel, MA., Research Engineer
Head mathematical theory and analysis group Willow Run
Laboratories, electromagnetic wave theory, hydrodynamic
solution to boundry-value problems.

Dr. Hershel Weil, Ph.D., Research Engineer
Applied Mathematics, boundary-value problems.

t. Dr. Bruce A. Clarke, Mathematics
abstract algebra, probability theory, stochastic processes

Prof. Arthur H. Copeland (see above)

Asst. Prof. Donald A. Darling (see above)

Prof. H. H. Goode (see above)

Assoc. Prof Robert M. Howe, Ph.D., Aeronautical Engineering
design and application of electronic differential analyzers
to eigenvalue problems, wave propagation, heat-transfer,
flight simulation, structural dynamics; design and analysis
of feedback control systems.

Assoc. Prof. Alan B. Macnee, Sc.D., Electrical Engineering
design and development of electronic differential analyzer
for computing machines; research in the fields of network
synthesis and information theory.

Prof. Lawrence L. Rauch, Ph.D., Aeronautical Engineering
experiments and research in error reduction in anti-aircraft
height finder; theory of tangent trajectory range finder;
fire-control equipment and systems. Design of electronic
instrumentation for Uranium Separation Project. Research
in developing electronic differential analyzers to investi-
gate properties of nonlinear differential equations and
systems. Basic research in nonlinear systems, electronics.

APPENDIX IV

Prof. Robert M. Thrall, Ph.D., Mathematics algebra, particularly group theory and representation theory; lattice theory and game theory; operations analysis. Fellow in Operations Research Society of America.

Mr. Dean Wilson, B.S., Research Engineer operations research

APPENDIX V

CONTRACTS IN FORCE BETWEEN THE UNIVERSITY OF MICHIGAN
AND THE DEPARTMENT OF THE ARMY

JULY 1, 1953 THROUGH JULY 1, 1955

<u>CONTRACT NUMBER</u>	<u>TITLE</u>	<u>DATE</u>	<u>AMOUNT</u>
DA-20-018-ORD-12300	Ceramic Combustion Chambers and Ceramic Ram Jet Burners	4-1-52/8-31-54	\$ 24,000
DA-20-089-ORD-36259	Exhaust Gas Ejectors	6-5-52/7/31/55	48,480
DA-20-089-ORD-36543	Shock on Electrical Components in Track Laying and Wheeled Vehicles	4-29-53/4-28-56	43,890
DA-20-018-ORD-13047	Heating of Air Stream in a Wind Tunnel by an Electrical Discharge	6-1-53/6-30-55	19,400
DA-20-018-ORD-13146	Various Methods of Temperature Regulation in a Combat Tank	6-15-53/5-16-55	47,100
DA-20-018-ORD-36692	Carburized Final Drive Pinion Gears	6-26-53/4-4-55	42,000
DA-20-018-ORD-13281	Algebras with Radical	11-2-53/6-15-55	10,430
DA-20-018-ORD-13282	Rotational Flows of Compressible Gas	11-1-53/9-15-55	5,852.49
DA-20-018-ORD-13283	Interaction of Aside Groups in Organic Compounds with Adjacent Functional Groups	11-2-53/11-1-55	19,725
DA-20-089-ORD-36858	Shock Mounting	11-9-53/6/30-56	106,880
DA-20-089-ORD-36962	Air Induction System	2-13-54/10-6-55	51,790
DA-36-038-ORD-17782	Spark Ignition of Gun Liquid Propellant	4-1-54/10-21-55	90,411

<u>CONTRACT NUMBER</u>	<u>TITLE</u>	<u>DATE</u>	<u>AMOUNT</u>
DA-20-089-ORD-36982	Waterproofing Vehicle Components	3-3-54/5-6-56	\$ 30,000
DA-20-018-ORD-13429	Metallurgical Studies of Condemned 155 MM Tube Sections	5-14-54/11-13-55	16,500
DAI-49-186-502-ORD(P)-194	Trigger Tube	6-15-54/12-15-55	20,000
DAI-20-018-505-ORD(P)-21	Metallurgical Studies	6-28-54/12-29-55	8,115
DA-20-018-ORD-13585	Mathematical Analysis	9-15-54/9-14-55	7,800
P.O.#320-089-54-1539	Yuba Steam Engine Power Plant for the M-48 Tank	1-22-54/6-22-54	999,000
DA-49-007-MD-581	Chick Feeding Studies	9-1-54/8-31-55	25,050
DA-49-083-OSA-638	Psychological Research	2-2-53/6-1-55	21,380
DA-44-109-qm-1333	X-ray Diffraction of Natural and Synthetic Fibers	12-26-52/12-24-55	26,000
DA-44-109-qm-1826	Food Sterilization	6-7-54/10-6-55	20,845
DA-19-129-qm-140	Infrared Absorption Studies on Down Keratin	6-23-54/12-22-55	15,000
DA-19-129-qm-349	Gamma Ray Sprout Inhibition of Potatoes	4-20-55/4-19-56	23,521
DA-19-129-qm-388	Sterilization of Foods	6-7-55/6-6-56	28,500
DA-18-108-cml-5515	Scattering of Radiation by Particles	7-1-54/1-31-56	70,485
DA-11-190-ENG-8	Bearing Strength of Floating Ice Sheets	4-28-53/9-30-55	18,000
DA-44-009-ENG-2446	Infrared Spectrometers	2-10-55/2-10-56	5,000

<u>CONTRACT NUMBER</u>	<u>TITLE</u>	<u>DATE</u>	<u>AMOUNT</u>
DA-20-018-ORD-11918	Machinability of titanium-base Alloys	10-1-51/5-31-55	\$ 103,778.75
DA-20-018-ORD-12087	Noise in Military Vehicles	12-1-51/11-30-55	284,460
DA-20-018-ORD-12099	Stress-Strain Relations in Plasticity	2-1-52/6-30-56	56,070
DA-20-018-ORD-12242	Arc Discharge through a Liquid	4-1-52/12-31-55	32,100
DA-20-018-ORD-13655	Simulation Display System	1-14-55/9-30-55	10,896
DA-20-089-ORD-37343	Evaluation of Oil Coolers, Heat Exchangers & Other Power Plant Components	3-15-55/3-15-56	100,000
DAI-20-018-508-ORD(P)-42	Curing Systems and Curing Procedures	4-15-55/4-15-56	14,800
DA-20-089-ORD-37370	New Type Nuclear Power Reactor	5-13-55/5-12-56	8,000
DA-20-018-ORD-13754	Road Meter	4-14-55/10-14-55	16,121
DA-20-018-ORD-13821	Recoilless Rifle Blast	6-15-55/6-15-56	15,504
DA-20-018-ORD-13832	Precision Casting Processes and Techniques	6-3-55/6-3-56	308,000
DA-36-039-sc-52601	Magnetically Sensitive Electrical Resistor Material	6-1-53/8-31-55	36,400
DA-36-039-sc-52654	Project Michigan	5-7-53/1-7-56	8,297,243
DA-36-039-sc-56737	Upper Atmospheric Research	10-15-54/10-14-55	58,830
DA-36-039-sc-56736	Infrared Studies of Crystals	5-15-54/9-30-55	19,500
DA-36-039-sc-63203	Electronic Countermeasures	5-15-54/5-14-56	1,120,000

<u>CONTRACT NUMBER</u>	<u>TITLE</u>	<u>DATE</u>	<u>AMOUNT</u>
DA-36-039-sc-56714	Voltage Tunable Magnetrons and Backward Wave Oscillators	6-15-54/7-15-56	\$ 141,800
P.O.#23488-PH-54-92	Reduction of Data from Sphere Experiments	7-1-54/10-28-54	3,000
DA-36-039-sc-64627	Large-Scale Man-Machine System	4-1-55/2-28-57	211,473
DA-36-039-sc-64676	Low Level Wind Structure	5-1-55/4-30-56	34,468
DA-36-039-sc-64659	Upper Atmosphere Research in the Arctic	5-1-55/5-30-57	356,467

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