

ENGINEERING RESEARCH INSTITUTE

ANNUAL REPORT
For the Year Ended June 30, 1955

Submitted to Harlan Hatcher, President
The University of Michigan

To the President

Dear Sir:

I herewith submit the report of the Engineering Research Institute for the year ended June 30, 1955.

FUNCTIONS OF THE INSTITUTE

In the administration of the Engineering Research Institute during the year 1954-55 a program has been initiated for the more effective integration of research with the educational activities within The University, particularly in engineering and closely related fields. To effect this integration, aimed at obtaining more significant research results of importance to the teaching activities and to the sponsors of the research, some organizational changes within the Institute were required.

Budget funds available for Institute operations have enabled the research staff to take the leadership in exploratory investigations in several areas not adequately covered at present but of importance to future work of The University. These investigations include: developmental research on blast-resistant tier building construction; computation of thermodynamic properties of chlorine, using the MIDAC; study of vehicular traffic control, also partly by means of high-speed computers; evaluation of variable-thrust rockets; study of drag in accelerated flow; separation of cesium-137 from gross fission products; powder-metallurgy studies, employing autoradiographic methods; and problems in nuclear engineering, especially feasibility studies for nuclear power plants.

Institute Functions of Benefit to The University

Faculty

Participation in sponsored research, even though only to a limited extent, enables the teaching faculty to increase their knowledge in their specialties, for it provides an opportunity to become familiar with the present status of their areas of interest as well as with lines of important future developments in our rapidly growing sciences and engineering fields. These experiences are reflected beneficially in the technical content of University courses and original contributions in the form of publications and doctoral dissertations. In 1954-55, 203 members of the teaching faculty participated part time in Engineering Research Institute activities.

During the report year, fourteen Institute employees entered upon part-time teaching duties (equivalent to about four and one-half full-time appointments), leading to direct integration of sponsored research with the educational function of The University. These appointments were to the following academic ranks: two instructors, one assistant professor, two professors, and nine lecturers.

Students

The shortened time lag between scientific advances and their engineering applications has necessitated a shifting of educational values and changes in curricula to equip the student intellectually to handle new concepts and assimilate basic information rather than simply to draw on the engineer's fund of empirical data. A recognition of the need for these changes and the initial steps toward the necessary innovations were in part the result of experience gained through Institute research activities.

The Institute's activities also benefit students in engineering and the sciences by providing an opportunity to participate in sponsored research.

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

The following table shows the participation by students in Institute research activities during 1954-55.

TABLE I

STUDENT EMPLOYMENT (PART- AND FULL-TIME)

Undergraduates	634
Master's candidates	124
Doctoral candidates	<u>143</u>
Total registered students	901

Furthermore, a total of 39 Ph.D. candidates holding Engineering Research Institute appointments were engaged in the preparation of dissertations based to a large extent on Institute project work. During the year, 28 doctoral dissertations were completed.

Although no figures are available as to the number of students whose research earnings enabled them to continue their academic studies, the total is probably surprisingly high.

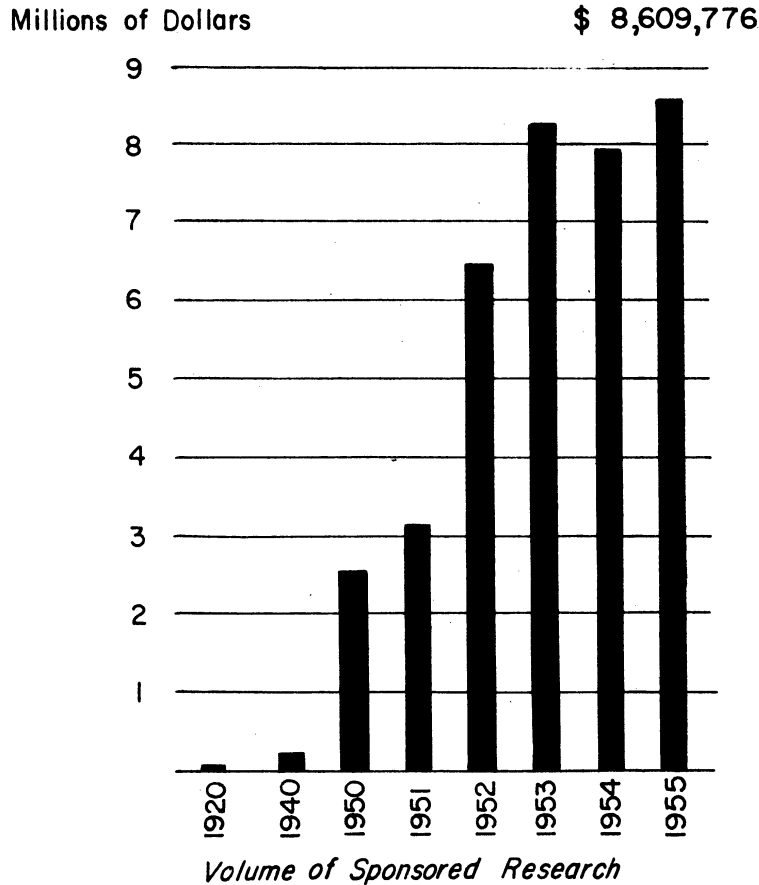
ACTIVITIES OF THE YEAR

Continued Growth

During the year 1954-55, the research activities administered by the Engineering Research Institute amounted to \$8,609,776, an increase of 8 per cent over 1953-54. Work went forward on 408 projects, of which 113 were terminated and 164 initiated during the year, leaving 295 projects to be carried over into the fiscal year 1955-56, with authorized research funds amounting to \$6,967,712.

The accompanying bar chart shows the growth of Institute-administered research. Table II breaks down the activities by college, school, or division, itemizing the number of projects investigated and the amounts spent by both

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN



industrial and governmental sponsors. There has been a 38 per cent increase in industry-supported research.

The Balance Sheet for the Engineering Research Institute appears as Table III.

Research Accomplishments by Areas

The areas of research include the interests of members of the teaching faculty in engineering and the physical sciences and of the research staff of the Institute. Table IV compresses the manifold fields of research undertaken into a few major categories. A certain amount of overlapping is unavoidable in so broad a classification, and some arbitrary decisions were made in developing these data.

Most of the research projects give evidence of originality of thinking and of creative achievement. Of the many research activities that have been

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

TABLE II

DISTRIBUTION OF SPONSORED RESEARCH

College or School and Department	No. of Projects			Volume of Research		
	Ind.	Gov.	Total	Ind.	Gov.	Total
<u>Engineering</u>						
Aeronautical	1	21	22	\$ 10,275.43	\$ 235,978.84	\$ 246,254.27
Chem and Met.	40	30	70	168,596.46	374,140.54	542,737.00
Civil	45	6	51	112,636.23	80,217.27	192,853.50
Electrical	4	10	14	7,158.96	711,884.37	719,043.33
Eng. Mech.	5	6	11	15,815.55	101,419.51	117,235.06
Mech. and Ind.	11	10	21	47,252.63	95,727.08	142,979.71
Production	11	3	14	33,637.57	38,943.52	72,581.09
Total	117	86	203	\$395,372.83	\$1,638,311.13	\$2,033,683.96
<u>Willow Run</u>						
Laboratories	3	30	33	11,162.28	4,941,059.31	4,952,221.59
<u>ERI</u>	49	41	90	156,186.22	744,781.71	900,967.93
<u>Architecture</u>	2		2	38,681.42		38,681.42
<u>Natural Resources</u>	3		3	4,879.89		4,879.89
<u>Medical School</u>		2	2		9,449.75	9,449.75
<u>Physical Education</u>		1	1		1,496.59	1,496.59
<u>L. S. and A.</u>						
Astronomy		2	2		15,876.94	15,876.94
Chemistry	5	12	17	14,204.41	110,718.03	124,922.44
Geology		2	2		4,284.85	4,284.85
Mathematics	5	9	14	13,793.83	31,317.51	45,111.34
Philosophy	1		1	10,368.33		10,368.33
Physics	3	30	33	14,036.27	365,096.14	379,132.41
Psychology	1	4	5	8,906.49	45,515.01	54,421.50
Total	15	59	74	\$ 61,309.33	\$ 572,808.48	\$ 634,117.81
<u>Miscellaneous</u>				34,276.66		34,276.66
GRAND TOTAL	189	219	408	\$701,868.63	\$7,907,906.97	\$8,609,775.60

TABLE III
BALANCE SHEET
June 30, 1955

ASSETS

Current Assets

Cash		\$1,692,224.89
Accounts receivable		1,244,347.58
Est. claim for rebillable OASI		42,000.00
Miscellaneous		21,261.71
Total		<u>\$2,999,834.18</u>

LIABILITIES AND EQUITY

Current Liabilities

\$ 962,194.48

Equity and Equity Reserves

Balance, June 30, 1954		\$2,360,950.70
Excess of expense over income current year	\$196,119.46	
Plus: Expenditures from equity reserves	<u>127,191.54</u>	
Net decrease in equity		<u>323,311.00</u>
Balance, June 30, 1955		<u>2,037,639.70</u>
		<u>\$2,999,834.18</u>

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

TABLE IV

DISTRIBUTION OF RESEARCH BY AREAS

Research Area	No. of Projects	Volume of Research
Metallurgy	51	\$ 271,150.91
Mechanics	4	71,116.66
Structures	18	173,846.49
Soil Mechanics	18	38,527.51
Machine Elements	21	111,863.87
Machinability	11	45,545.93
Materials	19	262,584.44
Infrared	9	664,807.02
Nuclear Energy	42	395,219.48
Acoustics	11	361,197.93
Communications	21	1,234,400.39
High-Speed Computers	17	339,668.42
Mathematics	12	54,947.63
Chemistry	27	250,463.96
Fluid Flow and Heat Transfer	48	463,461.02
Combustion	21	299,753.52
Geophysics	10	185,404.34
Meteorology	13	311,182.75
Human Engineering	8	87,596.28
Vision	12	706,047.42
Operations Research	5	1,289,612.83
Systems Analysis and Design	3	921,586.99
Miscellaneous	7	69,789.81
TOTAL	408	\$8,609,775.60

presented in some detail in the Engineering Research Institute News, the following three are representative:

Project MICHIGAN — Project MICHIGAN was established in 1953 to assist the Armed Services in problems of battlefield surveillance. The aims of the Project are (1) to carry out research on means for detecting military targets and for obtaining information regarding the battlefield situation and (2) to develop a coordinated system for making the best use of such information.

The program includes development of an integrated system for the collection, transmission, processing, and display of surveillance information leading

to a continuous, up-to-date representation of the battlefield situation. Recent developments in mass-destruction weapons and the increased mobility of modern armies demand such a system, capable of maintaining surveillance of a large combat area in all weather, twenty-four hours a day.

Theoretical studies carried out by the Project include detailed examination of the data generated by the surveillance system and the locations where such data are needed by the system, an analysis of the surveillance communications system, a study of weapon-system accuracies and surveillance requirements, and a study of the surveillance characteristics of military targets.

System concepts developed by the Project are tested in a system simulation center where synthetic warfare "fought" under closely controlled conditions can prove or disprove the merit of concepts much more economically and effectively than actual field maneuvers.

Research on the improvement of sensory devices is being carried on in many areas: acoustics, seismics, optics and vision, infrared, radar, and meteorology.

One of the large problems in battlefield surveillance arises from the need for handling an enormous amount of information obtained from many different kinds of sources. In response to this problem, Project MICHIGAN is carrying on a data-processing program to determine the applicability of various data-processing techniques to battlefield surveillance problems and to develop new techniques and equipment to assist in the extraction of intelligence from surveillance data. (Engineering Research Institute News, July, 1955.)

Air Pollution by Aeroallergens — Of the many aeroallergens, substances in the atmosphere which cause allergic reactions in sensitive individuals, ragweed pollen has received particular attention, since it is one of the most troublesome. The investigations have so far been concerned with evaluating (1) the diurnal variations of ragweed pollen concentrations in the atmosphere in rela-

tion to meteorological conditions and (2) the rate of penetration of pollen into buildings of various types as a function of wind speed and direction and atmospheric turbulence. Both phases have necessitated the development of special techniques and instrumentation.

The information gained from theoretical aerodynamic studies, in addition to experimental and clinical investigations, will aid in developing techniques of forecasting pollen concentrations to assist the physician in planning his treatments and to design pollen refuges for those patients who do not respond to routine therapies. (Ibid., December, 1954.)

The Liquid Bubble Chamber — The recent development of the liquid bubble chamber at The University provides another tool for the study of high-energy nuclear interactions. The bubble chamber is superior to the standard means for this study -- the cloud chamber and the photographic emulsion -- in that it offers much more substance for particles to collide with and, hence, raises by a factor of about a thousand the probability of obtaining a collision which will reveal something of the properties of the particles.

The chamber, which is essentially a container of superheated liquid kept under pressure to delay boiling, is placed in the beam of particles from an accelerator and the pressure is released. In the few thousandths of a second which elapse before the liquid boils, the particles speeding through the liquid ionize the atoms along their paths, and these paths, made visible by the tiny bubbles which form around the ionized atoms, are photographed.

The University of Michigan bubble chamber is currently being used at the Brookhaven National Laboratory to study the two-billion-electron-volt particles produced by the cosmotron at that installation. (Ibid., October, 1955.)

Other Accomplishments

The Institute operations relative to the educational programs of The University have resulted in the following noteworthy achievements:

- (1) an increase in the number of men well-trained in teaching and research activities; *and women*
- (2) intensified development of areas of special competence by attracting outstanding men and supporting their activities;
- (3) an increase in the number of Institute research employees devoting part of their time to advanced studies;
- (4) increased consideration in contract negotiations of the contributions of the research proposed, of its suitability for publication, of the special interests of teaching and research employees, of the long-term interests of the department or division of The University concerned, as well as of available laboratory facilities;
- (5) an increase in the amount and diversity of industrial projects; and
- (6) establishment of four predoctoral Engineering Research Institute fellowships. (This program has been so successful that five fellowships were recommended for 1955-56.)

Miscellaneous Activities

Publications — The University of Michigan Press Engineering Research Institute publications list was revised in January, 1955, to include three series: Bulletins, Miscellaneous Publications, and Special Publications, the latter being designated under four groups, viz., Monographs, Reports, Symposia, and Tables. Circulars and Reprints were discontinued, as well as Bulletins issued prior to 1940.

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

The following publications were issued during the report year: Basic Circuitry of the MIDAC and MIDSAC, by J. E. DeTurk et al.; A Shock-Tube Investigation of Detonative Combustion, by R. B. Morrison; and Noise-Reduction Manual, by the late P. H. Geiger.

Meetings and Symposia — During the report year the Institute has taken an increasingly active part in engineering and scientific meetings and symposia, particularly those taking place on the Campus.

Through project-supported activities, the following meetings have been sponsored directly by the Institute:

Airborne Radar, February 1-3, attendance 250

Physics of Semiconducting Materials, June 6-8, attendance 50

Project MICHIGAN Briefings, July, 1954, to June, 1955:

9 at The University, average attendance 130;

5 at various military installations, average attendance 80.

The Institute has cooperated with appropriate organizations in planning and conducting the following meetings:

Size, Shape, and Structure of Polymer Molecules, June 29 - August 10, attendance 50

Special Summer Session on Digital Computers and Data Processors, August 2-13, attendance 95 (In cooperation with University Extension Service)

Symposium on Electromagnetic Wave Theory, June 20-25, attendance 375

Seminar in Applied Mathematics, 2nd Semester (13 sessions), average attendance 10 (In cooperation with Department of Mathematics)

Institute Fellowships — During the report year four Engineering Research Institute fellowships were established to be awarded to graduate students who have completed a minimum of one year of at least half-time work in the Institute. Two candidates were granted fellowships for the entire academic year, and four for the second semester only. These fellowships are awarded on the basis of ability without regard to area of specialization. In view of their

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

value both to the recipient and to the Institute, five such awards will be made for 1955-56.

Nation-Wide Information Center Established — During the fiscal year, the Infrared Information Analysis Group (IRIA) of the Willow Run Laboratories was designated the national center for collecting, digesting, and maintaining information in the field of infrared physics and technology. This activity is being supported by the Office of Naval Research.

BOMARC — The relaxation of security restrictions on the Institute's largest completed project, BOMARC, has made possible the announcement that a large portion of the research on the IM-99 defensive missile was done at The University and that the letters MARC stand for "Michigan Aeronautical Research Center," predecessor of the Willow Run Laboratories.

Changes in Contract Stipulations — Representatives of the Department of Defense and The University have negotiated an overhead rate on government-sponsored research of 37 per cent of direct salaries and wages effective January 1, 1955, for a two-year period. (During the two previous years it had been 35 per cent.)

Two new industrial contract forms were adopted effective July 1, 1955. The overhead rates will be 60 per cent of direct salaries and wages when the sponsor does not desire patent rights (Form NR) and 75 per cent when the sponsor elects to acquire ownership of patentable developments (Form PR).

PERSONNEL

The advice and active interest of the Engineering Research Council, composed of the following members, contributed greatly to the success of the Institute's policy and operations.

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

G. G. Brown, Chairman
 W. I. Bennett
 E. F. Brater
 D. M. Dennison
 R. A. Dodge

W. G. Dow
 R. G. Folsom
 H. H. Goode
 C. E. Odegaard
 R. A. Sawyer

On May 1, 1955, Mr. Harry H. Goode relinquished his administrative duties at the Willow Run Laboratories and as Assistant Director of the Institute in order to accept a professorship in Electrical Engineering.

Dr. Newbern Smith was appointed Supervisor of Project MICHIGAN, effective October 11, 1954.

Mr. Harold A. Ohlgren, Assistant Director of the Institute, received the honorary degree of Doctor of Science from his alma mater, Macalester College, St. Paul, Minnesota, on June 6, 1955.

Institute research staff members and members of the teaching faculty engaged in Institute research published during the year almost 150 articles, based upon this research, in journals, transactions, and similar publication media. These publications involved nearly 300 authors, of whom slightly over 200 were Institute research personnel.

The total personnel employed by the Institute during the past year was 1759, varying from 1128 in October, 1954, to 1395 in June, 1955. A large portion, mainly students and faculty, were on a part-time basis. In Table V the personnel status is compared with that of the previous year.

TABLE V

PERSONNEL STATUS

<u>Classification</u>	<u>1953-54</u>	<u>1954-55</u>
Administrative Staff	7	7
Faculty	166	203
Visiting Lecturers	13	16
Academic Appointees on Projects	433	374
Nonacademic Appointees on Projects	359	366
Hourly Assistants on Projects	675	732
Office Staff	<u>58</u>	<u>61</u>
Totals	1711	1759

INSTITUTE NEEDS

Space

Space needs will become even more critical than in the past when student enrollment in the various instructional departments increases and the Institute is requested to return some of the facilities now being used to carry on its activities. Four possible methods of alleviating the space problem are being investigated:

- a. Rehabilitate space facilities in temporary buildings at the Willow Run Airport.
- b. Rent or lease space in Ann Arbor and renovate for Institute use.
- c. Make an arrangement with the Department of Defense to cooperate with The University for the construction of new buildings on the North Campus.
- d. Obtain permission from the Air Force to use the "Packard" building at the Willow Run Airport.

Organization

On July 1, 1955, significant revisions were effected in the accounting system of the Institute facilitating desirable organizational changes. Further changes, in conformity with resolutions of the Engineering Research Council, are anticipated. These include the elimination of the position of Director of the Willow Run Research Center and of the operation of that Center as an administratively and fiscally distinct unit of the Institute.

Staff

Due to the present severe shortage of engineers and physical scientists, and the very attractive salary offers made by industry and other research

ENGINEERING RESEARCH INSTITUTE • UNIVERSITY OF MICHIGAN

groups, increasing difficulty has been experienced in holding key research personnel, securing replacements for vacated positions, and finding more well-qualified men to meet the requirements of the Institute's growing research program.

Respectfully submitted,

R. G. Folsom, Director

