ENGINEERING RESEARCH INSTITUTE

UNIVERSITY OF MICHIGAN

ANN ARBOR

ANNUAL REPORT

JULY 1, 1949 - JUNE 30, 1950

October 15, 1950

ANNUAL REPORT

of the

ENGINEERING RESEARCH INSTITUTE

July 1, 1949 - June 30, 1950

During the year 1949/1950 the Engineering Research Institute operated under the general supervision of Dr. John A. Perkins, Assistant Provost, and an Engineering Research Council, consisting of the following:

Dr. John A. Perkins, Chairman
Professor F. E. Bartell
Professor G. G. Brown
Professor D. M. Dennison
Professor R. A. Dodge
Professor W. G. Dow
Professor C. T. Larson
Dean R. A. Sawyer, Member Ex Officio

During this period work was done on a total of 210 projects, of which 84 were received during the year and 80 were completed. It is, of course, not feasible to give in a report of this type full details with respect to each project. Some of the outstanding fields of investigation were:

Study of metals for high temperature service

Work in the field of guided missiles for defensive purposes

(This work is done in no educational institution in this country other than the University of Michigan.)

Infra-red spectroscopy

Supersonic wind-tunnel studies

Fundamental work dealing with the nature and character of combustion

Investigation of proper lay-outs of breakwaters to provide harbor refuge for small vessels and to prevent beach erosion

Fundamental work in the field of electronics

Studies in spectrochemical analysis

Investigations with respect to rockets and rocket motors

Investigations relative to the proper bearing power of soils for foundations (Some of this work was done in England to provide proper foundations for a steel mill. Another investigation in this field has recently been authorized to study the foundation characteristics for the proposed Mackinac Straits Bridge.)

Determination of heat transfer characteristics of gases and liquids

Hydrocarbon investigations and studies in gas research for industrial requirements

Studies relating to the development of synthetic lubricants

Investigations in the field of fluid flow

Determination of the machinability characteristics of metals, a field of prime importance as much of the material in industry and for defense requires machining

Elimination or reduction of noxious gases from ducts and chimneys

Photo-elastic studies

Investigations in the field of natural illumination and the application of glass blocks in this field

Determination of the composition and temperature of the upper atmosphere, a program of work which is performed both at

the University and at the test field at White Sands, New Mexico

Studies relating to improvements in the magnetron tube, a unit which is very important in radar

Studies relating to the construction of a synchrotron, of great importance in the field of nuclear energy

Reduction of noise in bearings, gears, automobiles, and various defense units for the Army, Navy, and Air Corps

Investigations of a mathematical nature dealing with military strategy

Shock tube investigations

It is difficult, indeed, to pick out any one investigation from the above group and others not listed as being of greater importance than any of the others. A relatively minor investigation, such as was carried out a few years ago to determine the stresses in steam pipe for one of the large paper mills in the State, may be of as much benefit as an investigation which involves a large outlay of capital. In fact, that investigation was of outstanding benefit to the paper mill and therefore was of real value to the people in the Kalamazoo area in which it is located.

The investigation requiring the largest expenditure of funds is the work in defensive guided missiles. It is expected that this work will very shortly go forward at the rate of about $2,000,000 a year and it is, of course, of prime importance and value in case enemy forces attempt to attack our country by means of bombs or guided missiles. The study is not only complicated but also involves many fundamental studies in various fields of engineering, including mathematics.

The work in the field of natural illumination through the application of glass blocks to school buildings is of real importance to the nation as a whole. The blocks, which are being made by a large industrial organization, have been designed at the University so that they will give a maximum of even illumination in all parts of a room. This investigation has met with marked success, and many of our schoolhouses are now being equipped with glass blocks along the principles laid down as a result of this study. As a matter of fact, some of the finest facilities for investigations in this field have been provided by the University, with the help of the industrial organization supporting the studies. At this writing, a model schoolhouse has just been completed in Massachusetts. It is laid out along the lines proposed by those in charge of the investigation. It is assumed that it will be used as a model for many of the school buildings in that state. The model schoolroom at the University has been used for similar demonstration purposes, with special reference to the buildings in Michigan, Ohio, and Indiana.

The investigations in the field of the proper design of harbors for small vessels and of breakwaters to prevent beach erosion should be of immense value to the people in the State of Michigan, since this State has the longest shore line of any of the states in the Great Lakes area. Already one such harbor has been completed, another one is nearly done, and work is started on a third.

SOURCE OF FUNDS AND EXTENT OF WORK

The support of the investigations to which attention has been called is from industrial and government units. The number of projects supported by industrial funds far exceeds the number supported by government funds, although the amount made available by each of the government projects, in general, exceeds the amount made available for each of the industrial projects. For instance, of the total 210 projects which are covered in this report 150 were supported by industrial interests and 60 by government agencies. However, the total amount made available by the government agencies is about six times that made available by the industrial interests. This is shown in the following table, wherein the number of projects and the amounts spent on the projects are shown for both the industrial and the government interests. In this connection, one project has been set forth by itself, namely, Project M679, which is the work for the Air Materiel Command on guided missiles.

TABLE I

DISTRIBUTION OF COSTS OF SPONSORED RESEARCH IN ENGINEERING AND PHYSICAL SCIENCES
July 1, 1949 - June 30, 1950

School or College and Department	Number of Projects			Research Costs			
	Indus.	Govt.	Total	Industrial	Project M679	Other Govt.	Total
Engineering							
Aeronautical	4	5	9	$ 14,461.48	$ 893,538.51	$ 210,369.00	$1,118,368.99
Chem. and Met.	54	9	63	122,160.91	-	222,649.88	344,810.79
Civil	43	7	50	45,818.17	-	45,454.25	91,272.42
Electrical	5	5*	10*	38,745.19	196,045.54	162,196.43	396,987.16
Eng. Mechanics	1	4	5	-	-	45,825.07	45,825.07
Mechanical	6	3	9	26,271.98	-	132,761.83	159,033.81
Metal Processing	8	0	8	20,725.14	-	-	20,725.14
Total Engineering	121	33	154	268,182.87	1,089,584.05	819,256.46	2,177,023.38
Engineering Research	10	0	10	23,473.62	-	-	23,473.62
Architecture	1	0	1	21,215.32	-	-	21,215.32
Forestry	3	0	3	11,339.26	-	-	11,339.26
Lit.,Science and Arts							
Astronomy	0	2	2	-	-	11,085.62	11,085.62
Botany	1	0	1	5,561.19	-	-	5,561.19
Chemistry	1	1	2	2,722.81	-	2,512.93	5,235.74
Economics	1	0	1	432.63	-	-	432.63
Geology	0	2	2	-	-	3,575.26	3,575.26
Mathematics	0	5*	5*	-	24,897.14	37,600.37	62,497.51
Philosophy	1	0	1	21,593.24	-	-	21,593.24
Physics	10	16	26	21,644.21	-	216,967.83	238,612.04
Social Sciences	0	1	1	-	-	-	-
Total L. S. and A.	14	27	41	51,954.08	24,897.14	271,742.01	348,593.23
Public Health	1	0	1	-	-	-	-
Grand Total	150	60	210	376,165.15	1,114,481.19	1,090,998.47	2,581,644.81**

* Does not reflect project count on M679, as this project count is under Aeronautical.

** To make this report comparable to preceding Annual Reports, $15,170.61 of the total represents encumbrances and certain other incidental accounts not included in the financial report of the University.

STAFF

To carry forward the work of the Institute, naturally, a considerable staff is required. The staff consists of both full-time and part-time employees. There are administrative assistants, members of the faculty, Provost appointees (which means that these persons have at least a bachelor's degree and many of them a doctor's degree), appointees on projects who are essentially technicians, hourly assistants on projects (mainly graduate students), and office staff. The sum totals for the year 1948/1949 and the year 1949/1950 are given in Table II. The number of people employed in any one month was between 600 and 700.

TABLE II

	1949/1950	1948/1949
Administrative Staff	6	6
Members of the Faculty	161	161
Provost Appointees on Projects	205	182
Personnel Office Appointees on Projects	186	157
Hourly Assistants on Projects	484	493
Office Staff	47	65
	1089	1064

FUNDS ADMINISTERED BY THE INSTITUTE

Of the total funds handled by the Institute, $2,012,301.04 was for direct costs and $569,344.54 was reimbursement for indirect costs of projects. About one-third of this was for the operation of the Institute, with the remaining two-thirds for the sponsorship of research and other activities for the well-being of the University.

The information with regard to expenditures for research equipment, research building facilities, research travel, and research is given in Table III. This shows that a total of approximately $150,000 was spent

TABLE III

EXPENDITURES FOR RESEARCH EQUIPMENT,

RESEARCH BUILDING FACILITIES, RESEARCH TRAVEL, AND RESEARCH

July 1, 1949 - June 30, 1950

	Building Facilities	Research Equipment	Research Travel	Research	Total
Willow Run Research Center	$16,478.13	$ 7,462.22	$ 776.24	$ 6,103.41	$ 30,820.00
Reserve for Other Departments		30,307.15	6,886.86	35,182.92	72,376.93
E. R. I. Grants from Current	168.89	2,964.72	4,308.31	6,107.87	13,549.79
High Temperature Lab. (DE-8)	20,500.00	12,995.65			33,495.65
Total	$37,147.02	$53,729.74	$11,971.41	$47,394.20	$150,242.37

for this purpose. The expenditure would represent the income at three per cent of $5,000,000.

NEEDS

The Institute, since it was established, has always been handicapped by lack of space. This has been true with space for both clerical and technical work. The facilities for the clerical work have been materially improved through the temporary acquisition of the Mary Markley House.

However, the matter of space for technical work has not undergone any improvement, and this has resulted in preventing the Institute from doing as much work as some feel it should do.

This handicap due to lack of space should not be attributed to a lack of cooperation from instructional departments. As a matter of fact, the Director has frequently been advised by various department chairmen that they would like to undertake a proposed program of work but that they have no space available. Also, in many cases, the work of the Institute has been handicapped because it is difficult to carry on research work in laboratories which are engaged in undergraduate instruction. Research and graduate instruction are often compatible, but this cannot be said for research and undergraduate instruction.

Suggestions have been made with regard to the advisability of a research center for both research and graduate instruction. Such a center might provide a number of buildings, some of which might be designated for specific purposes.

For instance, there could very well be a general laboratory building for physics. The Physics Department has been approached to take over

all work relating to the development of a proximity fuze. This suggestion has come from the Applied Physics Laboratory in Washington, which has given thought to the transference of this work to the University, in view of the fact that they have been requested to utilize their entire facilities for work on offensive guided missiles. This action on their part is in line with government policies to increase the work in the field of guided missiles, both of an offensive and defensive type, just as the Institute is increasing its activity in that field.

Also, in this same connection, a special acoustics laboratory is becoming increasingly necessary. Work in this field is now done in two different laboratories. The facilities are not as outstanding as they were a few years ago and should, beyond question, be modernized. The Institute has been approached to undertake a large-scale investigation involving acoustics in a field which is of primary importance to some of the defense needs of our country.

The synchrotron now being built in Randall Laboratory should be in a separate building because of the hazards, through stray currents, to the building itself and to the people working in the building. The same might also be said with regard to the cyclotron. A building to house properly both the synchrotron and the cyclotron, with needed facilities, would cost well over $1,000,000. Buildings to house both these units, without all the special facilities, would cost considerably less, and a building for the synchrotron alone would cost still less.

The conditions under which the Institute operates in its high-temperature work are far from satisfactory, although the floor space is probably adequate. The work is being done on the first, second, fourth, and fifth floors of the East Engineering Building and in a laboratory

which has been constructed adjacent to the Laundry. These locations do not make a favorable impression, considering the importance of the work, on such interests as the National Advisory Committee for Aeronautics, whose principal laboratory among educational institutions is here.

The laboratories for the guided missile work will hardly be adequate with the enlarged program which is in prospect. This means that it will be necessary to do expensive remodeling of the facilities which are now at the Willow Run Research Center or to construct buildings to house the present and future work in a location nearer to the University than the present Willow Run Research Center. If a new building could be constructed relatively close to the University, it is believed that much of the criticism to the effect that the Willow Run Research Center is not essentially a part of the University would be removed.

Buildings are needed for wind-tunnel work: one for a wind tunnel of low turbulence, and another for a supersonic wind tunnel. Although there is a supersonic wind tunnel at the Willow Run Research Center, it is not altogether satisfactory and is not conducive to bringing much supersonic work to the University of Michigan, especially when one compares it with the one at the Massachusetts Institute of Technology or the one at the California Institute of Technology.

A so-called "hot" laboratory for work which is expected from the Atomic Energy Commission is particularly needed. Space has already been made available for the "hot" feature of the laboratory. It will be adequate for a year or two, but after that time, if the proposed work for the Atomic Energy Commission is to go forward, new facilities will be needed.

Also, proper quarters are needed for the work on theories relative to the nature of combustion.

The equipment for concentration, evaporation, and distillation of liquids, which is now in the laboratories of the East Engineering Building, should be placed in quarters by itself, since the space in the East Engineering Building is badly needed by the Department of Chemical and Metallurgical Engineering for other purposes. The equipment is essentially for graduate instruction and research and could properly be housed in a building of its own in a research center.

There is also need for a hydraulics laboratory, wherein work could be done in hydraulics as well as in wave studies similar to those which are now being made at the Willow Run Research Center. Such a laboratory, of course, should be adjacent to the Huron River for an adequate water supply.

ACKNOWLEDGMENTS

It is obvious that this report covers the work not of only one person but of all those who have participated in the work of the Institute. The assistance given to the Institute by Dr. Perkins is especially appreciated. The friendly cooperation of the Engineering Research Council has also been most helpful. The attitude of the department chairmen in giving their time to the consideration of research projects and making facilities available is gratefully acknowledged.

Also, the Director wishes to thank personally all the members of the staff, including those engaged in administrative and clerical work as well as those in the technical fields, for their support and assistance.

Respectfully submitted,

A. E. White
Director

A D D E N D A

WILLOW RUN RESEARCH CENTER

The following material is taken from a report furnished by Mr. A. P. Fontaine, Director of the Willow Run Research Center. The information in the tables on pages 14 and 15 is partly incorporated into the main body of this report, although they show the operations at the Willow Run Research Center in fuller detail than does the Director's report.

Nature of the Work

All the work which has been conducted at the Willow Run Research Center during the past year has been Government sponsored and has had an important bearing upon the national defense problems so vital at this time. The investigations which were conducted are of a highly classified nature, and it is impossible to divulge in this report specific details concerning the nature of the work. It is desirable to mention, however, that the major contract (M679) of the Research Center has been revised and supplemented to require more analytical work and less actual laboratory work. This has resulted in an increase in the percentage of technical and scientific personnel required, particularly mathematicians and physicists. Considerable simulation and automatic computation has been utilized for improving the efficiency of the work. This not only increases the rate at which the work can be accomplished but also provides a means of checking theoretically calculated results.

The work undertaken through these governmental contracts covers a large variety of subjects, including: Operational Analysis, Systems Analysis,

Simulation, Electronics, Controls, Propulsion, Aerodynamics, and Acoustics. Work in some of these fields has necessitated laboratory tests to verify or establish limits for certain basic parameters used in the calculations. These tests have led to the establishment and expansion of many of the facilities necessary for conducting this type of work.

Projects

The Willow Run Research Center has conducted research during the past year on several projects for the Armed Services. The largest by far was Project M679 for the U.S.A.F., Air Materiel Command. The amount spent on this one project alone was $1,114,481 or 88.5 per cent of the total. The rest of the work was done on other projects for the Air Materiel Command and on a project for the Department of the Army, Detroit Arsenal.

The total dollar volume of work was $1,259,992 during the past year, compared with $1,293,000 during the previous year. The total cost as distributed in accord with standard Engineering Research Institute practice is as follows:

School or College and Department	Research Cost
Engineering	
Aeronautical	$ 801,648.62
Chemical and Metallurgical	1,659.10
Electrical	196,045.54
Mechanical	235,741.79
Total Engineering	$1,235,095.05
Literature, Science and the Arts	
Mathematics	24,897.14
Total	$1,259,992.19

The work of Project M679 has become an increasingly important part of the nation's overall defense program. The staff and facilities

built up for conducting this work are such that the University's role in the program is certain to become increasingly important during the coming year.

Staff

Normal employment of the Willow Run Research Center for the past year averaged about 245 persons per month, full- or part-time.

Distribution of the staff varies from month to month. Using February, 1950, as a representative month of this period, the distribution according to educational qualifications was as follows:

Degree	Number of Persons		Per Cent Part-time Participation
	Full-time	Part-time	
Ph.D.	6	8	26
M.S.	30	25	42
B.S.	45	36	46
Other	64	42	47
Total Personnel:	256		

During the representative month, 79 graduate students were employed part-time, with an average of 47.2 per cent participation. This accounts for 13 per cent of the total personnel payroll.

Part-time faculty personnel during the same month numbered 24 and accounted for 7 per cent of the total personnel payroll.