Characteristics of the twelve non-profit research institutions

George Paul Avellano

The University of Montana

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CHARACTERISTICS OF THE TWELVE NON-PROFIT RESEARCH INSTITUTIONS

By

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B.S., Eastern Illinois University, 1967

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1970

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Dean, Graduate School

Date April 21, 1970
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CHAPTER I

INTRODUCTION

Since 1957 and the launching of the first Sputnik by the Russians, the federal government and industry have increasingly relied on scientific research for technological innovation.

In the early 1950's the federal government's annual expenditures for scientific research were $1 billion. By 1965 the federal allocations for scientific research increased to $14 billion, and in 1968 totaled $17 billion. In 1968 industrial expenditures for scientific research totaled $18 billion, a six per cent increase over the 1967 figures. As the federal and industrial budgets for scientific research grew, the nation's dependence on technological innovation became more pronounced.

Purposes of the Study

The objectives of this study are (1) to describe the characteristics of independent non-profit research institutions in the United States and (2) to illustrate through select examples the range of technological innovations which

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they have made for industry and government.

S. L. Fawcett, President of Battelle Memorial Institute, defines technological innovation by examining each word in the statement independently. One definition of technology in which Dr. Fawcett concurs is "the totality of means employed to provide objects necessary for human sustenance and comfort." This definition blends engineering, business and economic knowledge, and experience for use in scientific investigation. To innovate is "to introduce as or if new; to make changes." Technological innovation is the end product of various combinations of all the means necessary to provide entirely new or modified products for human sustenance and comfort.

In terms of areas of research, the innovative process at the non-profit research institute involves the physical and life sciences, engineering, economics and the behavioral sciences. In a time when interdisciplinary research is a well established concept, the non-profit research institute is in an important position, relative to other research organizations, in providing the range of skills and disciplines necessary to conduct scientific research for the benefit of mankind. Technological innovation serves many needs of industry, state, and federal governments. These needs include fundamental studies in pure research for the sake of acquiring new knowledge, and

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applied research for the development of new products and processes.

Since this study deals only with the non-profit research institute, it is necessary to differentiate such an institution from other research organizations. The primary distinction made between the "non-profit" and the "profit" research organization is one of legality. The non-profit research institutions differ from other research organizations in that the non-profit institute is legally chartered as "non-profit." Although these research institutions do earn profits, financial gain is not their main objective. All profits are legally required to be reallocated to research operations. No dividends are distributed to shareholders as is the case for profit-oriented research organizations. The non-profit research institute is established solely to conduct scientific research for the benefit of mankind.

Justification for the Study

In 1969 Dr. Ronald S. Paul, a vice president at Battelle Memorial Institute, Washington, presented a lecture at the University of Montana entitled "The Science Business--Pure and Applied Research and Its Support." The lecture dealt with the non-profit research institute, its functions in research and development and the financial structure required to support the research institutions' research and development programs. Dr. Paul's lecture created a great
deal of interest among the students of business and economics and led many to seek further material on the subject. It soon became apparent that information about the operations of the non-profit research institutions was limited. A thorough search of secondary material in the library revealed few references to the non-profit research institutions. This absence of pertinent information about the operations and output of the non-profit research institutions led to the realization of a need for a synthesis of characteristics of these research institutions. A descriptive study does not exist, and it was therefore thought that one such as this would be of educational value.

**Scope of the Study**

There are approximately 5,000 profit and non-profit research organizations in the United States today. Among these organizations are large university laboratories, medical centers and industrial research centers; these research organizations are excluded from this study. Those which are included in this study are the non-profit research institutions and their affiliates.

The population sampled included twelve non-profit research institutions; only twelve exist in the United States today. The oldest institutions were all established before

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World War II. Initially they were formed to carry out exploratory research. The early areas of research included chemistry, metallurgy, and the physical sciences. Today, the non-profit research institutions have a research spectrum from atomic energy, marketing surveys on consumer goods, and the discovery of an inoculation for the cure of leukemia, to the invention of the first stay-press fabric.

The research institutions surveys are listed by date of charter:

- **Mellon Institute of Industrial Research**
  1913
  Pittsburgh, Pennsylvania

- **Battelle Memorial Institute**
  1925
  Columbus, Ohio

- **Illinois Institute of Technology Research Institute**
  1936
  Chicago, Illinois

- **Southern Research Institute**
  1941
  Birmingham, Alabama

- **Midwest Research Institute**
  1944
  Kansas City, Kansas

- **Franklin Institute Research Laboratory**
  1946
  Philadelphia, Pennsylvania

- **Stanford Research Institute**
  1946
  Menlo Park, California

- **Southwest Research Institute**
  1947
  San Antonio, Texas

- **Cornell Aeronautical Laboratory**
  1948
  Buffalo, New York
Research Triangle Institute
1955
Triangle Park, North Carolina

Spindletop Research Institute
1961
Lexington, Kentucky

North Star Research and Development Institute
1963
Minneapolis, Minnesota

Only two of the above research institutions have more than one establishment in the United States. They are Battelle Memorial Institute and Mellon Institute of Industrial Research. Battelle's Washington state atomic energy plant is located near Seattle, and Mellon's Bushy Run laboratory is twenty-five miles north of Pittsburgh, Pennsylvania. The other ten research institutions are self-contained within the areas stated in the preceding list. Although a few of the research institutions such as Battelle and Stanford operate research facilities outside the United States, these overseas laboratories will not be included in this study.

Methods

Secondary information consisting of pamphlets, newspapers, newsletters and president's reports published by the non-profit research institutions was obtained through correspondence with those organizations. Other information was acquired from scientific journals. Books pertinent to the study were read to gain perspective on the research institute.
Primary information was obtained through correspondence with the research institutions, beginning with a letter requesting information about the operations of their research operations. All twelve research institutions responded by providing data and a willingness to cooperate in this study.

Questionnaires were sent to a specific member of each research institute. The questionnaires were designed to obtain information not available in secondary sources. Data obtained from the questionnaires were used to complete seven tables. In the questionnaires the following questions were asked:

1. Who was your first president and what was his research background?

2. What was the amount and source of the initial capital investment available to your research institute at its formation?

3. What was your 1968 contract research income and total contract research income from date of charter to 1968?

4. How many research projects were contracted for by your research institute in 1968 and from date of charter to 1968?

5. How many employees did your research institute have on its staff in 1968; what was your total payroll for 1968; how many scientists and engineers did you have on your staff in 1968; of your scientists and engineers in 1968,
how many had a doctorate or masters degree?

6. How many patents did your research institute apply for and receive in 1968 and from date of charter to 1968?

7. What were your 1968 salary ranges for: research division directors; research department managers; new doctorate staff members; new masters staff members?

There was a 100 per cent return of the questionnaires.

Limitations of the Study

The investigation was impeded by the limited amount of secondary information available about non-profit research institutions. As a result, it was necessary to acquire information by correspondence with the research institutions. In the process of corresponding with the research institutions, invaluable, unpublished, primary data was obtained. These primary data proved to be both sufficient and appropriate for study.

Personal interviews with specific members of each research institution's staff were not made because of the cost and amount of time required. In addition, sufficient information was obtained through a study of secondary data sources and by mail questionnaires.

Definitions

The more frequently used terms in this study are defined as follows:

Non-Profit Research Institute. The non-profit
research institute is largely characterized by two major features: (1) it is of a non-profit nature, and (2) it has no corporate or ownership connection with any other type of organization. In addition, non-profit research institutions are primarily established to perform research which is beneficial to society in general.

**Contract Research.** The agreement between a client and a research institute whereby the latter performs certain types of research activities for the former is considered to be contract research. It differs from that research which the institute performs without having an outside sponsor.

**Product Development.** Product development is the process of creating new products or modifying existing ones for the market place.

**Order of Presentation**

Chapter II provides descriptive characteristics of the non-profit research institute. It presents their objectives, first presidents, formation capital and source, areas of research, clientele, contract research, prime source of income and tax status.

The purpose of Chapter III, "Technological Innovation," is to illustrate through select examples the range of technological innovations which the research institutions have made for industry and government. This chapter defines technological innovation and gives examples of its application.
to product development, industrial expansion, and new industrial development where none previously existed.

Chapter IV consists of a summary and conclusions of the study.

Biographical data on the non-profit research institutions are incorporated in the Appendix.
CHAPTER II

DESCRIPTIVE CHARACTERISTICS OF THE NON-PROFIT
RESEARCH INSTITUTIONS

This chapter provides descriptive characteristics of non-profit research institutions in the United States. There are twelve such institutions. Of these, six were established between World War II and 1948. Research Triangle was chartered following the Korean conflict, and Spindletop and North Star were chartered during the Vietnam War.

The non-profit research institute is characterized by two major features: (1) it is of a non-profit nature, and (2) it has no corporate or ownership connection with any other type of organization.

All non-profit research institutions state as their major objectives: (1) the advancement of scientific knowledge and education through creative research, (2) scientific research which aids federal, state and local governments and industry, and (3) research which is beneficial to mankind.

Other characteristics of the non-profit research institutions to be investigated are: research backgrounds of their first presidents, initial capital for investment and source, areas of research, clientele, the research contract, the prime source of income, and tax status. Another characteristic of the research institute is technological
innovation, which will be dealt with separately in Chapter III.

First Presidents

Typically, the institutions were under the directions of individuals who had experience in scientific research and management. Over half of the institutions employed presidents who were former research directors of previously established research organizations (see Table 1). All were educated in various fields of engineering. This pattern is still evident today. Several of the institutions began operations with executive committees.

The first presidents represented the research institutions in their attempts to acquire the necessary capital to begin operations. Initial capital for investment came from several sources.

Formation Capital and Source

State governments, industrial concerns, and private donors provided initial capital investments for the formations of non-profit research institutions. Seven of the twelve research institutions received initial capital funding from their state governments. Two research institutions relied on capital from private donors. The source and amount of initial capital for each institution are found in Table 2.

Cornell and Illinois received initial capital funding from individual corporations. Cornell was chartered
### TABLE 1

THE FIRST PRESIDENTS OF THE NON-PROFIT RESEARCH INSTITUTIONS AND THEIR RESEARCH BACKGROUNDS

<table>
<thead>
<tr>
<th>Institute</th>
<th>First Presidents</th>
<th>Research Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>Horace W. Gilbert</td>
<td>Metallurgical Engineer</td>
</tr>
<tr>
<td>Cornell</td>
<td>H. J. Wright</td>
<td>Vice President of Research, Curtiss-Wright Corporation</td>
</tr>
<tr>
<td>Franklin</td>
<td>Executive Committee</td>
<td>..</td>
</tr>
<tr>
<td>Illinois</td>
<td>William E. Hotchkiss</td>
<td>Vice President of Research, Armour Packing Company</td>
</tr>
<tr>
<td>Mellon</td>
<td>R. K. Duncan</td>
<td>Research Sociology Professor, University of Kansas</td>
</tr>
<tr>
<td>Midwest</td>
<td>Executive Committee</td>
<td>..</td>
</tr>
<tr>
<td>North Star</td>
<td>John W. Clegg</td>
<td>Chemical Engineer, Illinois Institute</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>George R. Herbert</td>
<td>Associate Director, Stanford University</td>
</tr>
<tr>
<td>Southern</td>
<td>Thomas Wesley Martín</td>
<td>Vice President of Research, Martin-Marietta Corporation</td>
</tr>
<tr>
<td>Southwest</td>
<td>Harold Vagtborg</td>
<td>Research Engineer</td>
</tr>
<tr>
<td>Spindletop</td>
<td>Beardsley Graham</td>
<td>Assistant Director Stanford Institute</td>
</tr>
<tr>
<td>Stanford</td>
<td>William Talbot</td>
<td>Research Director, Sun Chemical Company</td>
</tr>
</tbody>
</table>
TABLE 2
AMOUNT AND SOURCE OF INITIAL CAPITAL INVESTMENT
AVAILABLE TO THE NON-PROFIT RESEARCH
INSTITUTIONS AT FORMATION

<table>
<thead>
<tr>
<th>Institute</th>
<th>Initial Capital Investment</th>
<th>Source of Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>$2,000,000</td>
<td>Gordon and Annie Battelle</td>
</tr>
<tr>
<td>Cornell</td>
<td>5,000,000</td>
<td>Curtiss-Wright Corp.</td>
</tr>
<tr>
<td>Franklin*</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Illinois</td>
<td>35,000</td>
<td>Armour Meat Packing Co.</td>
</tr>
<tr>
<td>Mellon</td>
<td>1,500,000</td>
<td>Andrew and Richard Mellon</td>
</tr>
<tr>
<td>Midwest</td>
<td>2,000,000</td>
<td>300 companies, individuals and foundations; State of Kansas</td>
</tr>
<tr>
<td>North Star</td>
<td>3,786,000</td>
<td>Minneapolis-St. Paul; industry</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>2,000,000</td>
<td>State of North Carolina; industry</td>
</tr>
<tr>
<td>Southern</td>
<td>5,000,000</td>
<td>State of Alabama; industry</td>
</tr>
<tr>
<td>Southwest</td>
<td>100,000</td>
<td>Thomas Slick; State of Texas; industry</td>
</tr>
<tr>
<td>Spindletop</td>
<td>3,000,000</td>
<td>State of Kentucky; industry</td>
</tr>
<tr>
<td>Stanford</td>
<td>3,000,000</td>
<td>State of California; industry</td>
</tr>
</tbody>
</table>

*Data on Franklin are not available.
after World War II when the Curtiss-Wright Corporation (producers of World War II military aircraft) discontinued their operations in Buffalo, New York, and turned over their laboratories to Cornell University. Cornell University chartered the newly acquired laboratories as a non-profit research institute, thereby creating the Cornell Aeronautical Laboratory. Armour Meat Packing Company of Chicago gave its research facilities to the Illinois Institute of Technology, and the University chartered the research facilities in 1936 as the Illinois Institute of Technology Research Institute.

Although corporations and private donors funded several of the research institutions, the vast majority of these institutions received initial capital funding from a combination of state governments and industrial concerns.

War has contributed to the financial development of the research institutions, as it has contributed to industrial growth. War's exigencies have effectively brought science to the foreground, and the research institutions were among those forces which effected scientific exchange between the laboratory and the battlefield. This exchange caused the research institutions to specialize in areas pertinent to national security.

Areas of Research

Major divisions of knowledge which characterize the scope of research institutions include: atomic energy,
mechanical engineering, chemical engineering, electronics, metallurgy, systems analysis, operations research, economic analysis, biological science, and behavioral science.

These divisions are further divided into such subdivisions as: radioisotopes, solid and fluid dynamics, organic and inorganic chemistry, circuit design and development, x-ray and electron diffraction, computer process control systems, mathematical modeling, marketing and distribution, cancer research, and psychology and the human factor.

The preceding examples of divisions and subdivisions of research are by no means complete lists. They are examples used to illustrate the broad range of research being conducted at the research institutions. The variety of areas of research which these institutions provides attracts clientele.

Clientele

The largest contractor with the non-profit research institute is the federal government. Agencies of the federal government pay for 50 to 75 per cent of the present research conducted by the research institutions (see Table 3). State and local government and industrial contracts account for the remainder of that percentage. Research for state and local governments is not limited to the home state of the institute. Any state government, township, county, educational district, city government outside of the home
<table>
<thead>
<tr>
<th>Institute</th>
<th>Federal Government</th>
<th>State, Local Government and Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>60.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Cornell</td>
<td>70.6</td>
<td>29.4</td>
</tr>
<tr>
<td>Franklin</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Illinois</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Mellon</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Midwest</td>
<td>60.0</td>
<td>40.0</td>
</tr>
<tr>
<td>North Star</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>70.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Southern</td>
<td>75.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Southwest</td>
<td>60.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Spindletop</td>
<td>55.0</td>
<td>45.0</td>
</tr>
<tr>
<td>Stanford</td>
<td>70.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>

Note: Over 90 per cent of contract research with state and local government and industry is attributed to industry.
state is a potential client.

The percentage of contract research conducted for industry by the non-profit research institutions varies from 50 to 25 per cent. Of this contract research, most research is done for large companies. More than 70 per cent of such research is sponsored by companies included by Fortune magazine in its annual listing of the 500 largest companies in the United States.

**Contract Research**

The agreement between a client and a research institute whereby the latter performs certain types of research activities for the former is considered to be contract research. The procedures the research institute follows to establish contract research with a client are:

1. Identification of the research problem by direct discussion or correspondence with the interested organization or individual.

2. A meeting between the client and staff members of the research institute to discuss the project.

3. Staff conferences to explore various approaches to the problem.

4. Assignment of a project leader.

5. Preparation of a research contract by the division responsible for the project.

**Research Contract.** The research contract contains the following provisions:
1. Statement and definition of the project scope and goal.

2. Statement of the factors which create the problem and a justification of the study.

3. Estimation of the time needed for project completion and maximum costs.

4. A stipulation that inventions made by the institute belong to the client.

5. A stipulation that the institute will maintain open communications with the client concerning the project and submit a final report to the client upon project completion.

**Contract Fee.** The contract fee is determined by the direct cost of the proposed research project, including a percentage of the research overhead. The client usually reimburses the institute monthly for actual costs incurred for the month. Monthly costs include salaries for all technical personnel directly engaged with the project, costs of travel concerning the project, materials used for the project and special items purchased directly for the project.

The per cent of overhead portion included in the contract varies among institutions. Government contract fees are set by negotiations at approximately 6 per cent. Government research contracts do not allow interest on borrowed capital or the cost of preparing the research proposal.
Patent Procedures. In the event that the institute develops an invention while working on the client's project, the institute will make the invention known to the client. The institute will make the application for patents with all rights reserved for the client. The client must pay the cost of the patent application.

Post-Contract Follow-Up. The research institute's interest in a project may continue even after the time period designated in the contract expires. The institute follows the original contract with post-contract follow-up: It suggests new avenues for research, patentability of available discoveries, and it includes a critical evaluation of the project.

Contract research is not the only source of income available to the research institute, but it is its primary source of income. Other sources of income are foundations, donations, patents and published materials.

The Prime Source of Income

The largest research institute in 1968 was Battelle Memorial Institute with approximately $125 million in research contracts. Stanford Research Institute was the second largest research institute with $60 million, followed by Cornell Aeronautical Laboratory with $32.4 million. The smallest research institute in 1968 was North Star with $1.1 million; for the other institutions see Table 4.

Viewing the total dollar volume of contract research
<table>
<thead>
<tr>
<th>Institute</th>
<th>Contract Research for 1968</th>
<th>Total Contract Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>$125,000,000</td>
<td>$775,000,000</td>
</tr>
<tr>
<td>Cornell</td>
<td>32,400,000</td>
<td>300,000,000</td>
</tr>
<tr>
<td>Franklin</td>
<td>7,000,000</td>
<td>50,000,000</td>
</tr>
<tr>
<td>Illinois</td>
<td>29,000,000</td>
<td>450,000,000</td>
</tr>
<tr>
<td>Mellon</td>
<td>1,000,000</td>
<td>6,900,000</td>
</tr>
<tr>
<td>Midwest</td>
<td>7,000,000</td>
<td>65,000,000</td>
</tr>
<tr>
<td>North Star</td>
<td>1,100,000</td>
<td>3,400,000</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>5,400,000</td>
<td>26,500,000</td>
</tr>
<tr>
<td>Southern</td>
<td>6,500,000</td>
<td>130,000,000</td>
</tr>
<tr>
<td>Spindletop</td>
<td>2,000,000</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Stanford</td>
<td>60,000,000</td>
<td>750,000,000</td>
</tr>
</tbody>
</table>
from date of charter to 1968, Battelle ranked first with $775 million; Stanford was second at $750 million. North Star, the youngest research institute, had the smallest volume.

A few of the research institutions have received significant incomes from contract research. Although the non-profit research institutions are the largest of the research organizations in the United States, they have remained relatively small in relation to other sectors of the economy such as manufacturing and agriculture.

Research Projects. The average income per project varies significantly among the research institutions. For example, in 1968 Cornell had approximately the same number of research projects as Spindletop, but Cornell's contract research income was sixteen times as great as Spindletop's contract research income. Cornell ranked number ten in the number of research projects, but was third in income from contract research.

The institutions with the largest number of research projects for 1968 were Battelle, Illinois, and Stanford. The institutions with the largest dollar amounts of contract research for 1968 were Battelle, Stanford, and Cornell. Table 5 gives the number of projects each institute had in 1968 and cumulative from date of establishment. Table 6 shows average income per project for a select number of institutions.
TABLE 5
RESEARCH PROJECTS FOR 1968 AND TOTAL RESEARCH PROJECTS SINCE DATE OF CHARTER

<table>
<thead>
<tr>
<th>Institute</th>
<th>Number of Projects in 1968</th>
<th>Total Number of Projects From Charter Date—1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>1,850</td>
<td>14,000</td>
</tr>
<tr>
<td>Cornell</td>
<td>112</td>
<td>271</td>
</tr>
<tr>
<td>Franklin</td>
<td>300</td>
<td>1,500</td>
</tr>
<tr>
<td>Illinois</td>
<td>1,200</td>
<td>15,000</td>
</tr>
<tr>
<td>Mellon</td>
<td>205</td>
<td>1,000</td>
</tr>
<tr>
<td>Midwest</td>
<td>850</td>
<td>3,100</td>
</tr>
<tr>
<td>North Star</td>
<td>80</td>
<td>205</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>163</td>
<td>400</td>
</tr>
<tr>
<td>Southern</td>
<td>245</td>
<td>2,242</td>
</tr>
<tr>
<td>Southwest</td>
<td>712</td>
<td>2,400</td>
</tr>
<tr>
<td>Spindletop</td>
<td>100</td>
<td>246</td>
</tr>
<tr>
<td>Stanford</td>
<td>900</td>
<td>7,000</td>
</tr>
</tbody>
</table>

Note: The majority of research projects are completed within a two- to four-year period.
### TABLE 6

**1968 AVERAGE INCOME FROM CONTRACT RESEARCH**

<table>
<thead>
<tr>
<th>Institute</th>
<th>Average Contract Research Income Per Project—1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford</td>
<td>$66,000</td>
</tr>
<tr>
<td>Battelle</td>
<td>64,000</td>
</tr>
<tr>
<td>Cornell</td>
<td>29,000</td>
</tr>
<tr>
<td>Illinois</td>
<td>24,000</td>
</tr>
<tr>
<td>North Star</td>
<td>13,000</td>
</tr>
</tbody>
</table>

Note: Figures have been rounded to the nearest thousand dollars.

**Employment and Wages.** During 1968 Battelle had the greatest number of employees and was first in the number of research projects and contract research. Stanford had the second greatest number of employees, was third in the number of research projects and second in dollar volume of contract research. Employment size, payroll and types of degrees held by employees are given in Table 7.

**Tax Status**

The non-profit research institute is chartered as a tax exempt corporation. The qualifications for tax exemption are defined by the Federal Treasury Department and the research institute's home state tax board.

**Federal Tax Regulation.** The revised 1961 tax regulation (Regulation 1.501 (C), (3), Internal Revenue)

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<table>
<thead>
<tr>
<th>Institute</th>
<th>Number of Employees</th>
<th>Payroll (in dollars)</th>
<th>Scientists</th>
<th>Engineers</th>
<th>Ph.D.</th>
<th>M.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle</td>
<td>5,900</td>
<td>$53,000,000</td>
<td>1,700</td>
<td>300</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>Cornell</td>
<td>1,534</td>
<td>6,500,000</td>
<td>63</td>
<td>90</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>Franklin</td>
<td>350</td>
<td>3,000,000</td>
<td>150</td>
<td>40</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>1,850</td>
<td>16,600,000</td>
<td>1,250</td>
<td>200</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>Mellon</td>
<td>562</td>
<td>5,000,000</td>
<td>342</td>
<td>125</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>400</td>
<td>3,700,000</td>
<td>200</td>
<td>75</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>North Star</td>
<td>55</td>
<td>686,000</td>
<td>30</td>
<td>13</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Research Triangle</td>
<td>350</td>
<td>3,300,000</td>
<td>210</td>
<td>50</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td>496</td>
<td>3,900,000</td>
<td>389</td>
<td>49</td>
<td>349</td>
<td></td>
</tr>
<tr>
<td>Southwest</td>
<td>1,004</td>
<td>9,000,000</td>
<td>337</td>
<td>50</td>
<td>287</td>
<td></td>
</tr>
<tr>
<td>Spindletop</td>
<td>70</td>
<td>365,000</td>
<td>30</td>
<td>7</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Stanford</td>
<td>3,000</td>
<td>30,000,000</td>
<td>2,000</td>
<td>400</td>
<td>1,600</td>
<td></td>
</tr>
</tbody>
</table>
states that the non-profit research organization can engage in a certain amount of research serving private interest; however, federal income tax will be levied on any resulting net income from such private research projects. "Private projects" are defined as projects which are not "public." Public projects include contracts for government agencies, contracts which make available information for public use and research for public welfare.

State Tax Regulation. The non-profit research institute is exempt from state taxation. However, the payrolls of the institutions' employees are taxable.

The tax status of the non-profit research institute is a contributing factor to its financial success. In comparison to the non-profit research institute, research organizations which do not qualify for tax exempt status remain financially small.
CHAPTER III

TECHNOLOGICAL INNOVATION

Technological innovation is the end product of various combinations of all the means necessary to provide entirely new or modified products for human sustenance and comfort. Industry and government are the great implementers of technological innovation, and the non-profit research institute regularly works with both. The sponsors of research range from small companies to the largest corporations, and from government at the municipal level to the national and international level.

An important aspect of the research institute’s mission is to identify inventions and to assist in their development, through scientific research, to a point at which their usefulness is demonstrated. The research institutions have a vital role in the nurturing of inventions and the bridging of distance between inventor, industry, and, ultimately, the consumer.

Some ideas resulting from technological innovation lead to products or concepts so new and untried in the market that they require new venture companies to bring them to the market place. Thus, business structures, themselves, become products of the process of innovation, and the research institute has been active in the creation of new companies when they have been needed to manufacture and market products coming from the laboratory. Nearly
every useful material item in our daily lives is a product of technological innovation. Presently, alliance of industry and science is considered a basic necessity for economic progress; fifty-seven years ago this alliance was unknown. Few companies employed research people of their own. The first time a company established a research program in a university was in 1907. This program was initiated by Dr. Robert Kennedy Duncan. It led to the formation of Mellon Institute of Industrial Research in 1913. Since that time, the non-profit research institutions have conducted research for technological innovation.

Technological Innovations for Government

The research institutions' services to government are an extension of their research for private industry. This extension began when the federal government contracted with the institutions for weapons research at the beginning of World War II. Through contract research the research institutions provide a wide range of technological innovations. The following is a presentation of select examples illustrating this wide range of technological innovation characteristic of the non-profit research institutions.

An economic analysis and strategy game was introduced by Research Triangle at a recent Allied Social Science Association's meeting in Chicago. The game is a mathematical simulation of cause and effect economic relationships in the United States. The program combines policy planning and
future goals with an operations research model for economic forecasting. The game is an aid to government decision making.

Stanford has developed a computer program that translates 50,000 words of Russian into English per minute.

A small battery-operated particle counter and a companion size distribution analyzer have been developed by Southern. The particle counter is used by the federal government for studies ranging from air pollution control to chemical and bacteriological warfare.

A super-tenacity polypropylene fiber has been developed by Southern to be used in armoured vests to protect men in battle. This fiber has a greater strength than any fiber presently on the market. New heat-resistant polymers have also been developed at Southern. These polymers are based on silicon-nitrogen combinations and have potential applications in missile and space technology. Polymer fibers combine the best features of plastics and ceramics.

Representative examples of military achievements of technological innovations at Illinois include: the automatic revolver-type 20mm aircraft cannon, 106mm recoiless anti-tank rifle and new type ammunition, 115mm boosted rocket launcher, and the gyroscopic inertial guidance system for missiles. Other technological innovations at Illinois include: electro-mechanical articulated dummies to test space suits, thermal control coatings for space vehicles,
and a bomb-sensing device to detect possible aircraft hijacks.

The use of the laser for eye surgery was developed by Stanford. The finely concentrated laser energy is used to repair retina tears.

Rather than risk killing birds with insecticides, Stanford developed an insect control device which lures the insects into traps. A sex-attractant compound of the opposite sex is given off by the traps to attract "sexy" insects. Synthetic "eggs" have been developed by Southwest. These eggs are used to raise predator insects. The predator insects are themselves harmless and replace control by insecticides. This substitute for insecticides serves to reduce pollutions from ground-water run-off.

A class of amino acid polymers have been developed at Southwest. These polymers develop films for use as skin substitutes in the treatment of severe burns. A blood clotting control has been developed at Southwest from poly-electrolyte types of amino acid polymers.

Approximately one-third of the world's sulfur resources are contained in surface deposits of volcanic and sedimentary rock. By mixing heated pebbles with crushed ore, Southwest developed a thermal process to remove sulfur from these rocks. Also developed by Southwest is a new paving material used to line catch-basins and irrigation ditches for arid land water management. This new material
derives from fiber-reinforced sulfur. Other sulfur developments include: sulfur-aggregate concretes, sulfur-based traffic marking paint, and sulfur foams for structural application.

Southwest designed a portable fire extinguisher. The fire extinguisher was included in the flight equipment used for the successful Apollo 7 mission. The unit delivers a foam which can be applied to electrical equipment without impairing its function.

Since 1950 Cornell has to its credit numerous technological innovations involving anti-missile systems as defense against intercontinental ballistic missile attack. Examples of related technological innovations at Cornell are: penetration aids for tactical aircraft, radar and electro-magnetic propagation, and off-road mobility of military ground vehicles. Additional examples include future transportation systems for metropolitan areas, shock tube innovations in order to explore re-entry problems at the unparalleled speeds achieved by manned spacecraft returning from distant probes, and effective methods of decreasing snowfall, influencing its location, or even increasing snow as a water source in a selected area.

High hydrostatic pressure is a perimeter of the marine environment to which relatively little attention has been given in studies of ocean fauna and flora. Illinois developed food sources for the future by investigating the
effects of hydrostatic pressure on free living organisms.

**Technological Innovation for Industry**

The non-profit research institutions pioneered the concept of industrial research on a contract basis. It is through such research that it continues to make some of its most significant contributions to technological innovation. The contract concept has made it possible for the research institutions to conduct research which results in a wide range of technological innovations for industry. The following is a presentation of select examples illustrating this wide range of technological innovation.

MICR, a magnetic ink character recognition process, was developed by Stanford. Specially shaped numbers are printed on checks which can be read at speeds of 600 per minute by an electronic system which distinguishes between wave shapes of digits. MICR was developed for Bank of America.

The Southern Pacific Railroad Company contracted with Stanford to research the possibility of a safe, damage-proof box-car for transporting such fragile items as electronic apparatuses, machine tools, and military items such as rockets. The amount of damage to fragile products had run into millions of dollars. The Hydra-cushion freight-car, Stanford's development, alleviates this problem.

Stanford also developed the Long Range Planning
Program for industrial management. This program interprets changes in technical, economic, political, and social fields in terms of their impact on the business environment. It enables management to become aware of various economic changes and current research in industrial problems as they happen. The prime function of the Longe Range Program is to provide a series of reports to management, about 40 per year, on changes which have a major impact on industry.

Prefabricated brick units were developed by Research Triangle for the North Carolina Brick Company. This development gained international attention as a major topic of discussion at the International Structural Clay Products Convention in 1968.

At Stanford several discoveries resulted from research conducted on the manufacturing of tallow for soap-making. These discoveries include a "nylon" plastic from fats and animal feed.

Research on cotton ginning at Southern led to the development of a process which produces cleaner and with fewer "ends down" skeins of cotton. Wash-and-wear fabrics, synthetic rubber for improving the durability of cotton-pile carpets, flame-proofing and weather resisting fabrics, and the disposable garment from a nonwoven process have all been developed by Southern. Southern received the Industrial Research Award in 1964 for their development of the polypropylene fiber. Trade named Polefin, this fiber is of a
plastic composition and is used as a textile material.

The oxygen process for steel production was discovered at Southern, as were the processes of producing cement from blast furnace slag, oil of spearmint from grapefruit, menthol for tobacco from turpentine, and cinnamon from waste oat hulls. Vegetable oil research at Southern resulted in a new nylon processed from oil of crambe, a mustard producing plant. Sugar from wood and potable water from salt water are among the many technological innovations developed at Southern.

North Star's contributions to industry include: a new process for converting wastes from the food industry into animal feed, thereby turning a water pollution problem into a new product; a machine that automatically records the dimension of a client's product, records the serial number and tolerances, and rejects parts that have any dimension outside of specified tolerances; and a new film system for the desalination of seawater and brackish waters by reverse osmosis.

Southern has recently produced stainless steels with strengths approaching 400,000 pounds per square inch. With the best commercial alloying, heat-treating and cold-working procedures, the highest strength normally attained in steel sheet is approximately 300,000 pounds per square inch.

The first commercially practical magnetic tape recorder and magnetic film and sound track for 8mm and 16mm
movie film were developed by Illinois. Other technological innovations developed by Illinois are: titaniu alloy, flexible ceramic coating, an economical substitute for palm oil as a lubricant in cold rolling of steel, fiber metal, mechanical olive harvester, computer programmed optical lens design, automatic packaging and labeling machines, and an economical video tape recorder for home and classroom use.

Thirty years ago, the Connecticut Agricultural Experiment Station noted some strange-looking corn kernels in some ears of corn. In 1963 at Purdue University, it was discovered that these opaque kernels contained twice the normal content of lysine, an amino acid essential for animal growth. Later it was discovered at North Star that these kernels contained twice the normal content of tryptophan, another amino acid. When fed to rats, this corn accelerates growth by a factor of 350 to 400 per cent. North Star, in conjunction with Purdue University, produced a strain of corn that has the possibility of yielding more meat per pound in the animals fed this strain.

The invention of a process of xerography was submitted by Chester F. Carlson in 1944 to Battelle. Battelle developed the process and patented it as Xerox. Xerox is a copying machine.

Magnetic tape, MICR, polypropylene fiber, xerography, and other technological innovations are the culmination of
the non-profit research institutions' involvements in research. The research institutions formulate pure and/or applied research for their clients and in this process make contributions to product development, industrial expansion, and new industry. Product development is best exemplified by the patenting of Xerox from xerography, 8mm and 16mm sound movies and tape recorders from the invention of magnetic tape, and the Hydra-cushion freight-car from a modified box-car by adding a newly devised shock-absorbing system.

Industrial expansion resulting from technological innovation is best illustrated by the development of the Hydra-cushion freight-car. Fourteen years after the development of the Hydra-cushion freight-car, approximately 30,000 freight-cars on some fifty United States railroads have the shock-absorbing system. This new system has resulted in the establishment of the Hydra-Cushion Incompany, which is jointly owned by the Evans Products Company and Waugh Equipment Company of Chicago, Illinois.

Tallow research at Stanford led to the establishment of the Tallow Research Company. This new company is owned and operated as an extension of Armour Meat Packing Company. Continental Gin Company of California was founded as a direct result of Southern's development of wash-and-wear stay-press fabrics.

The oxygen process for steel production, developed
by Southern, was introduced to Germany and Japan after World War II, and it has revolutionized the steel industry. The oxygen process for steel production is the primary cause for Birmingham, Alabama's importance in steel production and her leadership in the production of cement from slag.

Technological innovation resulting in new industry where none previously existed is best represented by Xerox. From a single product for copying printed material, Xerox has developed into a multibillion dollar industry.

The non-profit research institutions continue to conduct their research operations commensurate with their major objectives. The research institutions advance scientific knowledge and education, aid federal, state and local governments and industry, and benefit mankind in general through technological innovation that results from research.

New areas of research opportunity where science can and must serve the needs of man remain unexplored. The non-profit research institutions are cognizant of these new areas. They are presently developing plans to broaden their research programs by re-defining their roles in technological innovation, further meeting the needs of mankind.
CHAPTER IV

SUMMARY AND CONCLUSIONS

The purpose of this paper was (1) to describe the characteristics of independent non-profit research institutions in the United States and (2) to illustrate through select examples the range of technological innovations which they have made for government and industry.

There are twelve non-profit research institutions in the United States. Six were established between World War II and 1948. Two were established during the Korean Conflict and one during the Vietnam War. War has contributed to the financial developments of the research institutions, and it has caused the research institutions to specialize in research areas pertinent to national security.

The major objectives of the non-profit research institutions are: (1) advance scientific knowledge and education through creative research; (2) aid federal, state, and local governments and industry through scientific research; and (3) conduct research which is beneficial to mankind.

The non-profit research institute is characterized by two major features: (1) it is of a non-profit nature, and (2) it has no corporate or ownership connection with any other type of organization. Common characteristics of the research institutions are: research backgrounds of
their first presidents, initial capital and source, areas of research, clientele, the research contract, the prime source of income, tax status and technological innovation.

The non-profit research institutions' first presidents were all experienced in scientific research and management. Fifty per cent of the research institutions employed presidents who were former research directors of previously established research organizations.

State governments, industrial concerns, and private donors provided initial capital investment for the formations of the non-profit research institutions. Illinois and Cornell received initial capital investments from individual corporations. The continual financial developments of the research institutions is attributed to military expenditures for research.

Research institutions on the whole have a wide range of major fields of knowledge within which they conduct investigations. Major divisions of knowledge are further sub-divided into highly specialized areas. These divisions and sub-divisions are illustrated by atomic energy and radioisotopes, systems analysis and mathematical modeling, biological science and cancer research. The variety of research areas the research institute provides attracts clientele.

The federal government is the largest customer of the research institutions. Currently the federal government
sponsors 50 to 75 per cent of the research conducted by the research institutions. Industry is the second largest sponsor, followed by state and local governments. Contract research is the primary source of income for research institutions. In 1968 Battelle was the largest research institute with a contract research income of $125 million. Stanford was second with $60 million, Cornell third with $32.4 million, and Illinois fourth with $29 million. North Star was the smallest research institute with $1.1 million.

Through contract research non-profit research institutions achieve a wide range of technological innovations. Select examples of technological innovation that result from contract research are: economic analysis and strategy games, pesticides, antimissile systems, prefabricated brick units, wash-and-wear stay-press fabrics, and the process of xerography. As a result of technological innovation that results from research conducted by the non-profit research institutions, new products are developed, industries may expand, and new industries may be created.

In 1968 Battelle had the largest number of research projects with 1,850. Illinois was second with 1,200. The third largest number of projects was 900 at Stanford. Battelle had the greatest number of employees, Stanford was second, and Illinois was third.

All twelve non-profit research institutions are exempt from federal and state taxation. As of 1961, non-profit
research institutions are required to pay taxes on income received from research on "private projects."

Conclusions

Contract research for the federal government represents a large part of the activity of the non-profit research institutions. At the present time about two-thirds of the expenditures for research in the United States are accounted for by some agency of the federal government. In 1968 this activity continued to be true. In 1963 total contract research for the federal government was as much as 80 per cent.

One initial policy of North Star Research and Development Institute was to limit its contract research with the federal government to 40 per cent. In retrospect, it has since been suggested by North Star that this policy may have limited the growth rate of the organization.

In 1969 there was considerable discussion of the future of financial support for research by the federal government. In some areas of research the rate of federal support is declining. In atomic energy research, environmental problems, and ecology, federal support is increasing. There seems little reason to doubt that the federal government will continue to be an important sponsor for research

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conducted by the non-profit research institute. There is reason to question whether a research institute which does not receive substantial financial support from the federal government could be expected to survive at its present financial level.

Next to the federal government, the large company is the most important sponsor for contract research conducted by the non-profit research institute. The majority of the large industrial sponsors of research are companies that also maintain their own research laboratories. There are several reasons why these companies buy research, including: (1) the research institute has physical facilities that are not feasible for the company to acquire; (2) the company may wish to conduct research in a particular area without making long-range commitments for facilities and personnel; and (3) the company seeks objective checks on the quality of work being done within their own research laboratories.

The percentage of research conducted for state and local governments, and small and medium size companies is small.

The role of technological innovation in government and industry is important and expanding. The range of problems that are potentially capable of being approached by the research institute is infinite and will continue to have significant impact on the future of technological
innovation. The additions to man's scientific knowledge and the products he consumes are a continuing contribution of non-profit research institutions.
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APPENDIX

BIOGRAPHICAL DATA ON THE NON-PROFIT RESEARCH INSTITUTIONS

The following is a presentation of biographical data about the twelve non-profit research institutions. The biographical data consists of information not included in the text of this paper. The research institutions are in alphabetical order.

Battelle Memorial Institute, 1925
Columbus, Ohio

In 1923 the concept of Battelle Memorial Institute was expressed in the will of an Ohio industrialist, Gordon Battelle. He provided $2 million for the establishment of a research institute. The research institute was to have the major objective of engaging in creative research and the development of discoveries and inventions. In 1925 additional endowment was provided for the research institute upon the death of Gordon Battelle's mother, Annie Norton Battelle.¹

Battelle concentrated on problems of atomic energy during World War II. After the war Battelle established

laboratories in Frankfurt, Germany, and Geneva, Switzerland. The European laboratories developed successfully and are presently financially self-sufficient. The European laboratories have channeled their research efforts into scientific research for European industry.

General Electric established the Hartford Atomic Laboratories in Richland, Washington. It was the objective of Hartford to conduct research to advance peaceful applications of atomic energy and to assist the Atomic Energy Commission with research. In 1965 Hartford and Battelle merged to form Battelle-Northwest.\(^2\)

In 1935 Battelle established the Battelle Development Corporation in Ohio. The corporation was established to assist Battelle in the identification, development, and patenting of inventions.

Battelle sponsors research exchanges with the university academic environment. In cooperation with Ohio State University, Battelle establishes advanced scientific studies, programs, seminars, and conferences for the advancement of scientific knowledge. Battelle has two research centers located at universities: Seattle Research Center at the University of Washington, and Battelle Chair of Metallurgy, Ohio State University.

\(^2\)Ibid.
Cornell Aeronautical Laboratory, 1948
Buffalo, New York

In 1943 Curtiss-Wright Corporation established a research laboratory to investigate problems of aircraft design and flight equipment. After World War II Curtiss-Wright discontinued the operations of the aircraft research laboratory in Buffalo, New York. In 1945 Curtiss-Wright converted the Buffalo research laboratory into a public research organization. Three years later Curtiss-Wright gave the public research laboratory to Cornell University. Dr. Theodore P. Wright became vice president of research and chartered the research laboratory as "non-profit." With the formation of Cornell Aeronautical Laboratory, Dr. Wright became Chairman of the Board. Dr. Furnas of Curtiss-Wright became director of research operations; he later served as Assistant Secretary of Defense.

Cornell conducts research primarily on defense contracts. The research program is extended into twenty divisions with six major sub-divisions: aero-science, flight dynamics, systems, physics, computer sciences, and transportation. Other areas of research include: air and water pollution, law enforcement, urban development and waste

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3 Cornell Aeronautical Laboratory, Organization, Capabilities and Facilities (Buffalo, New York: CAL, 1969), pp. 91-94.

4 Ibid.
disposal processes. National defense research includes: aerodynamics testing with wind tunnels, hypersonic shock tunnels, flight research, and anti-intercontinental ballistic missile systems.

Franklin Institute Research Laboratories, 1946
Philadelphia, Pennsylvania

In 1924 the Franklin Laboratories were established. They were not chartered as "non-profit" until 1946. The Franklin Institute Research Laboratory, named after Benjamin Franklin, is composed of a science museum, planetarium, science library and Bartal Research Foundation. Franklin's objectives are centered around the promotion of public understanding of science through programs encouraging young people to pursue careers in science. Franklin's major areas of research are primarily educational and medical.

Illinois Institute of Technology Research Institute, 1936, Chicago, Illinois

In 1936 Armour Meat Packing Company of Chicago gave its research facilities to Illinois Institute of Technology. The research facilities were chartered as "non-profit" and named Illinois Institute of Technology Research Institute. The major objective of the research institute is to aid industry and government by scientific research. Illinois

Research Institute has conducted research on 15,000 projects for 4,000 government and industrial sponsors.6

Illinois Research Institute's research facilities are: Riverbank Acoustical Laboratories, a high explosive test facility at Kingsbury Ordinance Plant, a gunnery test range; Institute of Gas Technology; Association of American Railroad Research Center; and John Crerar Library.

Illinois Research Institute has overseas research laboratories located in the countries of Mexico, Burma, Libya, Venezuela, and Colombia. The overseas research laboratories also have training programs which are financed by the foreign governments and the government of the United States. The purpose of the training is to educate local personnel to eventually man the research facilities.7

Mellon Institute, 1913 Pittsburgh
Pennsylvania

In 1907 Dr. R. K. Duncan, the first president of Mellon Institute, began the first of many industrial fellowships to be awarded in the United States. It went to the University of Kansas. The sponsor of the research program was a laundry company in Boston. The success of the research program led to the establishment of the American Institute

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7Ibid.
of Laundering and the expansion of the research scope at the University of Kansas.8

Dr. Duncan's concept of the research fellowship attracted attention. In 1911 Andrew W. Mellon and his brother, Richard B. Mellon, asked Duncan to come to Pittsburgh and discuss the establishment of a department of industrial research.9 In 1913 the department was chartered "non-profit" and became the Mellon Institute of Industrial Research and School of Specific Industries. The Mellon brothers financed the first research laboratory, a two-story wooden building. In 1937 in honor of Judge Thomas Mellon, the Mellon family donated to Mellon Institute an eight-story laboratory structure. The new laboratories are located near the University of Pittsburgh's campus, Carnegie Institute of Technology and Carnegie Institute.10

The major objectives of Mellon Institute are (1) to facilitate industrial sponsored research and (2) to initiate programs for fundamental and basic research.11 In 1947 a trust fund was established by surviving members of the Mellon family: General Richard K. Mellon, Dr. Paul Mellon, Mrs.

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9Ibid.
10Ibid., p. 7.
11Ibid.
Sarah Mellon Scaife, and Mrs. Alisa Mellon Bruce. This fund was established for the purpose of perpetuating basic research at Mellon Institute.\textsuperscript{12}

In conjunction with the University of Pittsburgh, Mellon operates a training school for students seeking advanced degrees in science and engineering.

In 1958, Mellon expanded its research facilities. Laboratories were established at Bushy Run, Pennsylvania. The Bushy Run laboratories have a Radiation Research Center and Chemical Hygiene Center. Records of research data obtained at the Chemical Hygiene Center are coded and filed at Bushy Run in the "four-million dollar memory bank."\textsuperscript{13}

The major areas of research at Mellon are: biochemistry, environment and public health, organic materials, physics, radiation and atomic energy.

\section*{Midwest Research Institute, 1944}
\textit{Kansas City, Missouri}

In 1944 Midwest Research Institute was chartered by a group of civic and industrial leaders. Some 300 companies, individuals, and foundations contributed approximately $2 million to establish the research facilities for

\begin{itemize}
  \item \textsuperscript{13}Mellon Institute, \textit{Bushy Run Laboratories} (Pittsburgh, Pennsylvania: MI, 1960), pp. 1-2.
\end{itemize}
"economic development of the Kansas area." Since 1944, Midwest has completed 3100 research projects for 1200 sponsors.

Several industrial and scientific concerns are located near Midwest. The concerns provide research projects for Midwest. Among these concerns are: Linda Hall Library of Science and Technology, University of Kansas Medical Center, and the Menninger Clinic. Linda Hall Library contains 350,000 volumes and receives 11,000 serials published in 36 languages.

Midwest's research facilities include centers for research on materials, environmental pollution, germanium information, and solid lubricant technology. Major areas of research at Midwest are: chemistry, biological science, engineering, mathematics, and economic development. In 1961 Midwest became the base for NASA's first Regional Dissemination Center. The center operates a program to transfer space science and technological knowledge to private industry. In conjunction with the University of Kansas Medical Center Midwest established the first bio-medical application team for NASA.15

14 Ronald S. Paul.

North Star Research and Development Institute, 1963, Minneapolis, Minnesota

In 1963 North Star, the youngest research institute, was founded through joint efforts of the University of Minnesota and local businessmen. Governing members of North Star are elected by regents of the University of Minnesota. The Board of Directors is elected by the governing members. Directors are selected from business, industrial, educational, and civic leaders from the Twin City area. The president of the University of Minnesota serves as the research institute's Board Chairman. 16

North Star's areas of research are: physical sciences, engineering, and life sciences. North Star's major objectives are: (1) to conduct research in the national interest, (2) to add to the general body of scientific knowledge, and (3) to develop new and improved products for industry and to aid in accelerating the economic growth of the Twin Cities. 17

North Star's research facilities are located near the University of Minnesota campus. North Star is in the process of expanding present research facilities.

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17 Ibid.
Research Triangle Institute, 1955
Triangle Park, North Carolina

In 1952 Governor Luther H. Hodges appointed a committee to plan the establishment of a non-profit research institute. The result of the committee effort is Research Triangle. Research Triangle was sponsored for "the heart and hope of North Carolina's industrial future." In 1955 Research Triangle was chartered as "non-profit." Research Triangle is located near three universities: Duke, North Carolina, and North Carolina State. Major areas of research at Research Triangle are: textiles, wood products, environmental health, data processing, educational testing services, and air and water pollution.

Southern Research Institute, 1941
Birmingham, Alabama

Southern Research Institute was established in the South to provide scientific research to alleviate technological deficiencies in that area. In 1941 Southern was chartered under Alabama law; actual operations of the research institute did not begin until 1945. Industry and private parties contributed the initial capital investment. Major areas of research at Southern Research Institute are:


textiles, steel production, chemical engineering, structural engineering, and medicine.

Southwest Research Institute, 1947  
San Antonio, Texas

In 1947, through the efforts of Thomas Slick, a Texas industrialist, Southwest Research Institute began operations. Southwest is located eight miles west of San Antonio, Texas. Expansion of research facilities is being financed under a long-term loan from the estate of Thomas Slick. Southwest's major areas of research are: chemistry and chemical engineering, air and water pollution, biosciences, electronics, nondestructive testing, naval dynamics, ocean science, fuels, and lubricants. Overseas laboratories are located in Puerto Rico. These laboratories conduct research on adhesives.

Spindletop Research Institute, 1961  
Lexington, Kentucky

In 1961 Spindletop Research Institute was chartered. Kentucky state officials, businessmen and educators sponsored the founding of the research institute. The establishment of Spindletop was motivated by the recognized need to advance the economy of Kentucky through research, science, and education. Spindletop's major areas of research are: textiles, thermodynamics and power engineering, nutrition and metabolism, pesticides, and x-ray and electron diffraction.
Stanford Research Institute, 1946
Menlo Park, California

In 1946 Stanford Research Institute was chartered by a group of West Coast businessmen. The major objective for the creation of Stanford Research Institute was to establish a research institute on the West Coast. Stanford's major objectives are: (1) to serve industry, government, regional and scientific interests; (2) to support advancement in all sciences; and (3) to contribute to scientific education and public welfare. Stanford Research Institute received operational data from Battelle Memorial Institute, Illinois Institute of Technology Research Institute, and Arthur D. Little, Incorporated. In 1953 Ford Foundation granted additional funds to Stanford.20

Operations began at Stanford with a government contract for the investigation and development of rubber from the Guayule plant. Major areas of research at Stanford are: agricultural engineering, biochemical science, biological science, behavioral science, and data processing. Stanford has overseas research laboratories in fifty countries. Major overseas laboratories are located in Sweden, Japan, Thailand, France, Argentina, Portugal, Australia, and the Philippine Islands.21


21Ibid., p. 6.