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Annual Report

FEDERAL RESERVE BANK OF BOSTON

Research Shapes New England's Economy

To the member banks of the Federal Reserve

Bank of Boston

It is a pleasure to send you the 1956 Annual Report of the Federal Reserve Bank of Boston.

Again this year we are continuing our practice of reporting in some detail on a major phase of the New England economy.

Under the title *Research Shapes the New England Economy*, we have surveyed some of the outstanding research contributions to New England growth made in the fields of industry, agriculture, forestry and medicine.

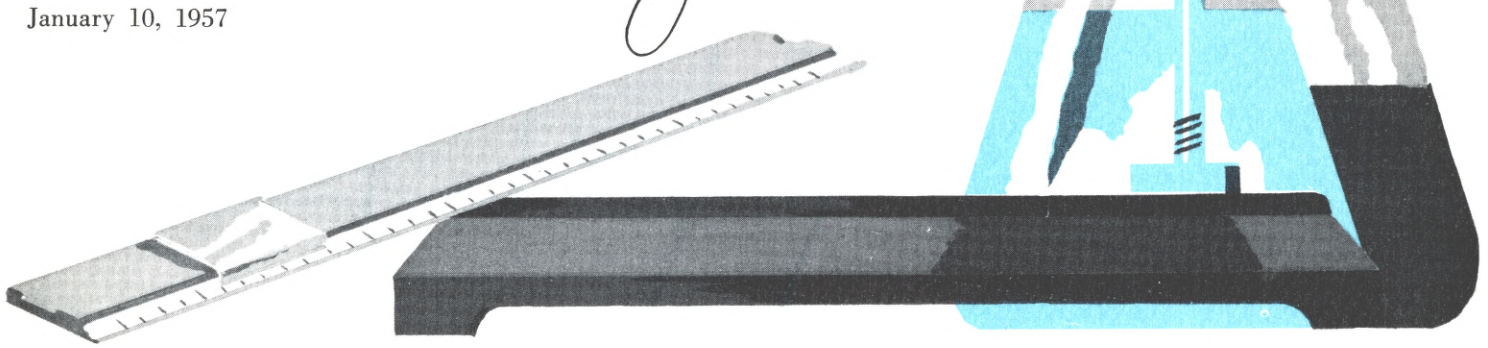
In 1956, New England business generally sustained or surpassed the new performance records established in 1955. We believe that much of the region's economic resiliency and vigor derive from the expanding use of research and development as a tool for progress.

The report also includes summaries on the Bank's operations. For the steadily increasing efficiency of these operations, I extend my own thanks and those of our directors to our officers and staff.

Our thanks go also to the bankers and business leaders of New England for continuing their generous cooperation.

President

January 10, 1957



Below the golden-domed State House and the old houses and brick sidewalks on Boston's Beacon Hill gleams the broad reach of the Charles River Basin. Along its shores lie what a competent observer has called "probably the greatest concentration of scientific, engineering and research talent in the world."

This talent comprises the men and women who make up the huge family that staffs what is known locally as Research Row. Fronting on the Charles in Boston and Cambridge are Harvard and Boston Universities, Massachusetts Institute of Technology, the Museum of Science, research and teaching hospitals, the country's oldest and largest firm of professional industrial research consultants, and numerous industries pre-eminently concerned with scientific research as the prime ingredient of their products.

Research Shapes New England's

Although Research Row is situated in the heart of New England — 30 per cent of New England's people live within 30 miles of Beacon Hill — its interests range far beyond the region or even the nation. In a broad sense Research Row focuses its attention on all mankind — and not only on mankind but mainly on the future of mankind. Here along the Charles the experiences of the past in almost every field of human knowledge are re-examined and re-appraised. Here the experiences of the present are recorded and analyzed. And here the past and the present are synthesized and transformed, first into new ideas which will help the man of tomorrow better to understand and adjust to the world he has created, and second, into new things that will more nearly help him meet his needs and desires.

Many of the thousands of investigations always underway in Research Row are of the kind that relate directly to our daily lives — such as finding cures for hitherto incurable diseases, working out means of increasing highway safety, developing new, more accurate techniques for forecasting the weather, examining the comparative merits of sales and graduated income taxes, or even just concocting a new flavor in chewing gum. Some would be more esoteric: investigating the electrical content of tornadoes or devising more efficient broadcast frequency-deviation monitors. And if certain of the research projects of the Row seem utterly remote from the practicalities of the day, it must be remembered that it was a short simple mathematical equation which stated the original terms for releasing the energy of the atom.

The studies being conducted in Research Row are of as much consequence to the nation and the world as to New England, and this is eminently in the New England

tradition. For generations, the Yankees have been exporting ideas and trained manpower as well as the physical products of their research and development work.

Research Row is not only a vast enterprise in itself — or rather a whole series of enterprises — it is also the symbol and the epitome of a regional resource of steadily increasing importance.

Except for its forests New England has always been a land without significant industrial raw materials or mineral fuels. In spite of the difficulties of having to haul both of these from relatively remote areas, New Englanders have built their region into one of the country's most highly developed and diversified manufacturing areas. They have accomplished this largely through their ability to conceive and implement new ideas — ideas for marketable new products, for ways of improving old products and for new ways of making things.

Economy

Since Colonial days the essential ingredients of New England's economic progress have been a demonstrated need or opportunity, inquiring minds, technical resourcefulness, and men and women with an abiding willingness to do a day's work. Or one might say that New England has thrived on the Yankee's aptitude for research and development and his increasing willingness to give it time and money.

The region's now dominant industries are research-oriented and tend continually to draw into their orbits individuals with scientific and technical training. One of the characteristics of a research-based economy is the ease with which large existing industries give birth to small ones. Some of New England's most successful young enterprises are the result of engineer-businessmen splitting off from a parent company in order to manufacture new products developed through research.

The following pages attempt to describe briefly how research shaped and is continually reshaping the New England economy. The story begins with industry since manufacturing is the principal source of income for all the New England states and thus provides a broad firm base for the growing service industries. The sections on agriculture and forestry are succeeded by one on medical research because the region's fundamental resource is its people and their continuing good health. The story closes with a description of the useful work done in the field of economic research by numerous agencies over the last two decades.

In these pages Research Row is held up as a symbol of a New England-wide activity. Despite its size and prominence, the Row must never be permitted to obscure the fact that research and development work of great importance is always being carried out in every New England state by both private and public agencies. And although documentation of this essay has involved the use of the names of many firms, agencies and organizations, such use does not imply that greater merit attaches to the names used than to the host of others which space precluded mentioning.

Just after Christmas in 1956 the Navy announced that the *Nautilus*, the world's first atomic-powered submarine, would return to her Groton, Connecticut, birthplace to be refueled for the first time — two years and 50,000 miles after beginning her service. Since her launching, a second sub, the *Sea Wolf*, had slid down the ways and New England shipwrights had begun work on four more atomic subs, one of them a radar-picket boat and the largest submarine ever built.

Earlier in 1956 the Atomic Energy Commission had authorized the construction of New England's first atomic-powered commercial generating station, and at year's end the site of the $35 million, 134,000-kilowatt plant was being cleared. Also in December, the directors of New England Electric System announced plans for a still larger atomic electric power unit to cost upward of $50 million.

During the year, work had progressed smoothly on the $2 million nuclear reactor being built at Massachusetts Institute of Technology as a center for medical and biological research, and in November a similar research reactor was approved for the Watertown Arsenal — where the first atomic cannon was largely designed and built. In Cambridge, Harvard University and MIT continued work on the plans of the $6.5 million "atom smasher" which they are jointly to build and operate.

The Atom Goes to Work for New England

In the summer of 1956, the Nuclear Products Division of Metals and Controls Corporation celebrated its fifth year of fabricating fuel elements for nuclear reactors by moving into its new million-dollar plant in Attleboro, Massachusetts. In its precision work with uranium, zirconium, thorium and niobium, however, this youthful veteran would soon be meeting new competition. In historic Concord, Nuclear Metals, Inc., had bought land for a new million-dollar atomic fuel plant. And in December, the just-forming Sylvania-Corning Nuclear Corporation made public its plan to construct in Andover, north of Boston, a $4.5 million atomic center where it would do research and produce fuel elements and components for reactors.

Industrial

In Windsor Locks on the Connecticut River, Combustion Engineering, Inc., announced in August the establishment of a new laboratory in which it would build a $10 million prototype reactor plant for powering small submarines. Farther down the River, at Middletown, hundreds of scientists and technicians will soon be working in the $10 million nuclear airplane engine laboratory operated by Pratt & Whitney Aircraft, and in Quincy, Massachusetts, Bethlehem Shipbuilding was getting ready to build the world's first atom-powered battlewagon and also had a design contract for an atomic merchant vessel.

Out on Route 128, the circumferential expressway which swings an 83-mile arc around Greater Boston, the postwar-born Tracerlab was putting the finishing touches on its new $1.8 million building and preparing to consolidate under a single roof its

nuclear instrument manufacturing operations which have been scattered through six buildings in downtown Boston and one in Kentucky.

These examples of new developments taking place in New England in the field of atomic energy highlight the degree to which New England industrialists and industrial and educational research organizations are moving forward into the youngest, most complex and perhaps the most exciting of the sciences.

A Primary Weapon of Competition

Although the region's atomic progress seized the headlines in 1956, the news about New England's constantly expanding electronics industries was also impressive. Raytheon, the region's largest electronics firm and third largest manufacturing employer, wound up the year with a backlog of military orders in excess of $245 million. In November, Avco Manufacturing bought 100 acres in Wilmington, Massachusetts, for construction of a $15 million electronic and missile research center. At the Lincoln Laboratory between Concord and Lexington, a team of computer experts on the payroll of Massachusetts Institute of Technology put the FSQ-7 — the largest, fastest, most flexible electric brain ever created — into service as a coordinator and interpreter of defense radar data. On the civilian front, Datamatic Corporation contracted to produce for the First National Bank of Boston a $1.75 million computer-directed machine system to help the bank with its snowballing volume of paper work. On the shores of the Charles River near MIT in Cambridge, the fledgling Hycon Eastern finished the planning and began assembling equipment for the complete nationwide communications system — telephone to television — which it will soon install for the government of far-off Lybia.

Although problems of the behavior and the harnessing of the atom and the electron preoccupied an ever-growing group of New Englanders in 1956, there were significant developments in some of New England's older industries. For example, just before Christmas, the Great Northern Paper Company set what it believes is a new world's speed record at its Millinocket plant deep in the Maine woods — production of a 24-foot-wide sheet of newsprint at a speed of 2,250 feet a minute. On the shores of Boston Bay where Donald McKay launched in the 1850's the world's fastest sailing ships, a new generation of builders undertook construction of the country's largest tanker — 100,000 tons. In Lynn, just above Boston, General Electric had under development a helicopter motor which, pound for pound, is the most powerful turbo-shaft engine yet announced. In East Hartford, Pratt & Whitney's Connecticut Yankees were clocking 7,600-mile-an-hour winds in their new hypersonic test tunnel and exploring the effects on planes of crossing the "thermal barrier."

The New England industrial news items reported above cannot convey the rich diversity and color and liveliness to be found in the region's economic life in 1956. But they have a characteristic in common, and it is one which more and more pervades the New England industrial scene — they all involve, or are the result of, a high level of scientific research and engineering ingenuity. Furthermore, they dramatize a continuing change in the nature of the area's manufacturing activities. And finally,

they point up New England's need for and reliance on research and development as a primary weapon of competition in this technological age.

Although literary societies may debate the authenticity of the "better mousetrap" proverb attributed to Emerson, economists seem to agree that manufacturing success in New England does not require lower costs so long as the producer turns out a unique or superior product. They also agree that the producer who makes merely a standard, "run-of-the-mill" product may find that his costs add up to an important competitive handicap.

New England's industrial history has repeatedly demonstrated the truth of both these statements. And both of them must be the continuing concern not only of the individual manufacturer but of all the New England people as well.

Manufacturing is still the principal source of employment and income in each of the New England states despite the rising importance of the service industries. So New England's economic good health depends very largely on the ability of the region's manufacturers to maintain sales, employment and profits.

These manufacturers enjoy certain general advantages derived from tradition and from an abundance of men, machines and money. On the other hand, their geographical situation has long confronted them with a handicap, and time and the development of other regions have brought them further problems.

The heart of the matter is transportation costs — the cost of bringing into New England from distant sources virtually all the region's industrial raw materials; the cost of bringing into New England the oil and coal which furnish most of the region's industrial power; and the cost of delivering in and servicing national markets relatively remote from the extreme northeastern corner of the country.

Some New England firms are successfully meeting these disadvantages by concentrating their manufacturing effort on products which are recognized as superior or unique in concept, function, design and workmanship. If such a course is not always feasible for some smaller or older firms, nevertheless it is safe to say that manufacturing success in New England is most likely to attend him who persistently researches and intelligently develops new and better products and new and better ways of making and using old products.

Grandparents of American Industry

The words "research and development" are comparative newcomers to the vocabulary of industry. But in their proper sense they are as old as New England manufacturing itself — indeed they are older, for they are the very parents of Yankee industry and therefore the grandparents of American industry.

It was the systematic research and development work done on textile making by Samuel Slater of Pawtucket around the 1790's which enabled New England to take its first great step toward large-scale manufacturing. As one historian puts it: "He was the first in this country to set up a system of manufacture in which the successive steps of the skilled artisan were broken down into such simple components that a group of children could out-produce the finest craftsman."

A second and even more important piece of New England industrial research and development took place in New Haven in 1798 when Eli Whitney invented the system of interchangeable parts, the basic principle of mass production. In this method of manufacturing, which permitted an unskilled man to turn out a product as good as one made by the most highly trained machinist, Whitney laid the foundations of the whole edifice of modern industry. Almost as important as his theory were the metal-working tools which Whitney designed and built to make the theory workable — among them, the jig and the fixture, limit gages, and the milling machine.

Slater found for New England and the infant republic the short cut to quantity. Whitney combined quality with quantity. Between them, these two researchers launched New England, a land almost destitute of manufacturing raw materials, into a way of life that soon made it the most highly industrialized region of the Western Hemisphere. And they also set the two basic patterns of industry which still predominate in New England — metalworking and textile manufacturing.

The research-minded Yankees who followed Slater and Whitney first transformed the face of New England and then provided the machinery for transforming the face of America. The heart of this transformation was the machine tool — the machine for making the machines which are vital to almost every phase of manufacturing. In New England were born the jig and fixture and limit gage, the milling machine, the copying lathe, the turret lathe, the automatic screw machine, and the cylindrical and surface grinders, to name but a few.

Utilizing these basic devices for precision metalworking, New England quickly made itself the machine shop of the new nation. In addition to turning out machine tools, New England manufacturers developed both for their own use and for sale a great variety of specialized machinery for making textiles, guns, shoes, ships, sewing machines, farm and household equipment, an ever-widening range of hardware, and many of the necessities and luxuries demanded by a rapidly expanding population.

New England's Three Largest Spenders

From those early days to these, New England has always been in the vanguard of American industrial research. To be sure, some decades have been more fruitful than others in the development of new products and new methods. It is true, too, that there has always been considerable variation among individual firms and even among entire industry groups in the amounts of imagination, energy and money devoted to research work.

Perhaps longevity and prosperity offer some measure of the vigor and effectiveness of a company's capacity for meeting change — certainly one of the prime objectives of research. If so, then New England has a host of names to be proud of, including nearly a score of internationally-known metalworking firms which are more than a century old.

The predominance of metalmen on the region's roster of manufacturing centenarians points up a long-term trend in the New England economy which has been accelerating sharply in recent years. Over the last quarter-century, the metal-based

industries have steadily expanded until collectively they are now the region's top employer. Since 1939, they have more than doubled their employment, which stood in November 1956 at 672,000, over four times the current regional employment in textiles. It is estimated that the number of New England metalworking plants has tripled since 1939, and value added by manufacture has increased still more.

A study made by the Bureau of Labor Statistics reports that the aircraft, electrical machinery and instruments industries are the country's highest in terms of research expenditures. They are also among the fastest-growing industries as shown by percentage employment increases over the period 1947-1953, both in the nation and in the region.

As this report is written, New England's three largest manufacturing employers are: United Aircraft Corporation, General Electric Company and Raytheon Manufacturing Company, in that order. All of them work mainly in metal, and they are the region's three largest spenders on research and development.

$330,000,000 For Industrial Research in 1955

To get a broad picture of the amount and general characteristics of the industrial research carried on in New England, the Federal Reserve Bank of Boston recently surveyed by questionnaire some 3,500 of the region's manufacturers. The returns accounted for 22 per cent of New England's manufacturing employment and are believed representative enough to make the findings valid for the region.

In 1955, New England manufacturers spent more than $330 million on research and development. This huge amount — some $33 for every person in the six states — is over two-and-a-half times the volume of similar expenditures in 1950.

It is estimated that approximately two-thirds of the $330 million is spent by private industries from their own operating incomes, and one-third is accounted for by federal government spending through research and development contracts. Industries producing such defense materiel as aircraft engines, missiles and components, communications equipment and nuclear materials and equipment are particularly heavy in government contracts. Of course the results of the research studies sponsored by both government and private enterprise are having, and will continue to have, strong leverage on the sales of these research-minded manufacturers.

In the communications equipment industry, survey respondents indicated that 77 per cent of their 1955 sales were derived from products developed since 1945. In the nonelectrical machinery, transportation equipment, instruments, chemical and industrial electrical equipment industries, more than 45 per cent of the respondents' sales were in products new since 1945. In nondurables, new product sales ratios of textile respondents were 20 per cent, and the shoe and leather industry followed with a ratio of 19 per cent.

The six industries which allocate the largest amounts to research and development programs account for more than 40 per cent of total value added by manufacturing in New England. Regional employment in these industries expanded by some 18 per cent between 1950 and 1955, and accounted for 85 per cent of the total gain

in employment for all industries which recorded employment increases during the period.

New England's industrial research laboratories are of several varieties and it is not easy to draw a quick over-all picture of them. The most recent survey (National Research Council, 1950) showed that the region had 311 industrial laboratories operated by individual concerns. This was 11 per cent of the national total in an area which then had 9.7 per cent of total manufacturing employment. A breakdown of these 311 laboratories by industry group showed that nearly two-fifths of them were in metalworking, including: nonelectrical machinery, 41; instruments, 28; electrical equipment, 27; and communications equipment, 16.

Parenthetically, in a recent analysis of the industrial research spending of 191 large companies, Harvard found that 42 per cent of the research funds went toward the creation of new products or processes, and 50 per cent went to improving existing products or processes. Only eight per cent was "uncommitted to specific problems."

In addition to the 311 "captive" laboratories described above, New England in 1950 was the home of 40 commercial consulting industrial laboratories, one of them being the country's largest. Finally, some 50 New England colleges and universities, including a number of the country's outstanding institutions, furnish technical training and operate research laboratories.

In a study of 41,000 American scientists it was found that nearly 14 per cent of their PhD's and more than 12 per cent of their bachelor's degrees had been awarded by New England institutions.

Research Row on the banks of the Charles River in Massachusetts is the country's most dramatic illustration of the whole research idea. Along with extensive laboratories of the institutions enumerated on page two of this report, Research Row contains a group of research-based manufacturing concerns whose products range almost the whole spectrum of science.

The Scientific Research Team is Developed

In addition to exhibiting the successful marriage of science and industry and their lusty offspring, Research Row demonstrates in the firm of Arthur D. Little, Inc., that research has become a full-fledged industry in itself.

When Mr. Little and an associate announced in 1886 that they were available to "undertake . . . investigations for the improvement of processes and the perfection of products" they established what is now the nation's oldest and largest firm of technical consultants. They established, too, a new technique of research and development in which teams of scientists and engineers collaborate with industrial management on a fee basis in working out problems of almost any nature and magnitude. Since its founding, ADL has grown into an integrated staff of 400 scientists and engineers which is backstopped by an equal number of laboratory-office workers. And the team technique has proved so successful that ADL was retained to organize, staff and put into operation General Motors' first centralized research department.

Another type of research activity which has proved helpful to New England

was pioneered by ADL in the field of national and regional economic analysis and development. After foreign experience in this work, ADL undertook "A Survey of Industrial Opportunities in New England," with the sponsorship of the Federal Reserve Bank of Boston. That study, published in 1952, and a companion piece, issued in 1956 with the title "Diversification — An Opportunity for the New England Textile Industry," explored new avenues for further economic expansion.

Research Is Vital To Every Business

New England's three-way combination of research facilities — the laboratories of professional consultants, of educational institutions and of individual firms — has built up a large reservoir of special talents and technical skills which is focused constantly on the future. The personnel of these agencies are drawn together by common interests and intermingle freely, with a corresponding cross-fertilization of ideas. And each year this research-oriented community is made larger by new graduates from colleges and professional schools.

New England's growing pool of scientists and engineers and the atmosphere which surrounds it is proving of unexpected assistance in the region's continuing industrial development. The $15 million Avco research center mentioned earlier is to be located in Wilmington because the firm was especially anxious to be near the scientific facilities and personnel of the educational institutions of Greater Boston. RCA established its new laboratories in Waltham for much the same reason, and it is said to have played an important part in the decision to build the $11 million Quartermaster Corps' research laboratory in Natick.

Still another interesting development in industrial New England is the increasing number of young engineer-scientist-businessmen who establish plants to manufacture products growing out of their own research or that of their friends. Typical examples are: Polaroid Corporation with its light-polarizing products and Land camera; National Research Corporation with its high-vacuum work which, among other things, led to the huge frozen juice industry; Tracerlab, Inc., with its nuclear instruments; and High Voltage Engineering Corporation with its electrostatic generator.

New England industry was built on research and research is constantly transforming it. The multi-storied factory by the millpond, in its day the most advanced of manufacturing structures, was the product of research — and it was more research which made it obsolete. Because of the complexities of modern science, the old-time Yankee inventor — Howe of the sewing machine, Colt of the revolver, Corliss of the steam engine — has largely given way to the research team. Today's teams are concentrating more and more of their scientific and engineering work on the development of products with a high content of skilled labor in relation to bulk and weight. And more and more New England manufacturers are demonstrating their conviction that research is vital to every business desiring to remain competitive and profitable.

No major region of the United States is entirely self-sufficient in its production of foodstuffs. Each region specializes in those products for which it is most suited by virtue of its climate, soil and other conditions, and exchanges its specialties with other areas. Through this process of regional specialization and through product improvement resulting from research, today's farmers are bountifully producing for a population 22 per cent greater — but with a farm labor force 20 per cent smaller — than in 1940.

New England participates in this regional specialization, for its production of potatoes, poultry meat, and cranberries exceeds its consumption. The region is largely self-sufficient in the production of fluid milk. For all other food commodities it is a net importer, although very sizeable quantities of eggs, apples, cheese, skim milk powder, meat, and greenhouse and nursery products are produced in the six-state area.

Agricultural

Receipts from farm marketings returned about $750 million to New England farmers in 1955. Poultry and dairy products accounted for about two-thirds of the total, with dairy income in 1955 at $255 million and poultry at $231 million. Potatoes, greenhouse and nursery products, tobacco, vegetable crops, and fruits follow in that order.

Limited agricultural resources coupled with large and favorable near-by markets characterize the area. For these reasons one of the principal objectives of research has been to select the wisest uses of the available resources and to get maximum efficiency in production and marketing.

Country's First Farm Research Center

Agricultural research findings in New England have included hybrid corn, scores of new vegetable varieties, and a whole series of discoveries that have helped make possible the development of a huge New England poultry industry.

Formal agricultural research in the United States had its birth here in New England with the establishment of the first agricultural research center in America in Middletown, Connecticut, in 1875. This station was later moved to New Haven.

In 1887 Congress authorized the setting up of publicly supported agricultural research stations at each of the state agricultural colleges. Thus organized agricultural research was largely created and has been supported by public funds. Perhaps even more important, it has been tied in closely with educational institutions able widely to disseminate the information learned.

Today there are seven agricultural experiment stations in New England, including the six that are located at the state agricultural colleges as well as the station at New Haven, Connecticut. During the last fiscal year the expenditures by these seven

Research

experiment stations totaled approximately $4 million and there were more than 1,150 people on their payrolls.

Over the years the findings of these New England research centers have been a tremendous force in shaping the New England agricultural economy. The development of the poultry industry is an outstanding example.

Not all of the research findings that facilitated the growth of the poultry industry were made in New England — but an impressive array of them were. Late in the 1800's, Rhode Island poultrymen had started the development of a new strain of chickens. The Rhode Island State College of Agriculture recognized the potential value of the strain and was a leader in refining and purifying the bloodlines to the point where a new breed was established. The Rhode Island Red was the premier bird of her day and is still a highly popular breed.

One Discovery Saves $5 Million in 1955

Other developments were needed and they were fast to follow. The invention of the incubator was not a product of New England genius, but it was a major factor in permitting expansion of the poultry industry. New England researchers swung open the gates again when the Connecticut station at New Haven demonstrated that birds could be raised in confinement without ever seeing sunlight if their feed was properly reinforced with Vitamin D. This discovery, which incidentally cost less than $1,000 in research funds, made poultry a source of year-round income.

Then the Massachusetts poultry geneticists started their long succession of discoveries that helped to lick "broodiness," the mother instinct that kept hens sitting on their eggs rather than busying themselves in producing more.

By the early 1920's the poultry researchers at the University of New Hampshire, working with poultry breeders in that state, had developed the New Hampshire breed, the backbone of today's tremendous broiler industry. In fact, it is claimed that the first carload of broilers ever sent to New York City was shipped from Durham, where they had been raised by students of the University.

As the industry began to develop, however, it met with one obstacle after another. First was pullorum, the dread disease that wiped out young chicks. Connecticut pathologists proved that it was carried from the mother hen through the egg to the baby chick, and they evolved a blood test that located the disease in the hens. Here the New Hampshire station and others joined the fight and assisted in setting up a field method of control that has resulted in almost complete elimination of the disease.

By the 1930's the efficient teams of poultry research men at the agricultural experiment stations had proved their ability to meet problems as they arose. Since that time they have made major contributions in the development of controls for such diseases as coccidiosis, bronchitis, and "crazy chick" disease, to mention only a few.

There were many discoveries that opened up new possibilities for efficiency — for example, the development of the so-called high-energy rations by the station at Storrs, Connecticut. This one discovery can be demonstrated to have reduced production costs over $5 million in 1955 alone on the broilers raised in New England.

Today poultry is the major source of agricultural income in Maine, New Hampshire, Massachusetts and Connecticut; and it is a sizeable income-producer in Rhode Island and Vermont. For New England as a whole, income from poultry is only moderately less than that from dairying, which is the region's leading source of agricultural income. That the poultry industry should be so significant a factor in the total agricultural economy never ceases to impress people who are uninformed as to the ways in which good management can offset the disadvantage of being located at the end of the grain pipeline. Because New England is so far removed from the corn belt and because grain constitutes so large a proportion of total costs in egg production, the common reaction is one of surprise that New England commercial egg farms can retain local markets despite midwestern competition.

Without question premium local markets are a factor in the development of egg production in the region as are also a favorable climate and a low mortality rate. But the solid rock on which the industry rests is the high efficiency in egg production resulting from the applications of the latest research findings. One noted poultry economist estimates that an increased production of 10 eggs per hen annually is the equivalent of an eight-dollar-per-ton saving in grain costs. Production of New England's flocks is consistently above the national level; in fact, year after year the six New England states have ranked within the high six or eight states in the nation for production per bird.

This increased production does involve some modest added costs, but primarily it arises from superior management. Not only does this higher production per bird result in lower feed costs per egg but it also results in increased eggs per man hour. Thus, poultry research, much of which was conducted in New England, has been responsible for placing egg production on a sound economic basis. Much the same may be said for the broiler industry where a low mortality, premium production, and high efficiency in converting grain into broilers have enabled New England producers to meet competition from other sources.

Corn, Potatoes and Midget Watermelons

Some of the early fundamental agricultural research was of tremendous importance and without it modern farming would be severely handicapped. For instance, the Rhode Island station discovered in the late 1800's that lack of lime in the soil was a severely limiting factor in crop production on New England's mineral soils. Since that time millions of tons have been used to correct soil acidity.

Also about this time scientists at the Storrs station proved that legumes had the ability to take nitrogen from the air. This basic discovery showed conclusively the importance of legumes in hay and pasture seeding mixtures.

Other early findings included the discovery of many of the essential amino acids by the station at New Haven and their place in both human and animal nutrition.

The gypsy moth was introduced into Massachusetts in 1869 by people who thought that it had possibilities in the production of silk. It soon got loose and became a tremendous menace to shade trees and ornamental shrubs. In the course of bringing

it under control, entomologists at the Massachusetts station discovered lead arsenate as an insecticide — one of the most widely used insecticides in history.

The station at New Haven brought hybrid corn to the world in 1917. The increased vigor from hybridization had been recognized earlier, but Dr. D. F. Jones and his associates at New Haven developed a practical method of producing hybrid seed. This discovery alone raised yields per acre by 15 per cent and is estimated to have produced millions of dollars in new wealth. In fact, this single piece of research has more than paid for the operation of all the nation's agricultural research stations for all of the years that they have been in existence.

As one might expect, the Maine station has been a leader in potato research. It has turned out a steady succession of discoveries vital to the health of the Maine potato industry, which produces over 15 per cent of the total national crop. In cooperation with the United States Department of Agriculture it has developed several important potato varieties including the Katahdin, the most widely planted variety in the Northeast today.

The early discovery of potato ring rot and the development of control measures are estimated to have saved $1.5 million annually, nearly three times the budget of the Maine Agricultural Experiment Station.

The work in potato marketing has also been of importance. Researchers at the Maine station have played a major role in production procedures and marketing tests for developing such potato products as potato chips, sticks, and more recently potato flakes.

The Maine station has developed methods of potato washing, the use of plastic containers, and presently is testing both chemicals and irradiation as a means of sprout inhibition. Recently it has developed potato pulp for livestock feed as a by-product of the potato-starch industry.

The New Hampshire Agricultural Experiment Station has done particularly good work in recent years in developing vegetable and fruit varieties that are tailor-made to fit the New England climate. These varieties have found wide use by both home gardeners and the commercial truck gardeners. Since the 1930's the New Hampshire station has released a steady stream of varieties such as New Hampshire midget watermelons, Durham raspberries, Double-rich tomatoes and Bush Buttercup squash.

Time and Motion Studies in Dairying

Vermont has been one of the leaders in dairy production research. Researchers in this state, which supplies 70 per cent of the milk for the Boston market, have come up with a string of triumphs in increasing efficiency in the production of milk.

Early in the 1940's, Vermont made the first broad application of time and motion studies to agriculture. Stimulated by the war-induced shortage of labor, R. M. Carter and J. A. Hitchcock devised labor-saving techniques for dairy barn chores — the most time-consuming job on the farm. They demonstrated that the time required to milk a typical dairy herd could be cut nearly in half by the application of the known

principles of work simplification, and with very modest demands for capital improvements. Later this work was expanded to include the harvesting of roughage.

Another outstanding achievement of the Vermont station was in the conservation of nutrients in farm manure. These nutrients were valued at upwards of $4 million annually in Vermont alone, and at least one-fourth of this amount, mainly nitrogen, was lost into the air and through leaching by water. The discovery of using superphosphate with the manure was widely accepted, and by 1952 had eliminated at least one-half of this hitherto million-dollar loss to Vermont farmers.

Agricultural Economy Strengthened

In many cases New England research stations have pooled their efforts. One of the signal pieces of regional research is the development of the formula which determines the price of fluid milk for the Boston market. This formula is acknowledged by farmers, milk handlers and consumers alike to have been an especially effective tool in the setting of prices that accurately reflect supply and demand. Through its mechanism, farmers have developed a method of sharing equally the surplus production that inevitably results from time to time in an industry where forces of nature quickly change output and where demand fluctuates from day to day. This is only one example of an increasing volume of agricultural research that is conducted on a regional basis.

Obviously not all of the agricultural research has been done at the state universities. Many commercial concerns operate their own research farms and they have made highly significant discoveries in such fields as feed formulations, field and vegetable crop variety testing, and poultry breeding. But the great bulk of the agricultural research in New England continues to be done by the state universities where consumers and producers alike share the costs.

Thus, research has played a major role both in shaping the New England agricultural economy and in strengthening the region's various agricultural enterprises. The results of this research have been, and will continue to be, a notable raising of the standard of living of farm families. But equally important, the efficiencies introduced into agriculture through research have meant a constantly improving diet for a growing number of consumers.

Since those Colonial days when New England's straightest and tallest white pines were marked with a broad arrow and designated as masts and spars for the King's Navy, the region's forests have constituted perhaps its most important single natural resource. Even today about three-quarters of all New England carries some kind of forest cover, and the region's extensive lumber, pulp and paper, and furniture industries all use wood as their basic raw material. Research to maintain or improve New England forests therefore has a multiple impact on the region's economy.

This point is easily illustrated: The value of the timber cut each year in this region is roughly $30 million; the wood cut from this timber and delivered at roadside is worth more than $75 million; and this same material delivered at manufacturing plants throughout the New England states probably has a market value which is well in excess of $100 million.

Forests a Benefit to All New England

But these figures still do not adequately represent the value of our forest resource because they do not include those of the important manufacturing industries utilizing wood for their raw material. For example, New England's paper and allied products, lumber and timber products, and wooden furniture industries employ about 115,000 workers and pay annual wages of about $400 million. The value added by manufacture for these three classifications was approximately $700 million in 1954.

In the long run, it is safe to say that forest research is many times more important to the New England economy as a whole than it is to the owners of our forest land.

Forestry

Much of the forestry research in New England is carried on in the regional research centers and field laboratories of the United States Forest Service. Second in importance are the university experiment stations supported not only with state and private funds but with federal funds as well. Finally, some of the large users of forestry products have worked on cooperative projects with public research agencies or have initiated their own experiments in forestry practice.

According to a survey recently completed by this Bank, 20 state and federal agencies and private organizations reported expenditures of approximately $1 million during 1956 for research connected with New England forestry. Of that total, 51 per cent was provided by the federal government, 39 per cent by private organizations (principally in the form of university endowments and foundation grants), and the remaining 10 per cent by state agencies. The $1 million spent this year for New England forestry research is almost double the figure for 1946.

In addition, new product and process research and development expenditures by New England's paper and allied products industries are currently running about $6 million annually.

Research

The most common species of trees in northern Maine and in the higher elevations in northern New Hampshire and Vermont are spruce and balsam fir. Of course, hardwoods are intermixed with these, but spruce and fir are dominant.

One of the experimental forests serving this spruce-fir region is the Penobscot Forest located near Bangor, Maine. This 3,800-acre tract is managed by the United States Forest Service in cooperation with a number of paper companies which purchased the land in 1950 and turned it over to the Forest Service under a 99-year lease.

Nine hundred acres of this forest are devoted to tests of different levels of management treatment, ranging from practices which foster the maximum possible growth to complete liquidation cuttings in which all merchantable trees are cut and no thought is given to future returns. These studies are designed to find out how the various levels of management affect the quality and quantity of tree growth and how these treatments influence forest production costs.

Helicopters Spray Hardwood Poisons

Many of the forest experiment stations in New England have devoted considerable effort to developing techniques for maintaining the white pine which since 1900 has been steadily losing out to the more vigorous hardwoods. The pioneer work in this field was done at the Harvard Forest at Petersham, Massachusetts, and the Yale Forest near Keene, New Hampshire. More recently, the forestry department of the University of Maine has established a series of white pine experimental plots which will test the whole gamut of forest cutting techniques.

The work at each of these forests shows that natural enemies of the pine — wind, fire, insects and disease — are perhaps even more difficult to control than hardwood competition. In 1947, most of the Massabesic Forest in Maine was destroyed by fire, and the 1938 and subsequent hurricanes destroyed much of the old-growth pine stands at the Harvard and Yale forests. Experiments conducted at these university forests demonstrate conclusively that forest managers must anticipate destructive winds in the future and give more serious consideration to the risks of leaving the larger pines standing in the forests. They also suggest the wisdom of more access roads to permit the quick recovery of blowdown trees before they deteriorate.

Some of the experimental forests are research testing various poisons which have been prepared to kill competing hardwoods. For example, researchers at the Massabesic Forest have conducted extensive experiments with tractor-mounted mist blowers and with helicopter spraying to spread chemicals which kill hardwood but do not affect white pine if applied in small concentrations. Foresters hope that before long it will be economically feasible to control inferior hardwoods on thousands of acres of land in New England which are well stocked with suppressed white pine seedlings.

Until relatively recently, most research efforts were devoted to white pine and spruce-fir. Hardwoods received little attention because they were not as commercially important as these other species. However, high quality hardwood saw logs are now very valuable and the new technology of hardwood pulping is opening up markets for the smaller hardwood trees.

A 1953 survey made by this Bank showed that New England's pulp mills are using constantly increasing quantities of heavy hardwood as raw material, and another survey made in 1956 showed that the nonintegrated paper and paperboard mills in southern New England were purchasing ever larger amounts of hardwood pulp. Furthermore, new hardwood pulping processes have already stimulated industrial expansion at several locations in northern New England.

These are fortunate developments for New England where twice as much hardwood as softwood is grown, and where only 24 per cent of the hardwood growth is cut, but where the annual cut of softwood exceeds the annual growth.

A number of experiment stations are now working on methods for improving the growth rates of the more valuable species of hardwoods such as yellow birch, paper birch and hard maple. Some are attempting to develop vegetative propagation techniques for sugar maple trees. This work is particularly valuable to the maple sugar industry for it would permit landowners to plant trees which could be counted on to have sap with a high sugar content.

One of the most valuable services of the United States Forest Service is its systematic inventory of the forest resources of each state and region in the United States. The resulting data shows the forest growth in each state, the volume of sawtimber, the cubic volume of standing timber, growth rates, the species composition of the forests, the ownership of forest land, and the volume of timber being cut each year. This information is invaluable to those interested in industrial development and to industries planning expansion in New England and in all regions.

Basic Research in Tree Physiology

In another field, the Sears Roebuck Foundation is cooperating with several other agencies and institutions in sponsoring a study of the costs and returns of forest ownership of 50 small woodland owners in New Hampshire. As a result of this study, it is expected that foresters will be able to give small landowners more competent advice in the years ahead.

Many other types of forest research are important. For example, soils research is being conducted at many New England universities. Knowledge in this field is greatly needed in order to judge the inherent productivity of different types of forest land. Even more important in the long run is the basic tree physiology research work being conducted at Harvard and Yale under grants from the Maria Moors Cabot Foundation and the Hartford Foundation. This type of basic research will be useful to forest researchers the world over because far too little is known about the life processes of trees.

All this research effort is contributing to the basic fund of knowledge about forests which will be so necessary in the future when New England's wood-using industries will need much larger quantities of raw material.

Boston is now generally conceded to be the medical research center of the world. And because of the quality and quantity of research carried on in the hospitals, medical schools and laboratories of other communities in the region, New England has become an outstanding contributor to the advancement of modern medical science.

Through basic research and skillful practice, New England institutions are playing leading roles in reducing infant mortality, in restoring crippled limbs to normal use and sight to the blind and hearing to the deaf, in curing sick minds as well as sick bodies, and in providing a general increase in life expectancy.

Within the region's relatively small geographic area are located six medical schools, two dental schools, a school of public health, more than 400 hospitals, and a number of laboratories working in medical and allied fields. Proximity and a common interest have stimulated close collaboration among institutions, and as a result of this working together there have been great advances in the understanding, care and treatment of the human body. The reputation for excellence in teaching and research facilities in New England attracts students from all over the world.

New England Contributions Begin Early

New England's participation in the advancement of medical knowledge began during the Revolutionary War when the need for trained doctors was acute and there were no institutions for medical education in the region. At the urging of John Warren, head of the Continental Army hospital in Boston, the Harvard Medical School was founded in 1782 to help meet the needs of the new nation.

It soon became apparent that physicians trained at Harvard required hospital facilities in which to treat their patients. In 1810, two doctors associated with the Harvard Medical School circularized a letter to raise funds for the construction of a hospital. Their efforts led to the opening in 1821 of the Massachusetts General Hospital.

Meanwhile, the Dartmouth Medical School had been organized in 1797 and instruction had started at the Yale School of Medicine in 1813. The opening of the Boston University School of Medicine, Tufts University Medical School and the College of Medicine at the University of Vermont followed.

Medical

New England's tradition for medical research was established early and has grown steadily. One of the region's foremost early medical contributions was the first public demonstration of ether as an anesthetic in surgery performed in 1846 at the Massachusetts General Hospital. Another early development at the same hospital was the description in 1886 of appendicitis, an illness formerly diagnosed as typhus fever.

After the 1916 polio epidemic, orthopedic surgeons at the Children's Hospital in Boston made many advances in correcting deformities left by the disease. And in the twenties, the Children's initiated use of the Drinker respirator which had been

devised by a group at Harvard Medical School. Later, during another widespread polio epidemic and the resulting insufficient supply of respirators, simplification and improvement of the machine was undertaken by a "rather unique machine shop located above a fish emporium in Harvard Square, Cambridge." From the work done by the shop's proprietor and his four young Harvard associates came the Emerson respirator, the prototype of the modern iron lung.

Another example of how New England medical science and industrial research and production work together is the Cohn Blood Fractionator, originated under the direction of the late Dr. Edwin J. Cohn at the Harvard Medical School and researchers at Protein Foundation, Inc., and engineered and manufactured by Arthur D. Little, Inc., of Cambridge. In a single closed sterile circuit the Fractionator takes blood from a donor, separates it into its component parts and packages the resulting cellular fractions in sterile containers ready for use or storage. This process minimizes the handling of blood and enables new economy in its use since, rather than whole blood, a patient may be given only the component needed to treat his specific ailment.

The long and impressive list of New England's contributions to medical research includes the studies carried on at Massachusetts General Hospital by Dr. Fuller Albright on diseases of the endocrine organs, and the pioneer work of Dr. Joseph C. Aub and the late Dr. Ira T. Nathanson on the effects of various hormones in the treatment of cancer.

It was at Boston's Peter Bent Brigham Hospital that the late Dr. Harvey Cushing developed his revolutionary techniques of brain surgery, and the hospital's Dr. Samuel A. Levine and Dr. Dwight E. Harken, together with Dr. Robert Gross of the Children's Medical Center, were pioneers in heart surgery. Research at the Brigham led to the development of an artificial kidney, permitting many people to be restored to a normal life following temporary failure of the kidneys. And it was also at the Brigham that a healthy kidney was first successfully transplanted from one identical twin to another.

Three Nobel Prizes for the Region

The New England Center Hospital, a part of the New England Medical Center with which Tufts University Medical School is associated, did much of the original work in developing the means for counteracting antibodies which destroy the red cells in certain types of anemia.

Among other New England medical achievements was the development at the Boston Dispensary of the widely used Hinton Test for syphilis, and the first diagnosis of blindness in premature babies in 1942 at the Massachusetts Eye and Ear Infirmary, where the Howe Laboratory had been established in 1926 as the country's first privately endowed eye research institution. A new method of diagnosing glaucoma is another of the Laboratory's well-known accomplishments.

In recent years, researchers working in Boston hospitals have achieved world-wide recognition by winning the coveted Nobel Prize in medicine. Dr. George R. Minot and Dr. William P. Murphy received the award in 1934 for work which led to the

discovery of liver therapy for pernicious anemia. In 1953, Dr. Fritz A. Lipmann received the prize for his work on the energetics of cellular metabolism. In the following year, Dr. John F. Enders and his associates, Dr. Thomas H. Weller and Dr. Frederick C. Robbins, were cited for their work in growing poliomyelitis virus in tissue culture, making possible the development of the Salk polio vaccine.

The Yale University School of Medicine has carried on much basic research in nutrition, including bodily requirements of protein components and vitamins. Researchers at the school, which is associated with the Grace-New Haven Community Hospital, have made outstanding studies of several infectious diseases and contributed to the treatment of diabetes, nephritis and hyperthyroidism and work fundamental to the development of the Salk polio vaccine.

Research Examines Entire Life Cycle

To measure the extent of medical and related research now being conducted in New England, the Boston Reserve Bank, in the Fall of 1956, surveyed over 400 of the region's institutions in the medical and public health fields.

Of the 210 schools, laboratories and hospitals which participated in the survey, 62 were actively engaged in research and planned to spend close to $18 million for this purpose in 1956. This represented more than a fourfold increase in the past 10 years and was 17 per cent more than was spent in 1955. It is believed that these institutions account for the major share of research expenditures in the region.

In 1956, some 2,600 professionally-trained people, assisted by over 1,500 non-professional workers, were engaged either full-time or part-time on research projects in these 62 institutions. Although this total of nearly 4,200 researchers seems small compared to the total number of persons in and associated with New England's medical profession, their work in extending medical knowledge is of vital importance.

While many institutions devote substantial amounts of their own funds to medical research, the federal government is the largest single source of such funds. The 62 institutions surveyed indicated that federal or state sources provided 46 per cent of their 1956 research funds; private foundations supplied 27 per cent; the institutions' own operating funds accounted for 12 per cent; and five per cent came from private enterprise in the form of grants or for work done on contract. Other sources, such as bequests, endowments and gifts from individuals were given for the remaining 10 per cent. This information clearly indicates the great reliance placed by the institutions on outside support for funds to carry out their research projects.

The variety of current research projects supported by such funds ranges the entire life cycle of the individual from pre-natal development through senility. Some are seeking causes and cures for such specific diseases as the common cold, poliomyelitis and cancer, but much work is also being done in the basic sciences in an effort to reach a greater understanding of fundamental life processes.

The Children's Medical Center in Boston is unique in the world. With the already affiliated Children's Hospital and Infants' Hospital as a nucleus the Center was founded in 1946 and now consists of nine organizations devoted to the care of children, and

to teaching and research. One of these is the Children's Cancer Research Foundation, established in 1948 as the first institution in the world for research concerning the nature, the treatment and, hopefully, the cure of cancer in children. Here in the clinic of this Foundation and in its attached research laboratories was made the first breakthrough into the chemotherapy of cancer incurable by other methods.

Nuclear Sciences Open Up New Fields

Several hundred research studies are underway at Massachusetts General Hospital ranging all the way from the basic study of the chemistry of cells to controlled studies on patients in the hospital wards. Much of this research is done in collaboration with the Harvard Medical School. The General's Huntington Laboratory is devoted to cancer research, and at this hospital Dr. Paul Dudley White, medical consultant to President Eisenhower, continues his investigations into the causes of coronary heart disease.

The Hitchcock Foundation, Hanover, New Hampshire, has a relatively young research program and is associated with the Medical School at Dartmouth. The research program at the University of Vermont College of Medicine has been greatly expanded in the past decade with staff members investigating a number of fields.

In addition to this definite concentration of research activity near teaching institutions, there is a worldwide aspect to the work of researchers at the Harvard University School of Public Health. Supplementing the research carried on here at home, field studies in population dynamics are underway in India, studies of intestinal diseases are being made in Finland and Norway, a study of certain eye diseases is being made in cooperation with the Arabian American Oil Company, and nutrition studies are in progress in South America.

The Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Maine, is especially interested in cancer research and genetics, although work is also being done on tissue transplantation, tumors, muscular dystrophy and immunology and blood grouping. One of the laboratory's most important contributions to research has been the development of a pure strain of mice for use in scientific experiments.

In the field of mental health, much research is underway in both private and publicly supported institutions. Increased attention is being directed to problems associated with aging and with chronic diseases. Cooperative research is being carried on in some special fields. For example, at the Yale Center for Alcohol Studies medical authorities pool their knowledge with that of other scientists to learn more about alcohol and problems related to alcoholism.

The medical researchers have been quick to adapt to their own work new developments in other fields. They are making extensive use of electronic equipment and through the nuclear sciences have opened up whole new fields of investigation. Studies of the effects of radiation are underway at several New England institutions and radioactive elements are being more and more widely used, particularly as tracers, in medical research.

The application of radioactive iodine to problems of the thyroid gland, studied

jointly by researchers at Massachusetts Institute of Technology and Massachusetts General Hospital, was one of the first uses of radioactive isotopes in medical history. During World War II, as a result of this collaboration, radioactive iron was first used for the study of the preservation of blood. Work already has been started on a new nuclear reactor at MIT for medical and biological research which will be used in part as a center for research and treatment of certain cancer conditions. It will permit MIT to pioneer in atomic medical research and will make available for the first time in New England many neutron-produced, short-lived isotopes for use in research and medical treatment. The therapy room of the reactor is to be available to all medical organizations in the Boston area.

This discussion of medical and related research in New England has been able to consider only a few of the many organizations and thousands of projects which contribute to the total research activity in the region. Nevertheless, it reveals the importance placed on research by the region's institutions and the scope of this activity. The fruits of these studies are providing longer, healthier and more productive lives for the region's and the nation's richest resource — their people.

Industrial, agricultural, medical and other forms of research have as a common objective the improvement of conditions surrounding human life. By applying research findings, New Englanders alter the physical aspects and the social and economic customs of their towns, cities and states. At times the changes are clearly beneficial; at others they create severe problems. With the increasing complexity and interdependence of economic life, community leaders show increasing appreciation of the fact that community economic development may not safely be left to chance.

In the years following World War II, attention to the economic aspects of community and state growth intensified. Zoning laws and plans for community facilities prepared by newly-activated planning boards set the course for community development. Sometimes through municipal government action, but more frequently through

Economic Research

privately-financed committees or foundations, city after city conducted extensive economic appraisals as preliminaries to economic development action. Such studies frequently resulted in the establishment of permanent agencies to stimulate and guide community growth.

At the state level, establishment or revitalization of agencies to help develop the state's natural resources has been typical. State departments or commissions devoted to promoting industrial development have been strengthened, often by increasing economic research to provide factual groundwork for effective action. For example, in 1953 the Massachusetts Department of Commerce was established with separate divisions on research, planning and development. In 1955, Maine expanded its activities by creating a Department for the Development of Industry and Commerce.

The regional economy has been subjected to extensive and continuing analysis during the postwar years. A decade ago the Federal Reserve Bank of Boston enlarged its research staff and began its long and continuing series of studies of the region. Over the years, the Bank's resource economists studied forest utilization and management, taxation and fire insurance, water and mineral resources and the region's growing stake in nuclear energy developments. The industrial economists studied the shoe, textile, electronics and other industries, power costs, manufacturing location factors, transportation facilities, industrial development techniques, development credit organizations and others. The agricultural economists studied the growing broiler industry, Maine's potato-based economy, agriculture in the Connecticut Valley, and means of further developing farm income and credit. The financial economists studied income

and expenses of commercial banks, trust department operations, institutional investors in New England, New England's financial relations with the federal government, and others.

Through research grants, the Reserve Bank supported and published studies of the Port of Boston, the origin of new manufacturing firms in New England, industrial opportunities for New England manufacturers, textile diversification, sources and marketing of new ideas for new businesses, the fishing industry, the region's transportation systems, wood-waste utilization, investment in timberland and many others.

The Reserve Bank has also worked closely with other agencies studying New England's economy. A committee of seven New England economists appointed by the President's Council of Economic Advisers relied heavily on the studies and staff of the Bank in preparing its report on "The New England Economy." Reserve Bank economists directed the research staff and conducted independent studies as part of the work of the 100-man Committee of New England of the National Planning Association, and they prepared the final text of the voluminous report on "The Economic State of New England."

Numerous college and university teachers and groups have prepared reports on the region's economy. The New England Council maintains a current flow of information about the region's developments in its own publications and through the press. Study groups established by the New England Governors' Conference have prepared definitive reports on special subjects. For example, all major aspects of the textile industry were studied, and public transportation in New England is now being examined in 10 reports currently being published as a result of two years of study by the Governors' Committee on Public Transportation.

It is frequently difficult to determine where economic research leaves off and the development work that leads to new employment and income begins. Many agencies incorporate both kinds of activity. According to a survey conducted by the Reserve Bank for a committee of the New England Council, there are several hundred organizations that are concerned with economic development of some geographic segment of New England. Ninety of these, including the largest, employed the equivalent of 828 full-time persons and spent $8.8 million in 1955.

It is almost impossible to measure the specific results of economic research and development work in terms of business decisions, improved laws, new manufacturing employment and reduced waste of resources. They are real, nevertheless. Research on forest taxation was influential in shaping New Hampshire's present forest tax laws. Research on financial problems of new businesses led to the creation of state development credit corporations in New England. Research on problems of water resources may pave the way for improved flood control legislation and protection, and research on bus transportation may pave the way for changes in state regulation and taxation. In these and in countless other ways, economic research continues to help shape the New England economy.

Comparative Statement of Condition

ASSETS

	December 31, 1956	*December 31, 1955*
Gold Certificates	$ 928,799,005.90	$1,016,398,408.20
Federal Reserve Notes of Other Federal Reserve Banks	29,465,410.00	24,368,335.00
Other Cash	22,291,083.32	23,566,907.53
Loans and Advances	1,800,000.00	1,360,000.00
Industrial Loans	312,000.00	
U. S. Government Securities	1,352,693,000.00	1,346,972,000.00
Uncollected Cash Items	525,926,663.26	485,279,750.95
Bank Premises	5,361,085.39	5,641,950.89
Other Assets	13,445,702.06	8,412,548.16
TOTAL ASSETS	$2,880,093,949.93	$2,911,999,900.73

LIABILITIES

Federal Reserve Notes	$1,623,169,295.00	$1,613,945,595.00
Deposits:		
Member Bank Reserve Accounts	778,900,207.77	861,914,188.60
U. S. Treasurer-Collected Funds	33,984,008.24	29,376,931.30
Foreign	17,464,000.00	23,160,000.00
Other	6,196,648.22	6,114,582.62
TOTAL DEPOSITS	$ 836,544,864.23	$ 920,565,702.52
Deferred Availability Cash Items	348,117,468.44	308,186,913.87
Other Liabilities	661,566.66	658,997.73
TOTAL LIABILITIES	$2,808,493,194.33	$2,843,357,209.12

CAPITAL ACCOUNTS

Capital Paid In	$ 16,801,450.00	$ 16,161,600.00
Surplus (Section 7)	43,947,826.20	41,666,629.28
Surplus (Section 13b)	3,010,527.20	3,010,527.20
Reserves for Contingencies	7,840,952.20	7,803,935.13
TOTAL CAPITAL ACCOUNTS	$ 71,600,755.60	$ 68,642,691.61
TOTAL LIABILITIES AND CAPITAL ACCOUNTS	$2,880,093,949.93	$2,911,999,900.73

Comparative Statement of Earnings and Expenses

Current Earnings:	1956	1955
Advances to Member Banks	$ 784,141.84	$ 441,464.34
Foreign Loans on Gold	4,145.09	56,911.59
Industrial Loans	9,769.81	
U. S. Government Securities — System Account	31,363,787.40	21,965,707.33
All Other	16,991.63	14,094.45
Total Current Earnings	$32,178,835.77	$22,478,177.71
Net Expenses	8,368,632.39	7,926,272.10
Current Net Earnings	$23,810,203.38	$14,551,905.61
Additions to Current Net Earnings:		
Profit on Sales of U. S. Government Securities (net)	$ 16,547.55	
All Other	5,350.38	$ 270.05
Total Additions	$ 21,897.93	$ 270.05
Deductions from Current Net Earnings:		
Loss on Sales of U. S. Government Securities (net)		$ 83.35
Reserves for Contingencies	$ 37,017.07	35,397.29
All Other	1,830.92	6,952.26
Total Deductions	$ 38,847.99	$ 42,432.90
Net Deductions	$ 16,950.06	$ 42,162.85
Net Earnings before payments to U. S. Treasury	$23,793,253.32	$14,509,742.76
Paid U. S. Treasury (Interest on Federal Reserve Notes)	$20,531,028.23	$12,221,590.59
Dividends Paid	981,028.17	930,217.64
Transferred to Surplus (Section 7)	2,281,196.92	1,357,934.53
	$23,793,253.32	$14,509,742.76

Summary of Principal Changes

The *Total Assets* of the bank were $31.9 million lower at the end of 1956 than 1955. The principal change during the year was the decrease of $87.6 million in *Gold Certificate* holdings which was largely offset by a sharp increase in *Uncollected Cash Items* and small increases in most other assets.

Gold Certificate holdings declined principally because private business account transfers to other districts more than offset a gain in Treasury transfers to this district.

Loans and Advances showed only a small increase at year-end. Member banks, however, used the discount facility to a greater extent to meet temporary needs for reserve funds at various times throughout the year.

U.S. Government Securities representing our allocation of System Open Market Account increased $5.7 million — not significantly changed from a year ago. This reflected continuation of the System's restrictive credit policy.

Check clearing activities set new records. The increase of $40.6 million in *Uncollected Cash Items* resulted from a larger volume, as well as from the difficult problems of processing mail at the end of the year. The float at year-end was almost identical with a year ago.

On the liability side, *Federal Reserve Notes* rose $9.2 million to a new high. The rise coupled with the increase in use of notes of other Federal Reserve banks pushed the region's currency supply above the record in 1955.

Member Bank Reserve Accounts declined $83 million, while U.S. Treasurer's account increased $4.6 million.

Capital Paid In increased $640,000 and approximately $2.3 million was added to *Surplus*.

Net Earnings of $23.8 million were $9.3 million greater than in 1955. The increase was due largely to higher average yield on the holdings of *U.S. Securities*.

Net Expenses were $442,000 greater than last year.

After dividend payment of $981,000 to member banks, 90 per cent or $20.5 million of net earnings was transferred to the U.S. Treasurer in payment of interest charges on Federal Reserve Notes levied under Section 16 of the Federal Reserve Act.

The reduction in *Gold Certificate* holdings and the increase in *Federal Reserve Notes* outstanding resulted in a decline of the bank's reserve ratio from 40.1 to 37.7 per cent.

Volume Figures for Years 1955 and 1956

Transaction	*Daily Average Volume in Pieces or Units* 1956	1955	*Annual Total Volume in Dollars* 1956	1955
Check Collections	1,104,500	1,057,062	$67,582,937,064	$61,986,434,698
Coin Counted and Wrapped	3,697,588	3,429,608	85,723,150	78,140,400
Currency Sorted and Counted	1,057,922	983,381	1,726,561,866	1,599,667,011
Noncash Collections:				
Notes, Drafts, and Coupons (except U. S. Government)	4,039	3,980	352,700,143	361,214,937
Safekeeping of Securities:				
Pieces Received and Delivered	1,252	1,218	14,772,199,000	14,891,140,000
Coupons Detached	1,575	1,342	32,860,139	24,765,056
Transfers of Funds	321	293	48,377,150,966	42,258,356,849
Issues, Redemptions, and Exchanges:				
U. S. Securities (Direct Obligations)	768	783	11,049,837,447	11,496,549,380
U. S. Savings Bonds	41,198	41,304	856,557,601	819,319,186
U. S. Government Coupons Paid	1,818	1,975	111,369,731	117,028,632
Federal Taxes: Depositary Receipts and Direct Remittances	2,747	2,485	1,495,292,882	1,213,550,968
Currency Verified and Destroyed	258,984	281,492	91,270,000	101,299,000

Federal Reserve Bank

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