Journal of the
BOSTON SOCIETY
of
CIVIL ENGINEERS SECTION
AMERICAN SOCIETY
of
CIVIL ENGINEERS

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1976-1977

President's Message

Our publication, the *Journal* represents some 63 years of continuous communication between the Boston Society of Civil Engineers Section and its members. The publication has gained an international reputation for the quality of its content. As we begin the 128th year of the society, the *Journal* maintains its integrity by again publishing articles of significant interest to section members.

Competition from periodicals of National ASCE and other societies has through the years caused concern as to the number of submissions and the quality of papers by members. Two years ago the status of the *Journal* was reviewed after the merger of BSCE and Massachusetts Section/ASCE, to see whether there was justification for committing the effort and support to continue its publication. The Board of Government decided that it was important to continue the *Journal* and furnish to our membership papers of local interest as well as papers of a technical nature and high quality. Therefore, it is important that the members continue to support the *Journal*, by contributing papers of the kinds mentioned.

This year, the third year after the merger, the society continues to grow and expand its services. Membership is on the rise; the professional and technical activities continue to be the most successful among all sections nationally; the publications (the *Journal* and the *Forum*) have received national recognition; membership support and participation in all areas of society affairs is unmatched and is one of our greatest assets; and the student chapters have again excelled *and* established programs and accomplishments of the highest caliber.

To continue with this success, our programs will be strengthened by the following:

- working with the student chapter committee and general membership to foster new directions and incentives in order that students may be directed into the mainstream of the society. We hope to give them a greater sense of responsibility and belonging.
- establishing a committee to reevaluate the associate member forum as to the lack of interest by younger members, and to make specific recommendations and to implement these recommendations.
- recharging the Intersociety Committee on Engineering Professionalism to continue its work relative to improving the financial status and image of engineers and encouraging professional responsibility.
- organizing a committee to prepare an operations manual for the society, outlining the responsibilities and purpose of each of our office holders, technical group chairmen, and committee chairmen.
- establishing a task force for the 1979 ASCE National Convention which is to be held in Boston. This task force will be formulating the programs and arrangements to guide the convention committee. At the New England Council Meeting the other state sections agreed to participate with us as hosts and make this a New England-sponsored ASCE National Convention.

Since our Annual Meeting I have been more than gratified at the support offered by the membership, which I would like to think is due in part to a remark I made in delivering my short talk at the close of the meeting:

"It is important, as members and office holders, not just to *serve* but to *contribute* so as to instill new ideals and new meaning, into our profession. Our profession needs this and needs your contribution."

Bertram Berger
President 1976-1977

JOURNAL OF THE
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TWO HUNDRED YEARS — AND MORE — OF ENGINEERING IN THE UNITED STATES

Presidential Address of Charles A. Parthum

(Presented Before the Annual Meeting of the
Boston Society of Civil Engineers Section, ASCE, April 13, 1976)

Introduction

There is a tendency in this bicentennial year to review the past two hundred years and to speculate on the future. I think this is appropriate. In the next few minutes, let's look at what has gone on before — and what the future may present to the engineering profession. Let's look at these issues from Society's viewpoint, from the viewpoint of the entire engineering profession, and most important, from the viewpoint of young engineers (college graduates) and of the public in this the start of our third century.

I hope this discussion will raise some questions and present some thoughts that can be considered individually, in companies, and particularly by younger engineers making decisions on which will hang their future careers and those of the profession.

History

Last fall at a ceremony in Lawrence, Massachusetts, the American Society of Civil Engineers presented a plaque to the Lawrence Experiment Station, naming it a National Historic Civil Engineering Landmark. Within the last two weeks, ASCE named the Granite Railway in Quincy as a National Historic Civil Engineering Landmark, and next July a presentation will be made honoring the Hoosac Tunnel in North Adams, Massachusetts. We in New England are fully aware that we are surrounded by history and that this recognition is deserved.

At the spring conference of the New England Council, American Society of Civil Engineers, held in Durham, New Hampshire on March 13th, former ASCE Vice President Ivan Viest presented a very interesting illustrated lecture on the history of ten different civil engineering accomplishments that have received the Landmark Award. In his remarks to the over 100 students at the conference, Mr. Viest reminded them that all physical development in the United States over the last two hundred years was accomplished with the help of engineers. The roads, the buildings, the railroads, water and sewer systems, dams, locks, airports, etc. all involved civil engineers. We civil engineers have a rich heritage. Things were done when they were needed and had to be done, and our country grew, developed and prospered. There was no red tape! Even the country's first President, George Washington, was a civil engineer!

If we wish to go further back in history, back to the Roman empire and perhaps beyond, we find that the success of any nation depended upon its ability to build and improve — all involving the work of the engineer.

One hundred twenty eight years ago, civil engineers in the Boston area founded the Boston Society of Civil Engineers. As we know, four years later the American Society of Civil Engineers was founded in New York by some of the same individuals. Since that time, the Boston Society of Civil Engineers has existed, has grown, has remained strong, has held to tradition and has served as a meeting place for engineers to discuss projects, get ideas, transmit knowledge and as a place where engineers could get together and "shoot the bull." The fact that the society has been in business 128 years proves that it has served both engineers and the public well.

I am a believer in tradition; tradition is one of the things that hold an organization together. It has been a tradition with the Boston Society of Civil Engineers to have the retiring president present an address every year at the annual meeting. I welcome this opportunity, and I hope that the Boston Society continues this tradition. Who knows; in some year, something of value may be stated that may have an effect on the future.

Two years ago, after much prodding and the "never say die" dedication of certain members of the Boston Society and the Massachusetts Section, ASCE, the Boston Society and of the Massachusetts Section of ASCE merged. This was long overdue and tonight we start our third year, just as our country starts its third century. What do we have to look forward to?

The Future

After the second world war, the United States turned its attention to improving itself. Massive highway systems were built — with engineers. Transportation modes were improved; more, bigger, faster cars, diesel locomotives and jet planes were introduced, all with engineers' help. We flew to the moon, and nuclear power grew up, all with the help of engineers. By the mid 1960's nothing seemed impossible. The country's horizons were practically unlimited and engineers continued to guide the technological aspects of this expansion.

Then something happened. It did not happen overnight, although looking back, it may seem that way. Concerned citizens began to ask, where are we going, what are we doing, how much is it costing, and what is happening to our resources?

We began to look at our environment. This became popular. Politicians saw the good in this attitude and rode the environmentalist wave because, as we know, everyone needs a cause. As a result, laws were passed aimed at the entire cleaning up of our water and air from the pollution of two hundred years of progress — with a ten year goal!

But something else also happened, or rather, failed to happen. No one asked the engineers if this 100 per cent clean-up was technologically or practically possible. Perhaps we did not try very hard to educate the public that this was not a feasible goal, but anyway we were not successful.

Thus a "monster" was born. Those old political standbys called "blue sky" and "motherhood" had a competitor. That competitor was to get elected on a platform of "clean rivers and clean air". Laws were passed, money was appropriated; the country ordered a "clean-up" and the problem from the politician's and public's point of view appeared to be solved.

As we all know, the pollution problem has not been solved; instead attempts to solve it have met with frustration. The public was sold a bill of goods that was impossible to achieve. The politicians did not consider the consequences of their actions on others. The effects now echo into every walk of life, and no one has dared admit the mistake. In fact, the pollution problem has gotten worse. We now are caught up in the Government's patented philosophy; if a law isn't working, issue more regulations. The wheels of progress have thus been slowed by Government regulation, stopped in many instances by misguided environmental impact statements, and pushed backward by ever changing red tape, with the public now saying, "Wait until next year; maybe a new federally aided program will give us more money."

In the March 1976 Public Works Magazine, an editorial entitled "Design by Decree," included these pertinent statements:

> "The municipal consulting engineer in the United States has traditionally enjoyed freedom in exercising his judgment in designing water supply and sewerage facilities. By having freedom of choice in reaching decisions and using it ethically, he has attained a peak of professionalism rivaled only by the practitioners of medicine. With the advent of regulation of design practice by state and interstate authorities when serving municipalities, there was some restriction of their freedom. But the power of those regulatory bodies, headed by engineers, was also tempered with judgment in most instances.
>
> Within the last few years, the picture has changed and the respected engineer-municipal client relationship has been challenged to the point where the professionalism of the consultant is in jeopardy. Where does the fault lie? Could it be over regulation caused by the funding power of the federal government? With the billions of dollars at stake in meeting the deadlines of the water pollution control act, the corporate interests behind equipment vendors and contractors could be waxing to the point of unprecedented greed. It is conceivable that standards of designs and strings on the funding can be made so tight that interpretation is possible only at the federal level — and possibly by a single prejudicial group in power. Dare one suggest that the prospective narrowness of such interpretation could be influenced by vendor-cor-

porate interest? Situations have been coming to light to indicate that this could be happening. Should it continue to be tolerated, honest competition between equipment manufacturers could be destroyed. There is already feeling among some manufacturers that the municipal market is not for them. Thus we have two American pedestals being threatened: The first is the spirit of competitive manufacturing in the pollution control field — the second which could be most fatal, the professional stature of the consulting engineer. What will the result be — design by decree?"

The above asks some very basic questions. It also asks, where does the fault lie? Who is to blame? Certainly not the politician, after all his heart was in the right place. Certainly not the public, they believed the politician. Certainly not the construction contractor, because he would like to build these projects if he were only given some to build.

The blame has been heaped on the engineer because things are not moving. Undeserved? Yes and No. It's undeserved because we knew all along it would not work. But perhaps part of it is deserved because we didn't look out for ourselves and the country. We were not vocal enough.

I have been working with the American Consulting Engineers Council, the American Society of Civil Engineers, the Water Pollution Control Federation, and the National Society of Professional Engineers and all of these societies are up against a stone wall. The federal government has become anti-engineer. Undeservedly, but true, the engineer is being attacked on all sides. With the major efforts now being through anti-trust actions, procurement regulations and professional liability — and all of these snowballing — a slow-down exists that is putting engineers out of work. With engineers out of work, designing and planning slow down. This will have a real effect on the entire country.

What is the cause of all this? Why it's fundamental. It's as old as time itself. It's a question of saving face. The government, in its endeavor to make a better world, passed laws, expanded and hired new people, mostly right out of college with no experience, put them in positions of great responsibility and then allowed them to run hog wild. Where was the older professionals' guidance, both in government and out? Now, although promises were made that could not be kept and things are getting more mixed up, government officials will continue to blame others as a face saving gesture. Are we to take the blame? Should we as professionals take the blame? Let's look at the picture. There are more engineers, more registered professional engineers, working for the government now that ever before. They must act on their best judgment and common sense — instead of expending their energies in frustrated fault finding. They must "tell it like it is." They must not explain that their hands are tied by stupid regulations, but instead act like professional engineers and fight to correct the situation. They must not feel that they must cover their trails because of legal and audit clouds that government hangs over their heads continuously. Question: If engineers in responsible positions, both in government and out, cannot control misguided actions, do not speak out, but instead let other interests sway their better judgment — should they be called engineers? Should they be allowed to continue to be registered? Are they hypocritical in belonging to professional societies?

I have been personally requested by professional engineers in positions of responsibility to alter my best engineering judgment in order to expedite some project because it appears to be the politically expedient thing to do. Something is dead wrong. Either these professional engineers are afraid or they don't know what professionalism is.

I wonder if academia has a responsibility that it is not aware of, not able to teach, or not willing to face. Most graduates do not have (nor should they be expected to have if no one taught them) much feeling for the professional side of engineering when they graduate. All of this then leads to what in my opinion are necessary, essential future responsibilities of the Boston Society of Civil Engineers Section.

Future Essentials

At Student Night on February 26, 1976, in Lowell, the subject of the presentation was "Unionism and Civil Engineers". The discussion was led by a man experienced on both sides of the fence. He emphasized that unions are not for professional engineers, simply because unions attempt to upgrade all of their members at the same time and at the same level while professional engineers improve them selves individually without having to pull everyone else along with them. During the question and answer period, it became clear that there was misunderstanding and confusion in the minds of civil engineering students. It was implied by some students that if professional societies cannot go to management and get salary increases and physical improvements, such as a new desk for the individual engineer, what good are these professional societies?

In other words, the students were equating professional societies with unions and expecting each to do about the same thing. You, I, we, all have to give them an answer and soon. These students are going to be the future profession and if government continues to expand, more and more of them will become our bosses in the future whether we like it or not. They have got to gain an understanding of what a professional engineer does, what his problems are, what his philosophy is, and the value of professional engineering societies.

Who educates the engineer once he leaves college? In the January 1976 issue of "Corrosion" magazine, an editorial appeared which carries some important thoughts along these lines: Post graduate engineering education in the United States is a haphazard affair, including on the job training, technical societies, university short courses, and the products of over eager publishing houses. One is impressed frequently with the fact that most failures that occur in the engineering world were not caused by lack of new information, but by the failure to use existing available knowledge.

Coming upon us like the plague is the specter of malpractice suits. Medical doctors, unfortunately, have been the chief targets, but every professional group will ultimately be affected. We will be held increasingly more responsible for our actions as professionals. The move to multiple-party liability in the law is a result of the demand by society for competent (maybe perfect) professional performance.

Who, then, provides a cohesive basis for technological information transfer and accreditation? Is it in fact the professional engineering societies? I think so. These societies can exert an important influence on the course of the economy and the quality of the nation's engineers.

The argument for increased support of societies by their members can be made along several lines. For example, any member of an engineering society has at his easy call services of many professional acquaintenances. On any given day, he can call friends in industry or university organizations and obtain help in solving pressing problems. This alone is worth more than the nominal support which some members now provide.

The engineering societies offer opportunities for individual advancement. Today accreditation of technologists is at a trivial level. Despite the great interest in professional engineering, the title of professional engineer does not carry the impact it should. It should have a status equivalent to that gained by passing the bar exam or the medical examinations. But it does not. Why not accredit different groups — technicians, practicing engineers and applied scientists? Should we have a separate accreditation for registered engineers not affiliated with professional societies and for registered *professional* engineers?

The engineering societies provide many functions which benefit individuals as well as their respective companies. They expose their members to a broad intellectual base. Engineering societies provide a peer review which frequently is not possible within a particular company. Often a person is an individual specialist with a small company or even a large one and others in the company are not able to provide a critical review of his ideas. On the other hand, within a engineering society meeting, a paper may be constructively criticized and the author thus enlightened. The society also serves as a management training organization through member participation in society activities. Often the judgments of management operations provided by peers in an engineering society are as severe and critical as they are within companies. Societies also serve as employment brokers. Companies interested in employing new people have ready access through contacts made in societies. Conversely those who find it necessary to obtain other employment have ready access to many possibilities through acquaintances made in engineering societies.

The Boston Society should continually look at and assess ways in which its value to engineers can be improved. Let's also find out how the needs of companies can be met more effectively and also how companies could support more extensively the activities of engineering societies. We should make a greater effort to identify and offer the benefits of professional engineering societies to students and recent college graduates.

Engineering societies are as important to the practicing engineer as the universities are to the undergraduate. We should treat the Boston Society of Civil Engineers Section accordingly and look more energetically and carefully at our effectiveness.

It may not be too long before a requirement for renewal of a license to practice engineering will be the showing of evidence of continuing education and upgrading of knowledge in one's chosen field. The question of how to achieve continuing education credibility for future renewals of registration certificates must be addressed by professional engineering societies. No other civil engineering society is in a better position to do this than BSCES/ASCE, technically as well as professionally. If BSCES/ASCE and other societies on a country wide basis do not assume these responsibilities, more and more graduates will be "trained" (and bossed) by politicians, lawyers and, more recently, accountants, all to the detriment of this country in its third century.

Since the future belongs to those who prepare for it, we must become dead serious as a profession or we shall surely become dead as a profession.

THE FIRST FREEMAN HYDRAULICS PRIZE PAPER

Committee Announcement

Hunter Rouse's new book *Hydraulics in the United States, 1776-1976,* being published in installments in the *Journal* starting on a following page, earned him the first Freeman Hydraulics Prize, awarded by the Boston Society's John R. Freeman Fund Committee(1) on November 18, 1975.

John Ripley Freeman, who established the Freeman Fund in 1925, was an outstanding engineer and a great benefactor of the engineering profession. The memoir of this remarkable man is reprinted here (from the *Transactions of the American Society of Civil Engineers,* Vol. 98, 1933).

It is most appropriate that Dr. Rouse should be the first recipient of the Freeman Prize. At the start of his career he was a Freeman - M.I.T. Traveling Fellow in Hydraulics and in 1966 he was the Boston Society's first Freeman Memorial Lecturer.(2) Throughout a long and distinguished career, Dr. Rouse has been a major and prolific contributor to the field of hydraulics. He was Director of the Institute of Hydraulic Research at the University of Iowa from 1944 to 1966, then became Dean of the College of Engineering at Iowa, and was Carver Professor until his recent retirement.

The prize winning book which was prepared under a grant from the National Science Foundation will soon be published in hard cover by the Iowa Institute.

Subsequent Freeman Hydraulics Prizes of $2,000 may be awarded annually if exceptionally useful papers in the field of hydraulic engineering are submitted. Papers (or books) should be comprehensive, tracing the historic development of their thesis, explaining its theoretical basis, giving practical examples of its application and citing pitfalls it may help to avoid. They must be original in overall presentation but will be acceptable if they cover the state-of-the-art in a superior manner. They should be well illustrated and edited.

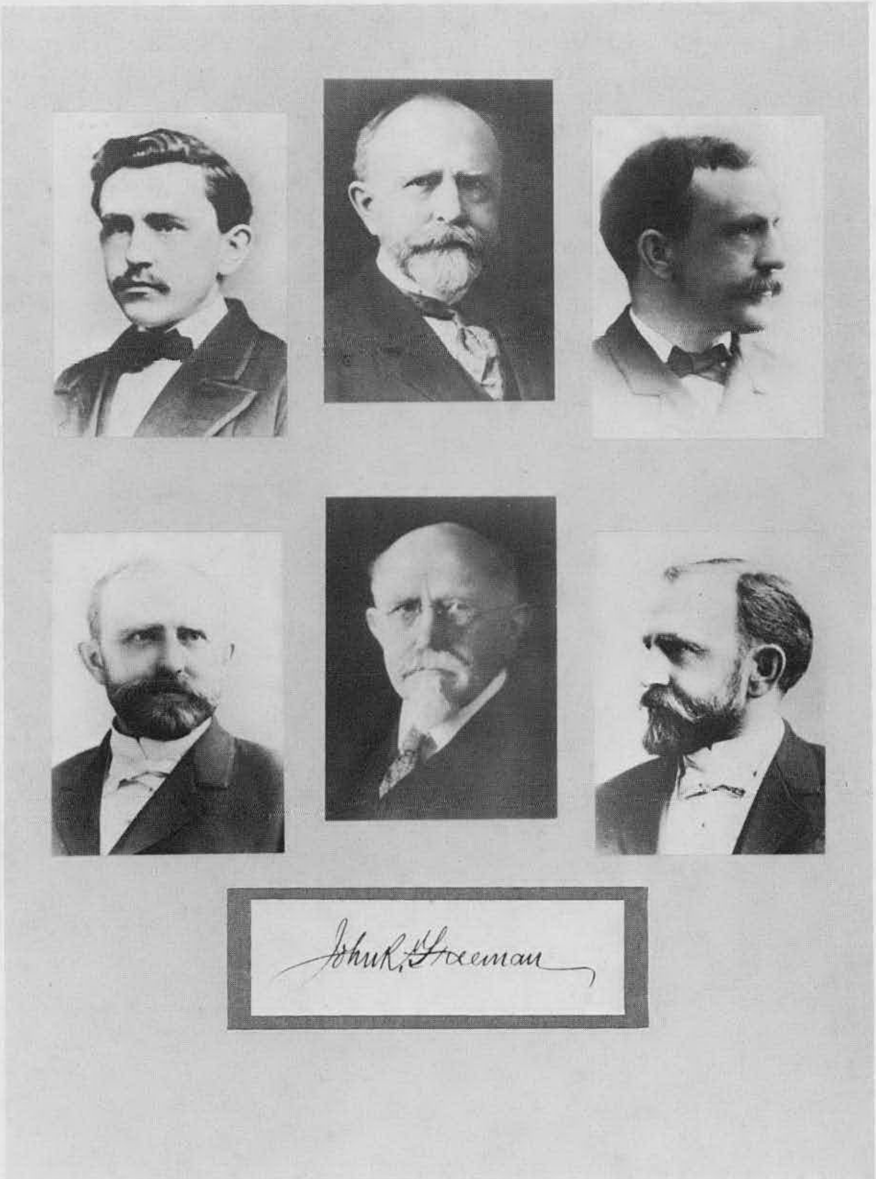
All papers submitted shall become the exclusive property of the Boston Society of Civil Engineers Section American Society of Civil Engineers — a non-profit, tax-exempt, professional organization. The papers or major parts thereof shall not be or have been submitted for publication to or published by any other organization — public, private, or academic. The Boston

(1) Members — Lee Marc G. Wolman, David R. Campbell, Harry L. Kinsel, Lawrence C. Neale and Donald R. F. Harleman.

(2) Rouse, H. "Jet Diffusion and Cavitation", *Journal BSCE,* Vol. 53, No. 3, July 1966.

Society will publish all prize-winning papers in the *Journal* and may also publish the papers separately or in special collections. More than one prize may be awarded in a given year, but this might necessitate deferment of future prizes. While non-prize-winning papers submitted may qualify for *Journal* publication, authors of such papers will be given the option of withdrawing them.

Papers are judged by the Boston Society's John R. Freeman Fund Committee. They should be submitted by registered mail to the Freeman Fund Committee, c/o Boston Society of Civil Engineers Section American Society of Civil Engineers, 230 Boylston Street, Boston, Massachusetts 02116. To be eligible for the prize in any year, papers should be received by the end of June of that year. The competition is worldwide. Interested applicants are invited to correspond with the Committee before preparing final applications.



Photographs of John R. Freeman taken upon his graduation from MIT (upper left) and at later stages of his life. The signature is reproduced from the files of Dr. Hunter Rouse.

MEMOIRS OF DECEASED MEMBERS

JOHN RIPLEY FREEMAN, Past-President and Hon. M. Am. Soc. C. E.[1]

Died October 6, 1932

John Ripley Freeman was born on July 27, 1855, in West Bridgton, Me., where his early life was spent on his father's farm and where he began his education at the country schools. Later, he attended the public schools of Portland, Me., and Lawrence, Mass. He entered the Massachusetts Institute of Technology, in Boston, Mass., in 1872, and became a student in the Department of Civil Engineering, graduating in June, 1876, with the degree of Bachelor of Science.

After graduation, Mr. Freeman went to work for the Essex Company, a water power company at Lawrence, Mass., on the Merrimack River, which had previously employed him during his vacations at the Institute. He soon became Principal Assistant Engineer to the late Hiram F. Mills, Hon. M. Am. Soc. C. E., the Chief Engineer of the Essex Company, one of the foremost hydraulic and sanitary engineers of his time and a member of that eminent New England school of hydraulicians represented by Charles S. Storrow, Hon. M. Am. Soc. C. E., Uriah Boyden, James B. Francis, Past-President and Hon. M. Am. Soc. C. E., and Joseph P. Davis, M. Am. Soc. C. E. Mr. Mills at that time was engaged on extensive hydraulic experiments, the results of which have only in part been made public, and he was also carrying on a large consulting practice devoted mostly to problems of water power, foundations, and factory construction. In all this work Mr. Freeman was an active assistant and there he laid the foundations for his remarkable career.

After ten years of this apprenticeship at Lawrence, Mr. Freeman resigned his position there in 1886 to become Engineer and Special Inspector for the Associated Factory Mutual Fire Insurance Companies, of Boston, Mass. He re-organized the corps of inspectors employed by those companies, conducted experiments looking to the improvement and standardization of fire prevention apparatus, and conducted scientific researches into the causes of fires. During this period he presented to the Society his papers entitled "Experiments Relating to the Hydraulics of Fire Streams"[2] and "The Nozzle as an Accurate Water Meter.[3] For the first of these papers he received the Norman (Gold) Medal of the Society in 1890, and for the second the Norman Medal of 1891. While in Boston Mr. Freeman arranged to give one-half his time to a consulting practice in water power, municipal water supply, and factory construction. There, he also began his long career in the public service, to which he gave so much of his life. He was a member of the Water Board

[1] Memoir prepared by Walter E. Spear, M. Am. Soc. C. E.

[2] *Transactions*, Am. Soc. C. E., Vol. XXI (1889), p. 303.

[3] *Loc. cit.*, Vol. XXIV (1891), p. 492.

of Winchester, Mass., where he made his home, and in 1895 and 1896 he was Engineer Member of the Metropolitan Water Board of Massachusetts, which was then engaged in preparing plans for the development of a large additional water supply from the Nashua River for the Boston Metropolitan District.

In 1896, Mr. Freeman left Boston to become President and Treasurer of the Massachusetts Mutual Fire Insurance Company and its Associated Companies, at Providence, R. I., a position which he held at the time of his death. Although best known to the profession as a Consulting Engineer in many fields, he gave fully of his time after he went to Providence to the insurance business and developed those natural talents as an executive and business man which gave him pre-eminence in the factory insurance field. His success was marked by a constant improvement in fire prevention methods and a steady reduction in insurance costs. His companies, which wrote about $65 000 000 of insurance in 1896, had about $3 000 000 000 on their books in 1932.

Mr. Freeman approached the problems of building construction and of safe-guarding life and preventing fire losses as an engineer and an insurance executive. He wrote extensively on fire protection matters and in 1905 issued a publication "The Safeguarding of Life in Theatres," which represented a comprehensive study of theatre fires, their causes, and means of prevention. In 1915, he presented to the International Engineering Congress at San Francisco, Calif., a paper on "The Fire Protection of Cities."

For many years Mr. Freeman was alive to the importance of adequate design and good construction in preventing the loss of life and property from earthquakes. He was a member of the Seismological Society of America and collected at Providence an unusual library on seismology. He devoted much effort to stimulating engineers, geologists, and seismologists to the importance of obtaining adequate information on the magnitude and character of earth movements in the vicinity of major seismic disturbances. He visited many earthquake regions in all parts of the world to study at first hand the causes of failures in buildings and other structures, and in 1932 published a book entitled "Earthquake Damage and Earthquake Insurance," which may be considered a textbook on the subject of earthquake-resisting design.

In an age of specialization, Mr. Freeman did not confine his work to those branches of engineering within which the civil engineer to-day is supposed to practice. He was at one time, for example, a civilian member of an Army Board on disappearing gun carriages. He was, however, pre-eminently an hydraulic engineer and his field was primarily in water power, river control, water supply, and allied problems of a sanitary and hydraulic character. Except for short periods on his larger undertakings he never employed a large organization in his consulting practice, preferring to give to each task a large measure of his personal attention. Mr. Freeman believed that a change of work afforded a complete rest. Engineering was his recreation, and he practiced it with an enthusiasm and thoroughness that made him early a prominent figure in the engineering world.

Mr. Freeman never lost his interest in the hydraulic and construction problems associated with the development of water power with which his early work in New England was identified. He wrote extensively on water power subjects and made many investigations and reports on water power projects in the United States, Canada, and Mexico. He organized in 1905 a staff of engineers for the preliminary surveys and investigations for the Feather River Development of the Great Western Power Company, in California, and subsequently advised on the Big Bend and Caribou Developments. In 1907 and 1908, he was Senior Consulting Engineer to the New York State Water Power Supply Commission, which was charged among other duties with that of conserving the water resources of the State. Among other storage projects which he studied was a reservoir on the Sacandaga River above Conklingville, N. Y., in the Adirondack Region, which has since been constructed. He was called in from time to time to advise upon the construction of the Massena Power Development on the St. Lawrence River, for the St. Lawrence River Power Company, and its successor at Massena, N. Y., the Aluminum Company of America; and afterward gave advice on ice difficulties and on back-water and other operating problems. He also advised the Aluminum Company of America on its power developments on several Southern rivers and on the design and construction of new aluminum smelting works at Niagara Falls, N. Y. He made investigations on water power development for the Canadian Government in Alberta, Manitoba, and British Columbia; designed high masonry dams for the Mexican Northern Power Company, and for the Pacific Gas and Electric Company at Lake Spaulding, California; designed and supervised the construction of a high masonry dam on the Missouri River, at Holter, Mont.; and prepared plans for many power projects which have not been executed, notably for the development of the Great Falls of the Potomac River, for a large hydro-electric project in the Lachine Rapids, on the St. Lawrence River, near Montreal, Que., Canada, and for a subterranean development for the Ontario Power Company, at Niagara Falls.

Not the least of Mr. Freeman's contributions in the broad field of Hydraulic Engineering were those on problems of river control and navigation. Among his writings on these matters was a paper on "Flood Control of the River Po in Italy"[4] which was presented at the meeting of the Society on June 6, 1928, and for which he received the J. James R. Croes Medal on January 21, 1931. In 1903, he was made Chief Engineer of the Charles River Dam Commission and prepared an exhaustive report on the project for the conversion of the lower estuary of the Charles River into a fresh-water lake, which has since been constructed. In 1904, he reported to the Massachusetts Metropolitan Park Commission on the improvement of the Mystic River and the drainage of the Fresh Pond marshes. In 1905, 1908, and 1915, Mr. Freeman was appointed by the President of the United States a member of Engineering Boards to report on a sea-level *versus* a lock canal and on problems of dam and lock foundations, and earth slides which blocked the Isthmus of Panama several times. From 1917 to 1920, he acted as Consulting Engineer

[4] *Transactions*, Am. Soc. C. E., Vol. 94 (1930), p. 161.

to the Chinese Government on the improvement of the Grand Canal and the prevention of disastrous floods on the Yellow River and the Hwai River, organized a staff of engineers to investigate these problems, and went to China himself in 1919. Between 1924 and 1926, Mr. Freeman was a member of the Engineering Board of Review of the Sanitary District of Chicago and prepared a program for the regulation of the Great Lakes. His report on these matters included exhaustive studies of winter evaporation from the Great Lakes and of minor earth movements or tilting affecting the problem of lake levels.

Mr. Freeman was greatly interested in the application of the hydraulic research laboratory to the study of the river and harbor problems. He made himself familiar with such laboratories in Europe, and presented to the Society a paper on the "The Need of a National Hydraulic Laboratory for the Solution of River Problems."[6] In order to stimulate the interest of American engineers in the laboratory approach to hydraulic problems he had translated and published in 1929 a series of monographs by leading European hydraulicians, entitled "Hydraulic Laboratory Practice." As a further means of educating American engineers to the importance of the hydraulic laboratory and to provide trained men to operate such laboratories when they were built, Mr. Freeman in 1923 gave $25 000 each to the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Boston Society of Civil Engineers, with which to provide for traveling scholarships in hydraulics open to young engineers and junior professors. The first scholarship was awarded by the Society in 1927 and since then, one or two men have studied each year in Europe. Mr. Freeman also conceived the idea of a National Hydraulic Laboratory in Washington, D. C., and was active in furthering the passage of the necessary legislation at Washington and in advising on its construction.

In the water supply field, Mr. Freeman had a long record of distinguished service, and his many published water supply reports made him perhaps best known to engineers in that field. In 1899, he was engaged by the Comptroller of The City of New York to investigate new sources of water supply for that city, and after eight months of intensive work he submitted an exhaustive report on all its possible water supply sources. In this report, he presented valuable experiments on the flow over the crests of model dams, a recomputation of the yield of the Croton System, and an estimate of the future water consumption of New York City, which has been well confirmed by subsequent events.

In 1903, he was a member of the Commission on Additional Water Supply of New York City, the so-called Burr-Hering-Freeman Commission, which investigated the yield and quality of all available sources of supply for the city and made a report which became the basis of the subsequent work of the Board of Water Supply. Mr. Freeman, with his insurance training, recognized the importance of ample water pressures in large cities and was largely responsible for the adoption of the Commission's recommendation

[6] *Transactions*, Am. Soc. C. E., Vol. LXXXVII (1924), p. 1033.

for delivering the new supply in the City at a considerably higher level than the existing distributing reservoirs at Croton, a recommendation that was followed in the construction of the Catskill Works. In 1905, he was appointed Consulting Engineer to the Board of Water Supply of New York City, the body created in that year to construct the Catskill System. He was active in the organization of the Engineering Corps of the Board of Water Supply and in the planning and construction of the Catskill Works. He continued as a Consultant to that Board until his death.

In 1906, Mr. Freeman was one of a commission of three engineers engaged to report on the Los Angeles Aqueduct, a project to bring the waters of Owens River 240 miles to the City of Los Angeles, Calif. In that work he recommended a location for the Owens River Aqueduct which made possible the development of power not previously considered feasible.

He was engaged in 1909 in the capacity of Consulting Engineer on the problem of new sources of water supply for the City of Baltimore, Md.; from 1909 to 1912, he was Consulting Engineer to the City of San Francisco, Calif., and planned the Hetch-Hetchy System, in which he made the development of electric power an important feature. Among other cities which had sought his advice on water supply matters were Nashua, N. H., Denver, Colo., Seattle, Wash., San Diego, Calif., and the City of Mexico, Mexico.

In addition to his country-wide public service, as a Consulting Hydraulic Engineer, Mr. Freeman was active during the World War as a member of the National Advisory Committee on Aeronautics, and reported at that time on the Hog Island Shipyard. He was also a member of the Visiting Committee of the Bureau of Standards, Washington, D. C. In Providence, which became his home after 1896, he identified himself with many local activities. In 1911, he made a study of city planning for the east side of Providence, including new highways, parkways, and parks. He also carried on as a private venture a large real estate development of higher character in the vicinity of his home. He served for ten years as a Director of the Rhode Island Hospital Trust Company and of the National Bank of Commerce, in Providence; in 1904, he was a member of the Rhode Island Metropolitan Park Commission; and, during the war, served as President of the Providence Gas Company.

Mr. Freeman was keenly interested in technical education and spoke and wrote on such educational matters. For forty years he was a member of the Corporation of the Massachusetts Institute of Technology, Boston and Cambridge, Mass. He was once offered the Presidency of the Massachusetts Institute of Technology and twice was offered the chair of Civil Engineering at Harvard University, but had to decline in each case, feeling that he was better suited to professional work.

On April 21, 1931, Mr. Freeman was given a testimonial dinner, sponsored by the Providence Engineering Society, at which engineers, scientists, educators, industrialists, and other friends paid him a remarkable tribute for his many varied accomplishments. He was an Honorary Member of the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, the Providence Engineering Society, the New England Water

Works Association, the Badische Technische Hochschule, Karlsruhe, Germany, and Mitgleid des Wissenschaftlichen Beirats des Forschungsinstituts, in Munich and Walchensee, Bavaria, and a Past-President of the first two of these societies. He held honorary degrees from Brown University, Tufts College, the University of Pennsylvania, Yale University, and the Sächsische Technische Hochschule, Dresden, Germany.

At its meeting on January 17, 1933, the following Resolutions were unanimously adopted by the Board of Direction of the Society:

"*Whereas:* It has pleased Almighty God to remove from our midst our late Honorary Member and Past-President, John Ripley Freeman.

"*And Whereas:* We realize that in his death, the World has lost a most useful citizen; the Engineering Profession an able leader; and the American Society of Civil Engineers a valued and loyal member.

"*Now, Therefore, Be It Resolved:* That the Board of Direction of the American Society of Civil Engineers hereby records its profound sorrow at the passing of its respected and revered friend and supporter.

"*Be It Further Resolved:* That the sincere sympathy of the Board of Direction be conveyed to his bereaved family; and

"*Be It Further Resolved:* That a page be set aside in the Minutes of the Board upon which shall be inserted this Resolution, a copy of which shall also be transmitted to his family."

In 1888, Mr. Freeman was married to Elizabeth Farwell Clark who, with one daughter and four sons, survives him.

Mr. Freeman was elected a Junior of the American Society of Civil Engineers on June 7, 1882; a Member on April 3, 1889; and an Honorary Member on September 29, 1930. He served as Director from 1896 to 1898; as Vice-President in 1902 and 1903; and as President in 1922.

HYDRAULICS IN THE UNITED STATES 1776 - 1976

BY

HUNTER ROUSE
Carver Professor Emeritus

Institute of Hydraulic Research
The University of Iowa
Iowa City

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HYDRAULICS IN THE UNITED STATES 1776-1976

PREFACE

There is said to be a bit of a snob in each of us, and it was probably something of the sort that led me to avoid England when I first went abroad to study, because I did not consider the English sufficiently foreign. (I was so wrong!) Much the same thing occurred when I wrote the final version of our *History of Hydraulics*: though I then gave full credit to British contributions, I treated our own as if they were of secondary importance. However, in a 1971 after-dinner talk to the effect that "Hydraulicians Are Human Too!" fully half of the fourteen men that I discussed happened to be Americans—four native-born, three immigrants by choice. And according to an article that I drafted in 1973, "Hydraulics' Latest Golden Age," people from the United States seem to have played as large a role as any in bringing about this century's renaissance of their profession. Whether I am actually biased pro or con, the temptation to help celebrate the bicentennial of our country's founding by devoting a whole book to American hydraulics has been too great to resist. True, the basic principles of hydraulics had all been formulated before the United States came into existence, and our earliest projects were really carried out almost completely as an art. But we eventually showed an inborn ability to apply the scientific principles that others had developed, and within the past four decades the fluid-mechanics approach to hydraulics has been advanced as far in this country as anywhere else in the world.

Just what is meant by "hydraulics" varies greatly from person to person, even within the one professional field. To some it signifies the use of the underlying principles in engineering design, and to others the discovery of the principles or their amplification. Still others think primarily of model testing, or of flow measurement in the field. Were this book to cover everything relevant to the term itself, it would have to be a multi-volume work. To me, the term refers to the science rather than to its application, though there is admittedly no sharp borderline between the two. Perhaps the factors on which I place the greatest emphasis are investigation and publication. In the opening chapters, of course, I have had to deal with the practical aspects of water supply and disposal, because that was all that existed. But as the principles came to be recognized and applied, advancement by cut-and-try processes could be given less and less prominence, and finally attention could be centered on research and analysis, as I have sought to do in the later chapters of the book. Even there the treatment has not been simple and straightforward, for the advancement of the subject has depended upon a diversity of influences: the people, first of all, and their associations with each other; such matters as wars, migrations, and study abroad; the professional societies, the federal agencies, and the variable largesse of the government. Whereas these influences might appear to have played a minor role in the early history, it has sometimes seemed to me that my present writing deals almost too much with people (particularly the ones I have known) and too little with hydraulics, even though the latter has been my primary interest for nearly half a century!

While this span of years has given me a broad overview of what has occurred in the States during the last two generations, the viewpoint is necessarily a subjective one, biased in the direction of my own experience. Events of at least the past decade, of course, are too recent to be seen in proper perspective, but they are included to round out our second century of endeavor. Items from the more distant past I have been able to recall to some degree from conversations with still older people, many of whom are no longer alive, but the material from over a century ago stems primarily from the literature. The stories of particular localities I have acquired to some extent from historically minded colleagues—such, for example, as Joe Johnson of Berkeley, who has done much to preserve the record of hydraulics in California's golden years. Nevertheless, many gaps must still remain, and some of my statements may well be inaccurate. Nine months ago I hence deemed it wise to send the prologue and subsequent chapters of the provisional manuscript (the epilogue was then still unwritten) to some twenty of my friends who knew various aspects of the story better than I, in the hope of producing a final result with which all would be reasonably well satisfied. The same material was submitted to the Freeman Fund Committee, Boston Society of Civil Engineers Section, American Society of Civil Engineers, which honored me four months ago with its first Freeman Hydraulics Prize. The revised manuscript is now to be published serially by the BSCE Section, and by the Iowa Institute of Hydraulic Research as an illustrated book.

Though I will have given some four years to the writing of the book and must accept final responsibility, during that period many of my colleagues have had the opportunity to provide additional input, whether of factual or illustrative material, for which I am very grateful. Particular thanks are due the following: M. L. Albertson, J. W. Ball, P. C. Benedict, E. F. Brater, F. R. Brown, J. E. Cermak, E. S. Cole, J. S. Cragwall, J. W. Daily, R. L. Daugherty, D. G. DeCoursey, J. B. Drisko, R. A. Elder, R. G. Folsom, A. H. Frazier, D. R. F. Harleman, R. Hazen, G. H. Hickox, L. J. Hooper, J. W. Howe, T.-K. Hung, G. D. Johnson, J. W. Johnson, J. F. Kennedy, C. E. Kindsvater, D. L. King, M. Kranzberg, G. Kulin, E. Layton, G. B. Lyon, Mary H. Marsh, L. C. Neale, A. J. Peterka, M. S. Petersen, E. B. Pickett, C. J. Posey, T.

Saville, D. B. Simons, J. B. Tiffany, V. A. Vanoni, R. M. Vogel, and S. W. Wiitala. Acknowledgment is also made to Linda Priest for typing the final manuscript, to Ada M. Stoflet and F. T. Allen of the University of Iowa Library for their extensive reference services, and to Norman Sage of University Publications for his able handling of all production details. Finally, I must express sincere appreciation to The University of Iowa and its Institute of Hydraulic Research for the time that I used during the last two years before my 1974 retirement, and to the National Science Foundation's Division of Social Sciences, whose three-year grant alleviated many of our financial problems.

Iowa City, 29 March 1976 HUNTER ROUSE

PROLOGUE

European Antecedents

By the time the American colonies began functioning as a unit, other civilizations had already existed from a few hundred to many thousands of years. The New World was thus still in the position of a receiver rather than a contributor in virtually all aspects of civilized life. In this study of American hydraulics, therefore, it would seem in order at the outset to assess the state of the profession elsewhere at that time, and then to estimate what portion of the existing knowledge was readily available to the colonists—and how much of this actually reached more than a very few of those who could appreciate it.

Like other engineering sciences, that dealing with the flow of water necessarily began as an art, its general principles still to be formulated millenia later as the result of experience acquired over countless centuries of practice in the field. Indeed, hydraulic engineering is among the most ancient of professions, for the need of providing water to drink and to irrigate crops is older than civilization itself—and, in fact, often influenced its course. There is still evidence of extensive canalization systems having diverted river flows in the Middle and Far East well before recorded history. Written evidence from Egypt, China, and Greece attests to the construction of reservoirs, wells, canals, and tunnels of surprising size several thousand years before the Christian era, and ships of that time are known to have ranged far and wide. Later writings of Vitruvius and Frontinus describe Roman systems of water supply and drainage of vast proportions.

During the millenium that followed the fall of Rome, ground was lost in many ways, for major structures were permitted to deteriorate, and practically nothing new of a scientific nature was discovered till the present millenium had begun. On the other hand, water mills increased in number (as well as windmills after the 12th century), land was drained or irrigated, and the size and range of sailing vessels advanced in proportion. By the time of the great upsurge in accomplishment marked by the Renaissance, hydraulic engineering was as ready as any profession to take its proper part.

The elements of hydrostatics, of course, had been known from the time of Archimedes in the 3rd century BC through successive translations of his works from Greek to Arabic and then to Latin and the more modern languages of Europe. His teachings were gradually amplified by the observations of Leonardo da Vinci, Stevin, Galileo, and Pascal in the 15th, 16th, and 17th centuries. Of considerably more interest at the moment, however, are the simultaneous contributions to principles of hydrokinetics and to hydraulic practice in general. Da Vinci, around 1500, not only first formulated the principle of continuity (the inverse relation between velocity and flow section) and conceived such devices as miter gates for canal locks and parachutes (akin to sea anchors), but he planned and supervised the construction of extensive canal and harbor works in Italy and France. Unfortunately, many of his writings and drawings disappeared for several centuries after his death, and his accomplishments hence had limited influence on the course of technology. Galileo and his followers, Castelli and Torricelli, had considerable effect a century later upon various aspects of experimental hydraulics (continuity, efflux of jets, pump suction), and Galileo is also rumored to have advised an engineer against river cutoffs, though apparently in vain. Drainage of Italian marshlands was then (and for centuries thereafter) of considerable importance, and open-channel hydraulics progressed apace. Domenico Guglielmini, who was born a few years after Galileo's death, was the first to write as well as practice in this field, and his works were widely read.

Although Italy was thus responsible for the naissance of hydraulic theory, other countries in turn soon took the lead. A contemporary of Guglielmini, Edme Mariotte of France, contributed as much to laboratory experimentation as the former did to field observation. Mariotte was interested in the shape of jets and the force they exert on deflecting surfaces, the resistance of bodies to the flow of air as well as water, and the compressibility of air; and a book containing his findings was published after his death. His German and English contemporaries Otto von Guericke and Robert Boyle (the latter of whom apparently coined the word "hydraulics") were also interested in the weight and compressibility of the air, as was Mariotte's compatriot Pascal. Later in the 17th century the Englishman Isaac Newton formulated in his *Principia* . . . the equality between the impulse of a force acting on a body and the rate of change of momentum that it produces, and he applied it to the motion of the planets, experimenting with various kinds of fluid resistance to prove (contrary to the belief of Descartes) that the planets moved through a void; he also developed an initial form of the calculus. Shortly thereafter the German Gottfried Wilhelm von Leibniz likewise invented the calculus, and just a year in advance of Newton's *Principia* introduced the equality between work and the change of energy that it produces (though without the factor ½ that eventually had to be applied to the kinetic term). Cries of plagiarism from the colleagues of both led to a rift between continental and island science that was to persist for generations. Johann Bernoulli and his son and pupil Daniel contributed to the application of Leibniz' calculus as well as to the principles of continuity, momentum, and energy in their books *Hydrodynamica* (by Daniel in 1738) and *Hydraulica* (by Johann in 1743); for want of the pressure term, however, neither truly included the primary theorem of hydraulics now known by their name. The spatial variation of pressure was first truly understood by Johann's pupil and Daniel's classmate (and fellow academician at St. Petersburg), Leonhard Euler, who first derived the so-called Bernoulli equation in 1752; primarily a mathematician, Euler laid the true foundation of hydrodynamics (including unsteady, nonuniform flow in conduits), in the course of which he also designed a primitive reaction turbine.

Mariotte's early efforts at hydraulic experimentation were followed by a series of related discoveries in various parts of Europe. Robert Hooke built in England in 1683 a vaned mill for air flow and a screw for use on ships' logs, sounding devices, and current meters. Henri Pitot discovered in France in 1732 a "machine" to indicate the speed of flowing water, consisting of an L-shaped tube pointing upstream and a straight one normal to the flow, with an interconnecting valve to be closed before withdrawing the instrument from the flowing water. Daniel Bernoulli in his St. Petersburg laboratory improved on Pitot's crude manometer (the normal tube) by inserting it in the conduit wall; he also discovered and analyzed the principle of jet propulsion. In England Benjamin Robins introduced in 1746 the rotating arm for gaging the resistance of bodies. In 1759 his countryman John Smeaton described the first scale-model tests, to determine the performance (i.e. efficiency) of both windmills and water wheels. The Frenchman Jean-Charles Borda less than a decade later used the rotating arm to compare resistance measurements of similar bodies in air and water. And his compatriot Charles Bossut wrote in 1771 the first textbook on "fluid mechanics" (actually hydraulics, with one volume on theory and one on experiment).

Indicative of the scientific ferment occurring in the 17th century was the formation of small groups of people interested in the advancements that were taking place. As a result of meetings held as early as 1645, the Royal Society of London was established by 1660, and both Hooke and Newton became active participants. The *Académie Royale des Sciences* came into existence in 1666 for similar reasons, and it was to have an equally great influence on scientific progress. With these as models, many other European countries followed suit in the century that followed. The learned publications of most of these societies received wide circulation.

By the beginning of the 18th century, engineers in France were held in considerable esteem. The national *Corps des Ponts et Chaussées* stood in high repute from the time of its establishment in 1716, and in 1747 the world's first engineering school was founded in its name. Members of the *Corps*, and eventually graduates of its school, were responsible for all the civil engineering works in the country, including the development of canals. Antoine Chézy, one of its outstanding graduates, devised in 1768 a similarity method of predicting the resistance of one channel from that already known for another, which today is still in use; however, the fact attests to the ability of the *Corps* members more than it speaks for the basic hydraulics principles then at hand, as Chézy's report was lost in the files of the *Corps* for many years.

By 1776 all of the books that have been mentioned were readily available—those by Guglielmini, Mariotte, the Bernoullis, and Bossut—as well as the many reprintings of other authors that had become the custom in Italy. There was no lack of bibliographies, moreover, for it was common practice for each successive book to review much that had gone before. A set of books also worthy of mention was the four-volume *Architecture hydraulique* by Belidor, published at Paris between 1737 and 1753, which was a descriptive compilation, beautifully illustrated, of existing engineering works of every sort. Unfortunately, none of these books had been translated into English, and the works originally written in English were limited in number. Those by Boyle, Robins, and Smeaton, of course, were readily available. A few treatises on hydrostatics were almost naively elementary. Three more extensive works, however, are worthy of mention: Stephen Switzer's *An Introduction to a General System of Hydrostaticks and Hydraulicks, . . .* (London 1729), which reviewed most of the books already listed; Martin Clare's *The Motion of Fluids* (London 1735); and Charles Vallancey's *A Treatise on Inland Navigation, . . .* (Dublin 1763), based on the works of Guglielmini, Belidor, and others.

While settlers of the Colonies also came from France, Holland, and Germany in limited numbers, by far the majority were of English ancestry, and it is pertinent to examine the state of 18th-century civilization in at least London (where one-tenth the English population was concentrated and which by mid-century had overtaken Paris in population) for clues as to what practical knowledge of hydraulics the migrants could have brought to America with them. Three aspects of the subject will suffice to depict the general state of things: water supply, sewage disposal, and shipping, together with a general remark on the social status of engineering.

Contrary to the situation in France, where the *Corps des Ponts et Chaussées* was a government organization containing even members of the nobility, construction in England was a trade, and no one in trade could possibly be a gentleman. (Though not gentlemen, it is to be noted, the inventors of the steam engine were all Englishmen—Thomas Savery, 1702; Thomas Newcomen, 1712; and James Watt, 1769—and the primary use of their machines was the pumping of water.) There were, of course, a few exceptions to this rule among the architects, city planners, and bridge builders, but John Smeaton (1724-1792) seems to have been the only noteworthy person among the hydraulic engineers.

He designed and built various English harbors, drainage works, steam-driven pumps, and—the project for which he was best known—the Eddystone Lighthouse, on which two previous contractors had failed. He was also an inventor (the hydraulic ram being among the devices attributed to him), a writer on various fields of mechanics, and a medal-winning member of the Royal Society of London.

Use of the River Thames for shipping, drinking water, and sewage disposal had probably occurred from time immemorial, and by the 18th century all three practices were inextricably associated. In the course of this century the number of ships belonging to the city grew from perhaps 1200 to nearly 2000, and tonnages as high as 1500 were involved in the India trade. Most of London's water supply—80,000,000 gallons per day by the end of the century for a city of nearly a million—came from the Thames, in which a series of tide-driven undershot wheels had powered piston pumps since Elizabethan times. However, neighboring streams (such as the Fleet and the Lea) were used as well, particularly as the system of inland waterways was developed during the Industrial Revolution into a network of canals for the barging of coal and timber. Springs and wells in the hills to the north were also tapped, and in the course of the century some 40 miles of conduits containing several hundred wooden aqueducts were built, with bored-elm-log pipes providing the final distribution. Iron pipes were tested as early as 1756, but well over half a century was required to bring them into wide use.

Sewage disposal was wholly unorganized. Streets drained into ditches and ditches into canals and streams; garbage and offal were dumped into one or another. Indoor and outdoor privies, many directly over the banks of ditches, canals, and streams, were the norm. Such sewer pipes as had been installed, following advent of the water closet late in the century, usually leaked, and what with the cesspools that existed in even the best of quarters, the odor in the basements was comparable only to that on the river banks at low tide. The York Building Water Works, which operated from 1675 to 1829, provided unfiltered water from a point in the Thames 600 feet offshore; this was preferred to another source because its water cleared faster! In 1755 Marchants Waterworks placed its intake pipe near the river bank not far from a sewer outlet. Both companies, to be sure, also drew from reservoirs fed by springs, but this did not prevent contamination of their supply. It is perhaps relevant that through much of the century the death rate exceeded the birth rate, though some blame the deaths not so much on the pollution as upon the quantities of gin drunk by the lower classes to overcome the stench. In any event, London's population increased markedly only as the result of migration from the countryside and other parts of the world. At intervals such streams as the Fleet "Ditch" were cleaned up and made navigable, but they rapidly reverted to conduits for garbage, offal, sewage, and silt, and eventually were covered over. The banks of the Thames, once tidal flats, gradually filled in so badly from such deposits as to impede shipping. Late in the century the banks were dredged for the construction of new docks, and the waste material was used to fill in the old Chelsea Waterworks reservoir. In 1796 it was proposed that several bends in the river below London be straightened to provide further docking area, but this sound engineering proposal came to nothing.

In much of its hydraulic engineering, England borrowed from or sought to emulate the French, who were then technologically far superior. Had the situation been reversed, colonial technology might have advanced more rapidly than it did.

Colonial Inceptions

Though civilization in 18th-century America had only as many hundreds of years to develop as that in England had thousands, it was the migrant English who determined in large part the course which colonial developments took. Thus, whereas the outposts of the Colonies might have seemed very primitive in comparison (as indeed they were, mainly for lack of roads or waterways for communication), the larger towns along the Atlantic seaboard, with their considerable ocean traffic, came to resemble those of the mother country more and more. Philadelphia, the largest, but New York and Boston no less, actually had much in common with the London cited in the Prologue to provide an example of the times, as a glance at the situation in New York toward the end of the Colonial period will suffice to show.

The population of New York, a bare 2000 only a century before the Revolution, was nonetheless growing at an exponential rate, roughly doubling each quarter century and reaching some fifteen times 2000 by the year the Revolution began. Shallow wells—first private and later public—were sunk for domestic and fire-fighting use, and gutters and outdoor privies served for waste disposal. So long as the population was small, the water was good, but the more finicky residents were gradually forced to go to springs north of town. The so-called Tea Water Well, a spring at what are now Chatham and Roosevelt Streets, was mentioned in the literature by 1750, and shortly before the Revolution it was capped by a pump and the area made into a garden, from which carts used to deliver water—for a price—to a more central distribution point as well as to private homes. As the yield became insufficient (and the water further into town more distasteful), the first of countless efforts was made to improve both the quantity and the quality of the municipal supply. Collect Pond, not far from the Old Tea Water Pump, might have alleviated the need for a while had it not become used instead as a sink rather than a source. In 1774 the Irish civil engineer Christopher Colles (1738-1816) proposed and built a well and reservoir east of Broadway between the present Pearl and White Streets, using one of Newcomen's atmospheric pumps to lift the water, a system of hollow logs to distribute it to the main streets, and bonds known as Water Works Money for financing. But the supply was still insufficient, and the Revolution put an end to the project.

Boston and Philadelphia evidenced much the same hydraulic problems, and they are of particular interest because the former was the birthplace and the latter the adopted home of Benjamin Franklin (1706-1790), who played a notable role in both colonial and post-colonial developments. The Boston Water Works Company had been formed in 1652 to develop what became known as the Conduit, a distribution reservoir fed by bored logs from nearby wells and springs. The Boston fire of 1711, for lack of adequate water, left a hundred families homeless. Philadelphia was not only densely settled for its time, but clustered its wells, privies, and graveyards far too closely for good health. Smallpox and yellow fever resulted in thousands of deaths, but their causes were only vaguely sensed. It is therefore interesting to note that Franklin was to bequeath one thousand pounds to each city, to be invested at 5% compound interest, one hundred thousand pounds of the total sum anticipated at the end of a century to be spent for public works, not the least of which was a good water supply!

In 1743, somewhat less than a century after the establishment of the Royal Society of London, Franklin published "A Proposal for Promoting Useful Knowledge Among the British Plantations in America," and later that year he was instrumental in founding the "American Philosophical Society," but interest therein soon lagged. In 1766 a group of Quakers organized "The American Society for promoting and propagating useful knowledge, held in Philadelphia." The following year it too began to decline, but The American Philosophical Society was then revived and considerable rivalry developed. In 1768 the two united under the rather bulky title, "The American Philosophical Society held at Philadelphia for Promoting Useful Knowledge." Franklin became its first president in 1769 and served till his death in 1790. Though it was not to receive its charter till 1780, its *Transactions* have been published continuously since the 1769 volume appeared in 1771. Other cities eventually followed suit in the development of such organizations, but in the meantime the one at Philadelphia played a very strong role in establishing the reputations of the Colonies in the field of science, in no small way through Franklin's writings. Though these were first almost insultingly spurned by the Royal Society of London, their worth was soon recognized by the

Académie Française, and the Royal Society later bestowed upon Franklin its Copley Medal (the award previously received by Smeaton) and elected him to full membership.

While Franklin is well known for his electrical discoveries (not to mention his political and diplomatic activities), a review of his extensive correspondence reveals an extremely great breadth of interest, not the least of which had to do with fluid motion. His concern with the weather stemmed very likely from his kite experiments. His frequent voyages across the Atlantic led him to study the course and ponder the cause of the Gulf Stream. In a letter of 1761 he discussed the fate of rivers leading to the sea, speculating on the amount of fresh water that evaporated before it could mix with the salt. In a letter of 1769 he considered the flow of air in houses and chimneys in both winter and summer. But it was his letter of 1768 to Sir John Pringle that is now of greatest import, for it describes the first towing-tank tests of ship resistance—conducted, to be sure, in England, but conceived and carried to completion by an American—nearly a decade before those of Bossut, d'Alembert, and Condorcet at Paris, not to mention the subsequent ones of the Englishman Mark Beaufoy. The letter deserves reproduction in full:

SIR, *Craven-Street, May 10, 1768*

You may remember that when we were travelling together in *Holland,* you remarked that the track-schuyt in one of the stages went slower than usual, and enquired of the boatman, what might be the reason; who answered, that it had been a dry season, and the water in the canal was low. On being asked if it was so low that the boat touch'd the muddy bottom; he said, no, not so low as that, but so low as to make it harder for the horse to draw the boat. We neither of us at first could conceive that if there was water enough for the boat to swim clear of the bottom its being deeper would make any difference; but as the man affirmed it seriously as a thing well known among them; and as the punctuality required in their stages, was likely to make such difference, if any there were, more readily observed by them than by other watermen who did not pass so regularly and constantly backwards and forwards in the same track; I began to apprehend there might be something in it, and attempted to account for it from this consideration, that the boat in proceeding along the canal, must in every boat's length of her course, move out of her way a body of water, equal in bulk to the room her bottom took up in the water; that the water so moved, must pass on each side of her and under her bottom to get behind her; that if the passage under her bottom was straitened by the shallows, more of that water must pass by her sides, and with a swifter motion, which would retard her, as moving the contrary way; or that the water becoming lower behind the boat than before, she was pressed back by the weight of its difference in height, and her motion retarded by having that weight constantly to overcome. But as it is often lost time to attempt accounting for uncertain facts, I determined to make an experiment of this when I should have convenient time and opportunity.

After our return to *England* as often as I happened to be on the *Thames,* I enquired of our watermen whether they were sensible of any difference in rowing over shallow or deep water. I found them all agreeing in the fact, that there was a very great difference, but they differed widely in expressing the quantity of difference; some supposing it was equal to a mile in six, others to a mile in three, etc. As I did not recollect to have met with any mention of this matter in our philosophical books, and conceiving that if the difference should really be great, it might be an object of consideration in the many projects now on foot for digging new navigable canals in this island, I lately put my design of making the experiment in execution, in the following manner.

I provided a trough of plained boards fourteen feet long, six inches wide and six inches deep, in the clear, filled with water within half an inch of the edge, to represent a canal. I had a loose board of nearly the same length and breadth, that being put into the water might be sunk to any depth, and fixed by little wedges where I would chuse to have it stay, in order to make different depths of water, leaving the surface at the same height with regard to the sides of the trough. I had a little boat in form of a lighter boat of burthen, six inches long, two inches and a quarter wide, and one inch and a quarter deep. When swimming, it drew one inch water. To give motion to the boat, I fixed one end of a long silk thread to its bow, just even with the water's edge, the other end passed over a well-made brass pully, of about an inch in diameter, turning freely on a small axis; and a shilling was the weight. Then placing the boat at one end of the trough, the weight would draw it through the water to the other.

Not having a watch that shows seconds, in order to measure the time taken up by the boat in passing from end to end, I counted as fast as I could count to ten repeatedly, keeping an account of the number of tens on my fingers. And as much as possible to correct any little inequalities in my counting, I repeated the exeriment a number of times at each depth of water, that I might take the medium. And the following are the results.

Water	1½ inches deep	2 inches	4½ inches
1st exp	100	94	79
2	104	93	78
3	104	91	77
4	106	87	79
5	100	88	79
6	99	86	80
7	100	90	79
8	100	88	81
	813	717	632
	Medium 101	Medium 89	Medium 79

I made many other experiments, but the above are those in which I was most exact; and they serve sufficiently to show that the difference is considerable. Between the deepest and shallowest it appears to be somewhat more than one fifth. So that supposing large canals and boats and depths of water to bear the same proportions, and that four men or horses would draw a boat in deep water four leagues in four hours, it would require five to draw the same boat in the same time as far in shallow water; or four would require five hours.

Whether this difference is of consequence enough to justify a greater expense in deepening canals, is a matter of calculation, which our ingenious engineers in that way will readily determine.

I am, &c. B. F.

Franklin's interest in ship resistance was indicative of the progress that was being made in colonial shipbuilding, which had already become competitive with that of England itself. Not only were American craft being produced more cheaply than those in the mother country, but they were smaller, sleeker, and faster. On the other hand, had Franklin devoted more of his time to contemplation of fluid motion, American hydraulics would surely have profited accordingly. Moreover, had more Americans spent as much time in France as Franklin did, this country would have had more of a French scientific heritage. True, such leaders as Adams and Jefferson followed in Franklin's diplomatic footsteps, but not his scientific, and as a result European hydraulicians of the 18th century were almost unknown in the Colonies. Aside from Newton's contributions, which were read by the well-educated few, there was much less scientific knowledge to be transmitted to the Colonies from England than from France, and the major English technical influence was that of such engineers as Smeaton, whether this was exerted by colleagues who migrated westward or by American engineers who visited England.

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CHAPTER I

THE FIRST HALF CENTURY

Although the Revolution and the accompanying change from colonialism to independence represented a discontinuity of normal activity and even considerable change in its direction, in some ways life thereafter—for at least the remainder of the 18th century—seemed simply a resumption of what had gone before. Franklin continued to write his many friends in Europe, one of his most pertinent letters being that of 1785 to David Le Roy, ostensibly composed on board ship and known as his "maritime observations." Therein he philosophized at length on such matters as the resistance of sails, storm anchors, jet propulsion (in which connection he not only referred to Bernoulli but improved somewhat on his very primitive design), air propellers (and their potential hydraulic counterpart), stability, drag experiments in an improvised air jet, free fall, flotation, buoyancy, inertia, and wind shear. And the success of Franklin's American Philosophical Society prompted John Adams and a group of other Harvard graduates to form at Boston in 1779 the American Academy of Arts and Sciences, which was chartered the following year and began publishing its *Memoirs* in 1785.

Though American-built ships of frigate class and below had not yet attained their full degree of effectiveness, it is interesting to note that the last quarter of the 18th century brought a related American contribution—the steamboat—definitely to the fore. James Watt, to be sure, had proposed as early as 1770 that his improved steam engine be connected to a propeller and used to drive a ship, but nothing came of it. However, the general idea was definitely in the air. In 1788 James Rumsey (1743-1792) of Virginia claimed to have applied to a small boat the Bernoulli principle of jet propulsion, as described in a certification provided by one of his friends:

> The boat was finished in the fall of the same year (1783). Her hull was built by Rumsey's brother-in-law, Joseph Barnes, who was a carpenter by trade. The estimated capacity of the boat was about six tons burthen. Her boiler was a primitive affair, being simply an iron pot or kettle, such as is ordinarily used in the country for culinary purposes, with a lid or top placed on its mouth and securely fastened there with bands, rivets and soft solder. The engine, which was constructed partly by the village blacksmith, but principally by Rumsey himself, was upon the Newcomen or "atmospheric" principle, its power being obtained by the weight of the air, pressing on the piston beneath which a vacuum had been created by the condensation of the steam. The

> mode of propulsion was by means of a pump, worked by steam, which, being placed toward the forward part of the boat, drew up at each alternate stroke of the engine a quantity of water, which, by the return or down stroke, was forced through a trunk at the bottom along the Kelson, and out at the stern under the rudder. The impetus of the water rushing through the trunk against the exterior water of the river, drove the boat forward; the reaction of the effluent water propelling her at a rate of speed commensurate with the power applied.

A further certification was given by George Washington, who had witnessed tests on a working model in 1784:

> I have seen the model of Rumsey's boats, constructed to work against the stream; examined the powers upon which it acts; been eye witness to an actual experiment in running water of some rapidity, and give it as my opinion (although I had little faith before) that he has discovered the act of working boats by mechanism and small manual assistance against rapid currents.
>
> That the discovery is of vast importance, may be of the greatest usefulness in our inland navigation, and if it succeeds (of which I have no doubt) the value of it is greatly enhanced by the simplicity of the works which, when seen and examined, may be executed by the most common mechanic.

Washington's paradoxical comment in a later letter is equally significant, as will soon be seen:

> . . . The counteraction being proportioned to the action, it must ascend a swift current faster than a gentle stream, and with more ease than it can move through dead water. But in the first there may be, and no doubt is, a point beyond which it cannot go without involving difficulties that may be found insurmountable . . .

In 1785 Rumsey wrote Washington that he had "taken the greatest pains to perfect another kind of boat upon the principles I mentioned to you in Richmond in November last . . . ." This boat was completed and tested in the Potomac with four friends as the sole witnesses, apparently in March 1786; an improved form was given a public demonstration on 3 December 1787, eventually making a speed of four miles per hour against the current. That winter Rumsey went to Philadelphia, where interest in his steamboat resulted in the formation of the Rumseian Society, with Franklin as president, and in his setting sail for England in the spring to promote further interest in the venture. There he died two years later, after building and demonstrating a still larger craft.

Whether the jet-propulsion idea was communicated by Rumsey to

Franklin or vice versa is still not clear. It is pertinent to note, however, that Rumsey's rival, John Fitch (1743-1798) of Connecticut, at one time thought to discard his original idea of paddle boards on continuous chains for the jet-propulsion idea proclaimed by Franklin in his "maritime observations," which were included in the minutes of the American Philosophilcal Society of 1785. (A posthumous claim was also made that he had once experimented with a propeller-driven boat on the Collect Pond of New York.) But he was persuaded by his mechanic to adhere to the original paddle-board idea, though this was soon changed to a system of crank-mounted paddles driven by a self-designed steam engine. A skiff so propelled made its first short trip on the Delaware with the two fabricators as passengers toward the end of July 1786, and an improved craft was demonstrated publicly the following year. A year or so later a better-streamlined boat with stern rather than side paddles was built, and by 1790 Fitch was operating a passenger and freight service between Philadelphia and Bordentown. Like Rumsey, Fitch sought exclusive patent and operating rights for his steamboat from various states, essential to which was the proof of priority of invention. For this he turned to Washington, Franklin, and many others, but in vain. Rumsey apparantly had the better claim (or at least the stronger backing), but to remove all doubt a bit of skulduggery seems to have been introduced by his supporters if not by Rumsey himself. The model that Washington certified was apparently a mechanical device not utilizing steam at all, as should be apparent from his forthright comments; and the other certification evidently describes the boat of 1786, for it agrees in detail with Rumsey's own description of 1788. Though Fitch secured many affidavits correcting such misstatement, Rumsey seems to have won his case. Dissatisfied with the recognition he received in the States, Fitch sought support in France, but with even less success. Plagued by unfortunate personality traits and bad luck, he returned home a bitter man.

The question of priority or even practicability is of less moment in these pages than the fact that both inventions were largely original, the one involving jet propulsion being well before its time and the one imitating hand-manipulated canoe paddles not warranting further attention. But two other American engineers soon brought the approach into line with future trends. One was John Stevens (1749-1838) of New Jersey, after whom the Institute of Technology at Hoboken was named. In 1802, with the financial collaboration of Robert Livingston (1746-1813), Nicholas Roosevelt (1767-1854), and the French migrant Marc Brunel (1769-1849), Stevens experimented with boats having at first a single steam-driven propeller and later two counter-rotating propellers. The date is particularly noteworthy, since the man who usually is given credit for introducing the propeller into American shipping—John Ericsson (1803-1889)—had not even been born. Credit for the steamboat as a practical means of transportation, of course, usually goes to Robert Fulton (1765-1815) of Pennsylvania. A man of many talents, in his youth he was both an expert gunsmith and a portrait painter. From 1787 to 1797 he lived in England, not only painting but studying their canal systems and inventing new methods of construction and operation. In 1797 he moved to France, where he sought to sell Napoleon on the use of a submarine for the placing of explosives under the hulls of enemy (i.e. English) ships. While in France, Fulton made the acquaintance of Livingston, who was there as minister plenipotentiary from the States. Now Fulton had experimented in 1793 with the propulsion of surface craft by means of pivoted paddles and paddles mounted on wheels (a device already known for a hundred years or more), though driving his submergible boat by a hand-cranked propeller; he had also had the opportunity to observe the endeavors of Rumsey in England and Fitch in France, and to study the experimental findings of the Abbé Bossut and of the Englishman Mark Beaufoy. Livingston, in turn, had been interested in steamboats for a number of years, and in 1798 he had even secured a New York grant of sole rights to steamboat operation within the state for a twenty-year period. It was therefore only natural that he and Fulton should join forces.

By 1802 Fulton had made model tests in a channel nearly 70 feet long to determine whether "paddles, skulls, endless chains, or water wheels" were superior, and later in the year he and Livingston signed a deed of partnership calling for the construction of a 120-foot 60-passenger boat powered by an English steam engine. An experimental boat with paddle wheels and a makeshift steam engine was built for trial on the Seine in 1803; Napoleon assigned a committee of such men as Bossut, Carnot, and Prony to report to him on its performance, once the first runs had been successful. Thereafter Fulton ordered the agreed-upon engine from Boulton, Watt & Company and moved back to England to follow its fabrication—and to promote rival interest in the submarine devices that Napoleon had not purchased. Near the end of 1806 he returned to the States for the construction of the projected boat (plus an effort to sell his ideas for submarine warfare to his own country). The new boat had both its trial run and its public demonstration in August 1807, and—eventually christened the *Clermont*—began regular service on the Hudson, making the 150-mile trip between New York and Albany in 30 to 36 hours. Fulton was obviously not the inventor of the steamboat, but he was surely the one who made it practicable. It was not long before steamboat traffic spread across the country, from New York to New Orleans, along the Ohio and the Mississippi, and through the Great Lakes. In the meantime John Stevens (who had declined an invitation to collaborate with Fulton and

Livingston) was the first to take a steamboat on the open sea. The first steam-equipped sailing ship to cross the Atlantic (the *Savannah,* in 1819) was also American. However, the general application of steam power to ocean ships was primarily an English undertaking, though Marc Brunel (and in particular his son) had a large part in it after his return to Europe.

While pre-revolutionary engineering projects of a public nature had been scattered and of very minor importance, in the remaining quarter of the century such activity increased in a notable fashion—if not in actual undertakings, at least in the serious discussion of them. In New York, plan after plan for a municipal water supply was submitted to the city administration, but each was rejected for one reason or another, usually political. Christopher Colles, the Irish engineer who had constructed the inadequate well and reservoir system for New York just before the Revolution, next proposed to clear the Mohawk, the Ohio, and other rivers for purposes of navigation, and to connect Lake Ontario and the Hudson through a combination of natural and artificial waterways. The English engineer William Weston (1752-1833) was requested just before the end of the century to prepare plans for damming the Bronx River and delivering a flow of 6 cubic feet per second to a Manhattan reservoir. His plan (which involved the advanced idea of a sand filter for improvement of the water quality) was opposed by a group that included, interestingly enough, both Alexander Hamilton and Aaron Burr, the former for reasons of public economy and the latter for private gain. Although banks in those days were in strong public disfavor, Burr and several colleagues succeeded in 1799 in obtaining a bank charter under the guise of a waterworks organization known as the Manhattan Company. The bank thrived (it still exists under a slightly different name) but produced only enough water to maintain its charter. Some thirty-odd years of maneuvers prompted by general dissatisfaction with the situation were still to be necessary before a satisfactory solution was found.

Other 18th-century ventures should be mentioned at this point: The Potomack Company, established in 1785 to improve navigation on that river, functioned under the leadership of Washington, and Rumsey served for a time as secretary. The Santee Canal Company was chartered shortly thereafter, to connect Charleston and Columbia in South Carolina. The promotion of New York canals began with the formation of the Western and Northern Inland Lock Navigation Companies in the 1790's. More or less concurrent were schemes to build the Susquehanna, Conewago, and Schuylkill Canals in Pennsylvania, and the South Hadley and Middlesex in Massachusetts. The former was notable for its use of a tank car on an inclined plane for lifting boats in place of the more customary lock. The Middlesex Canal, built to connect the Merrimack and Charles Rivers, contained 20 locks and 8 aqueducts in its 27-mile length. In many of these projects—particulary the latter—William Weston had a guiding hand. Another English engineer who was to exert a strong influence on American developments was Benjamin Henry Latrobe (1764-1820), who had studied in Germany, worked in England under Smeaton, and migrated to the States toward the end of the century; extremely versatile, his interests ranged from hydraulics to architecture to shipbuilding (in partnership with Fulton, Livingston, and Roosevelt); it was he, moreover, who most strongly urged the provision of clean water for Philadelphia to reduce the spread of disease.

Though capable engineers were definitely at a premium for the planning of new projects—not to mention their ultimate execution—and though Latrobe recommended repeatedly that they be sought abroad, not only did the Americans usually hesitate to utilize foreign authorities, but the foreigners themselves were difficult to attract across the ocean. At the same time, self-educated American engineers began to appear on the scene, some of whom had profited by training—or at least inspection trips—abroad. Their approach to practice was decidedly varied: some were surveyors, some contractors, some entrepreneurs, and some simply opportunists. Three, however, deserve mention at this point as well as in the following pages: Loammi Baldwin (1745-1807) of Massachusetts, James Geddes (1763-1838) of Pennsylvania, and Benjamin Wright (1770-1842) of Connecticut, the last two moving to New York State while still young. Baldwin, who instigated construction of the Middlesex Canal, worked originally as a surveyor, but during the Revolution he saw duty both as a military engineer and as an officer, and thereafter as a hydraulic engineer (not to mention as developer of the Baldwin apple). He was thus one of the first to demonstrate to his compatriots that both military and civil engineering have much in common.

This similarity became the clearer with the founding of the U.S. Military Academy at West Point in 1802, under the strong sponsorship of President Jefferson among others. Ostensibly for the preparation of military engineers, the Academy eventually came to train as many men for civilian life as for the army. In 1812, for example, the administration provided specifically for a professorship of civil and military engineering. One of West Point's early graduates was Sylvanus Thayer (1785-1872), of the class of 1808, who had previously studied at Dartmouth College and was eventually to return there to found the school of engineering now known under his name. After service in the War of 1812, Thayer was sent to Europe by President Madison to study the theory and practice of fortification design. In 1815-16 he had the opportunity of observing instruction at the *Ecole Polytechnique* in Paris, where mathematical analysis was (and still is) paramount, and his observations there were to play a considerable role in his development of the West Point curriculum. In 1817 he was appointed superintendent, and during his 16-year incumbency both science and engineering were greatly strengthened. The French engineer Claudius Crozet (1790-1864), a graduate of the *Ecole Polytechnique,* had preceded Thayer at West Point by a year and been given charge of the engineering department. Much of the instruction was patterned after the French system, in particular the strong emphasis on mathematics. Though there was periodic external criticism of teaching civil as much as military engineering, and of producing more engineers than the Army itself could absorb, it was invariably decided that this policy was salutary rather than misguided. For nearly two decades after its founding, West Point was the only American organization giving formal training in technology, but in that period it contributed well over a hundred engineers to civilian practice, and graduates remaining in the Corps of Engineers were also frequently given leave to supervise civilian works. In 1820, however, Norwich Academy began the teaching of a course in civil engineering, and Rensselaer School (later to become Rensselaer Polytechnic Institute) was established only four years thereafter. It is interesting to note that Norwich, founded by a disgruntled former acting superintendent of West Point, claimed to have more flexibility than the latter both coursewise and timewise, whereas at Rensselaer it was even held that no mathematics above arithmetic was required, because engineering training had to be practical rather than theoretical!

The first decade and a half of the 19th century was very much a continuation of the 18th so far as canal construction was concerned—considerable planning but little accomplishment. The South Hadley Canal had to be rebuilt in 1802. An attempt to build the Chesapeake and Delaware Canal failed in 1806. And in 1808 the Union Canal Company took over both the Delaware and Schuylkill and the Schuylkill and Susquehanna projects. But with the Peace of 1815, much of the earlier planning seemed to reach fulfillment. There had been agitation for longer canals in New York as early as 1804; in 1808 the legislature had requested a survey for the Erie project originally proposed by Colles; and in 1810, with the strong political support of DeWitt Clinton (who resigned a seat in the U.S. Senate to become mayor of New York City and then governor of the State), a commission was appointed to finalize the plans. Six years later Geddes, and then Wright, were each given authority over portions of the undertaking, and within two years Geddes had also been appointed chief engineer of a related project, the Champlain Canal. Nearly a decade was involved in the completion of the two. The Erie, 40 feet wide and 4 feet deep, with a total length of 363 miles and an elevation difference of some 500 feet, was not historically record-breaking, to be sure, but a most noteworthy achievement for so young a country. In fact, many constructional innovations—such as stump-removing and earth-moving equipment—came to be utilized that were unheard-of even in England, where hand shovels, picks, and wheelbarrows were still in common use. Above all, the operation is often said to have rivaled West Point in its production of engineers—the Erie School, it is frequently called—who learned on-the-job and soon came to be in demand in other parts of the country. The number of civilian engineers doubled in this period; it is estimated that some seventy-five became available, two dozen of whom were of high caliber. Probably the most notable of these was Canvass White (1790-1834) of New York, who among other things developed the first American hydraulic cement, a very essential element in lock and bridge construction.

The undeniable success of the Erie Canal naturally led to greatly increased activity in canalization around the country, generally involving the services of Geddes, Wright, and those like White whom they had trained. In 1824-28 the Blackstone Canal was built between Providence and Worcester, and in 1825-35 the Farmington Canal between New Haven and Northampton. There was also marked activity in Pennsylvania, Virginia, the Carolinas, and Ohio. Loammi Baldwin Jr (1780-1838), a lawyer-turned-engineer, made the survey for a projected canal from Boston to the Hudson River in 1825, but the project was abandoned because of the need for a tunnel through the Hoosac Mountain in the Berkshires. It is significant to note that a railroad later followed the same course, tunnel and all. As a matter of fact, the development of the railroad as a competitor of the canal for the economic transporation of goods began soon after this time, barely a half century beyond the birth of the nation, and this led to the gradual decline of canal construction. Though hydraulics was still involved only so far as drainage was concerned, construction for transportation by rail used much the same technical skills, and the engineering profession continued to thrive. West Pointers, in particular, were in their element. If steam power played a negligible role in promoting canal traffic, it did have much to do with its demise, for the adaptation of the engine to the powering of train locomotives proceeded apace, with John Stevens again taking a prominent part.

As has already been indicated, dissatisfaction with the water supplied by the Manhattan Company of New York was to continue unalleviated throughout the first quarter of the 19th century. Though Aaron Burr was soon deposed from leadership in the organization, many another politician succeeded him; among them was DeWitt Clinton (whose name is usually mentioned more charitably in connection with the Erie Canal). Many a stopgap measure to provide water was tried by the company, including the digging of cisterns to collect the rain and the sale of the water-supply aspects of its business to the city. But little improvement was noticeable, and fires and fevers continued to plague the inhabitants.

Other cities were to fare better, all but one of which—paradoxically enough—favored private companies like that of New York. Even as early as 1798 the Boston Aqueduct Corporation tapped Jamaica Pond's excellent water, and the Baltimore Water Company in 1804 pumped a new supply from nearby Jones Falls to a central reservoir, from which it would be distributed as usual by log pipes. In New York State, moreover, some twenty-five new aqueduct associations were formed—to be sure, among the smaller towns. By far the largest system, on the other hand, was the single public one at Philadelphia. Designed by Benjamin Latrobe, and utilizing steam-driven pumps fabricated by Nicholas Roosevelt, the system conveyed water from the Schuylkill River to two engine houses, the second of which—the Centre Square Works—was in the classic style usually favored by Latrobe the architect. Unfortunately, yellow-fever epidemics continued to occur, and the supply of water again became inadequate. Much of the latter difficulty lay in the log-pipe system, with blame being shared by the inaccuracy of the available flow formulas, the clogging of the pipes, and their gradual deterioration through misuse or lack of maintenance. At the instigation of Latrobe's assistant Frederick Graff (1774-1847), it was decided in 1817 to adopt cast iron for replacements, but wood was used for another year. Then in 1818 two miles of 20- and 22-inch iron pipe was laid, with such an improvement in performance that at least two more miles of it per year was installed through the next decade. In 1820, moreover, the Schuylkill River was dammed to increase the supply. The accompanying feud between the domineering Schuylkill Navigation Company and the city administration was a significant sign of the times.

The first half century of United States history has been seen to bring a series of developments of sorts that—with a bit of hindsight—might well have been anticipated. At the outset much that happened was simply a continuation of the pioneering endeavors of colonial times. Most of the colonists had come from the working classes, and their contributions were highly practical. Noteworthy among these were the inventions and writings of Oliver Evans (1755-1819) of Delaware, who had been apprenticed to a wheelwright as a youth. In later years he greatly improved mill machinery, developed a non-condensing steam engine, and wrote *The Young Steam Engineer's Guide* and *The Young Mill-Wright & Miller's Guide.* The latter contained such sections as "Mechanics and Hydraulics," "Rules for applying theory to practice," and "Directions for construction," including many numerical examples and diagrams in its 400-odd pages. But whereas such developments were often innovative, they were surely not what one would call scientific.

The relatively few who first participated in such organizations as the American Philosophical Society were surely familiar with English (and, to a far lesser degree, French) literature, but there is little indication—beyond Franklin's mention of Bernoulli and Evans' of Smeaton—that writings on hydraulics of that time were known.

Before the end of the century (1796) the American Fulton published *A Treatise on the Improvement of Canal Navigation,* but this was done in England rather than the States. Mention has been made of the towing tests of Bossut in France and Beaufoy in England, yet even the latter were to have no influence in America till Fulton returned to the States after the turn of the century. The same is true of books by the Frenchman Du Buat, the German Woltman, and the Italian Venturi, all of which appeared in the quarter century after the Revolution (it has been said that the English translation of Du Buat's second edition brought him the compliments of George Washington, but the existence of an English translation cannot be verified). An English translation of Venturi's 1797 booklet on flow expansions by William Nicholson in 1799 was published by Thomas Tredgold in his *Tracts on Hydraulics.* The early 19th century brought three more publications—a three-volume posthumous edition of Du Buat, and new books by the Frenchman Prony and the German Eytelwein, the last of which was also translated by Nicholson. At least the second was probably known to men like Latrobe, who recommended turning to Prony for aid in attracting engineers to the States. This period was also marked by the return of Americans such as Fulton and Thayer from abroad, bringing with them not only acquaintance with the English and French technical literature but copies of the books themselves. Though Loammi Baldwin Sr never went abroad, he is said to have collected a representative assortment of civil engineering books; many were destroyed by fire, but the remainder are in the library of Harvard University. Loammi Baldwin Jr began his very extensive collection of engineering works during an 1824 trip to Europe; it is now in the library of the Massachusetts Institute of Technology.

The first truly American books on engineering as such were by coincidence published the same year. One was by the physician and botanist Jacob Bigelow (1786-1879), who graduated from Harvard College in 1806 and in 1816 was the first to be appointed to its distinguished Rumford professorship. For some ten years he lectured at Cambridge and Boston under the terms of the Rumford grant on "application of the sciences to the useful arts," and then amplified his lectures in a book called *Elements of Technology*—a term which he appears to have coined. The Massachusetts copyright of Bigelow's book was dated 9 July 1829. On 2 March, however, Zachariah Allen (1795-1882) had secured a Rhode Island copyright on his *Science of*

Mechanics, which covered much of the same field though in a totally different manner. Whereas Bigelow was primarily a descriptive scientist, Allen—a graduate of Brown University at Providence—was a practical combination of lawyer, businessman, and inventor. Prior to writing his book, he had traveled in England and France to study their manufacturing practices, and his treatise compares those of all three countries. Bigelow discussed the technology of the times in wholly descriptive terms, devoting about ten percent of his 500-page manuscript to hydraulics; reference was made to essentially all of the European writers mentioned in the foregoing pages and many more. Allen, on the other hand, showed little familiarity with the foreign authorities, but devoted an even larger percentage of his somewhat shorter text to hydraulics, and sought through tables and numerical examples to permit the reader to obtain useful quantitative results. Though the two books together still lacked much of the hydraulic detail already available in the continental literature, they marked a very respectable start.

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CHAPTER II

EARLY WRITINGS AND INVESTIGATIONS

Apparently some fifty years of gestation were necessary to bring the citizens of the United States to the point of concerted action in the procurement of municipal water supplies that were both safe and ample, for—despite the continuation of political controversy—in the second half century of the country's existence real progress began to be made. Developments in the cities of New York, Philadelphia, and Boston will again be used to typify the drive that was to spread from these largest cities to others around the country. But notice must first be taken of two hydraulic engineers who were also writers and investigators who would provide a challenge for those who were to follow in gradually increasing numbers for the next century and more.

The first was the Liverpool-born James Renwick (1792-1863), a 1797 migrant and 1807(!) graduate of Columbia College. He served his alma mater from 1820 to 1853 as professor of natural philosophy and experimental chemistry, but was said to have been an authority on every branch of engineering. As an engineering consultant he investigated the feasibility of uniting the Delaware and Hudson Rivers, and thereafter designed and supervised the construction of the Morris Canal between them, which was opened to traffic in 1831. Its most noteworthy feature was the use, in addition to 23 normal locks, of an equal number of boat railways, which—though the idea was not wholly original—he had patented in 1827. These had an average rise of 63 feet on a 10% slope, the motive force being provided by a series of "Scotch mills" (an imported form of Barker's mill) having a total of some 700 horsepower. Renwick was also the author—from 1826 to 1833—of ten books on natural philosophy and applications of mechanics to practical purposes. Among these his 1832 *Elements of Mechanics* warrants special mention. As he stated in his Preface, "In the use of the term 'Mechanics,' it has been employed as including the whole science of Equilibrium and Motion, and therefore as comprising the departments of Hydrostaticks and Hydrodynamicks." Of the volume's 508 pages, 87 dealt with the equilibrium of fluids, including both gravitating liquids and elastic gases, and 122 with the motion of fluids, including chapters on orifices, tubes, pipes, open channels, rivers, canals, fluid resistance, waves, gases, chimneys, winds, and atmospheric vapors. The earlier parts were algebraically quantitative, reflecting the work of Mariotte, Pitot, Bossut, Du Buat, Coulomb, Prony, Venturi, and Venturoli; however, the approach necessarily became more highly qualitative as the topics progressed from the simple to the relatively complex. More immediately useful, of course, was his 1840 *Application of the Science of Mechanics to Practical Purposes,* and it now provides a good picture of the state of American technology at that time.

The second man was Charles Storer Storrow (1809-1904), a native of Montreal, whose early education was received in both American and French schools. During his last year at Harvard, Storrow studied civil engineering in the office of Loammi Baldwin Jr, and after graduation he went to England and France for further engineering training, particularly at the *Ecole Polytechnique* and the *Ecole Nationale des Ponts et Chaussées* in Paris. On his return to the States, Storrow at first practiced railroad engineering but eventually turned to hydraulics. In fact, he was the author of the first American book specifically on the subject: *A Treatise on Water Works for Conveying and Distributing Supplies of Water,* published at Boston in 1835. The volume was a small one (242 4x7-inch pages), and he said in the Preface "I can, of course, make few claims to originality . . ." beyond the conversion of the tables from metric to American units. But taken together with the sections on hydraulics in the more general books of Allen, Bigelow, and Renwick, it laid a firm foundation for the many works to come. As was the European custom, the Introduction reviewed much of what had gone before, in the course of which the author briefly mentioned the contributions of essentially all of the hydraulicians whose names have appeared in the foregoing chapters. As Storrow himself stated, he leaned most heavily on the writings of Prony, Eytelwein, and Belanger, for his primary emphasis was on the subjects of pipe and channel resistance and backwater calculations. His chapter titles were as follows:

I Theory of the Motion of Water in Open Channels
II Theory of the Motion of Water in Pipes
III General Remarks on the Means of Supplying Cities with Water
IV Means of Measuring the Flow of Water
V Conveyance of Water by Canals or Aqueducts
VI Conveyance of Water by Conduit Pipes
VII Of Pumps
VIII Reservoirs and Pipes for Distributing Water
IX Pipes of Different Diameters, and Jets d'Eau
X Artesian Wells

It is interesting to note that, except for introductory references to the work of Bernoulli and d'Alembert, practically no attention was given to phenomena of nonuniform flow. The calculus, on the other hand, was by no means scorned.

It might be remarked in passing that the *U.S. House Documents* for the 1st Session of the 23rd Congress contains a complete transcript of the 1833 Institution of Civil Engineers paper "Canal Navigation" interpreting the results of experiments on ship resistance made at the Adelaide Gallery, London, by the Englishman John MacNeill. Rather more pertinent is the fact that the experimental equipment used by MacNeill was constructed by the migrant American Joseph Saxton (1799-1873), a Pennsylvania-born clockmaker somewhat better known for the current meter that he had built and rated in 1832 in the same Adelaide Gallery flume. Saxton later returned to the States to take charge of the U.S. Office of Weights and Measures, forerunner of the present National Bureau of Standards.

Another early American author worthy of reference was Thomas Ewbank (1792-1870) of New York. He published in 1842 the first of at least four editions of *A Descriptive and Historical Account of Hydraulic and Other Machines for Raising Water, Ancient and Modern*, a five-part tome of 550-odd pages, copiously illustrated and as garrulous as its title would indicate. In fact, though the author protested that this was not to be the case, it seemed to describe every type of pump that had till then been invented, including a primitive centrifugal unit. In addition he discoursed on innumerable related matters like atmospheric pressure and the ability of flies to walk on ceilings. Ewbank later headed the U.S. Patent Office. While still on the topic of books, mention might logically also be made of the publication in 1848 by Walter Rogers Johnson of an American edition of the English translation, *Weisbach's Mechanics and Engineering*, and in 1852 of Joseph C. Bennett's translation of d'Aubuisson de Voisins' work under the title *A Treatise on Hydraulics, for the Use of Engineers*. The latter deserved rather less attention than it received and the former much more; in fact, although Weisbach's book was to have considerable influence upon American hydraulics texts, its effect might usefully have been still greater.

The year before Storrow's treatise appeared, his mentor Loammi Baldwin Jr submitted a report on the Boston water supply, recommending a gravity-flow aqueduct from a number of ponds some twenty-five miles west of the city. No pipes would be necessary till near the end, for Baldwin was a canal builder to whom the use of steam-driven pumps was still somewhat unnatural. For the usual reasons, his plan was not to be adopted for more than a decade. In the meantime New York, still plagued with high death tolls from cholera, slowly turned its attention from the previously recommended use of the Bronx River and Rye Ponds as sources of supply to the idea of running an aqueduct from the Croton River much farther to the north. This municipal undertaking was finally approved by popular vote in 1835; its urgent need was accentuated later that same year by the worst fire that the city had ever suffered, the water supplied by the Manhattan Company being wholly inadequate to control it. In 1836 John Bloomfield

Jervis (1795-1885) of New York (who had been a resident engineer on a portion of the Erie Canal, then chief engineer of the Delaware and Hudson Canal, and—after an interlude in railway construction—in charge of the enlargement of the Erie's eastern division) was appointed chief engineer of the Croton project. Under his able direction the main dam, 40 miles of masonry conduit on a uniform grade, 16 tunnels, many bridges (including the Harlem River High Bridge), and the Murray Hill distributing reservoir on the site of the present Public Library were constructed, and by 1842 the city had its first adequate supply of good water: 79,000,000 gallons per day for a population of 360,000.

Spurred on by the success of the Croton Aqueduct, Boston began in 1846 the construction of the project that had been recommended 12 years earlier by Loammi Baldwin Jr. Jervis was brought up from the Croton Project as consultant. Some 14 miles of brick conduit led from Long Pond—renamed Lake Cochituate—to a receiving reservoir at Brookline, whence two iron mains led to distributing reservoirs on Beacon Hill and Telegraph Hill. By 1848 a capacity flow of 16,000,000 gallons per day for a city of 128,000 had thus been provided; but soon another main to East Boston was required, and in 1851 the Water Board bought out the facilities of the old Jamacia Pond Aqueduct Corporation. In Philadelphia the earlier availability of relatively good water from the Schuylkill project, coupled with the city's relatively low incidence rate of cholera, had been used by New York and Boston as goals for their own projects. The latter, however, proved so far superior in water quality to that of Philadelphia that this city in turn had to undertake improvements. These took the then-novel form of keeping sources of contamination well removed from the canal by means of bordering parkland. Filtering had also been proposed there and elsewhere, but still without actually being adopted. In the meantime, water-supply projects were carried out at other large cities, such as Baltimore, Pittsburgh, New Orleans, and Chicago, with varying degrees of satisfaction.

The steam engine was evidently to play a vital part in powering the Industrial Revolution, not only through improving transportation by water and rail but by providing the motive force for machinery that was becoming ever larger and better. Nevertheless, the industrialization of New England resulted initially from water power rather than steam. Even before the turn of the century, water-driven spinning mills had been set up in various places, particularly in eastern Massachusetts. In 1792 a corporation named the Proprietors of the Locks and Canals on the Merrimack River (known simply as the Proprietors) had been formed for the purpose of improving navigation, and thirty years later a group of Boston capitalists comprising the Merrimack Manufacturing Company purchased 400 acres near the Pawtucket Falls, a site which soon developed into the town of Lowell. The Company constructed a

950-foot dam on the river, which produced a 35-foot head and 18 miles of backwater, the pondage feeding 11 independent mills. In 1826 the property was transferred to the Proprietors. Charles Storrow was retained by them in 1835 to measure the quantity of water used by each of the mills, so that costs might be justly shared. He later became chief engineer of a similar company formed to develop power 12 miles downstream at a point that is now Lawrence, where he designed and built another dam and several additional mills. The financial success of these mill cities gave rise to similar ventures in other parts of the country, where the power was used for many purposes beyond the spinning and weaving of southern cotton.

Storrow's commission to measure rates of flow to the various mills culminated in a number of reports on methodology submitted to the Proprietors in 1841 by James Fowle Baldwin (1782-1862), younger brother of Loammi Jr, George Washington Whistler (1800-1849), father of the artist, and Storrow. To provide an "absolute" basis of measurement, 7 paddle wheels 10 feet long and 16 feet in diameter were placed side by side across a channel having an 80x4½-foot flow section. Paddle clearances at piers and bed were no greater than ¼ inch, the bed was curved locally on the same radius as the wheels, and there were always two paddles of each wheel over the curved part, so that the rate of flow could readily be evaluated from the geometry of the wheel, the depth of water, and the rotational speed. In the approach channel, which was 150 feet long, 27 feet wide, and 8 feet deep, surface floats were timed over known distances, and through comparison with simultaneous paddle-wheel measurements it was possible to determine the ratio between mean and surface velocities and thence the coefficient of the float as a discharge indicator. The results were reported to be in accord with data obtained by Du Buat and by Prony.

James Bicheno Francis (1815-1892), a native of Oxfordshire, England, who had worked on canals with his father, migrated to the States in 1833 as assistant to Whistler on the New York-to-Boston railroad. When Whistler went to Lowell (as much for the building of locomotives as for the tending of canals), he took Francis with him; there his protégé first participated in the design of the locomotives and then succeeded Whistler as canal superintendent. In 1845 Francis became the Proprietors' chief engineer, remaining in this post for nearly 40 years. In his long and active life he served as consultant on many projects. Two of his responsibilities at Lowell are of particular interest to this story: continued measurement of the flows used by each of the manufacturing companies to permit fair assessment of costs; and improvement of their machinery for converting the flows into mechanical power. These are described at length in his tome *The Lowell Hydraulic Experiments,* the first edition of which was published in 1855, and the fifth still being in print a half century later. So far as measurement was concerned, Francis made numerous tests on sharp-crested weirs both with and without side contractions, using one of the idle locks as volumetric basin and thereby determining the numerical values in the so-called Francis weir formula, the form of which he acknowledged to have been suggested by his very able colleague Uriah Atherton Boyden (1804-1879), a native of Massachusetts, who was also the inventor of the hook gage first used in the tests. The velocity of approach was taken into account when necessary by the theoretical correction generally attributed to Weisbach (whose work was known to, but not respected by, Boyden owing to the many errors in the translated version). When limited to heads less than one-third the crest length (no mention being made of weir height) Francis claimed that his formula would yield accurate results for heads from 6 inches to 2 feet. Disagreement with the results of Poncelet and Lesbros he attributed to differences in scale. The second (1868) edition of his book included his studies of measurement with weighted floats extending nearly the full channel depth to obtain average velocities in the vertical, the corrected values for the whole cross section being compared with weir indications. Tests were also described on divergent tubes or diffusers, which he expected to play a significant role in hydraulic machinery. But before the power aspect of his work is examined further, the background of turbine development should be reviewed.

Though one of the earliest mills in the Colonies (1634, near York, Maine) utilized an undershot wheel driven by impounded tides, wheels used by American mills through the 18th century were traditionally of either the overshot or the breast type, on which literally hundreds of American patents were granted. Many "improvements," however, simply took the form of increases in size, and eventually wheels 20 to 30 feet in diameter were not uncommon; in fact, the 1851 Burden wheel at the Troy Iron Works in New York was 60 feet in diameter and 22 feet wide! At the beginning of the 19th century, machinery of a different sort commenced to appear: Barker's mills, of the jet-propulsion (i.e. reaction) type; flutter wheels, of the jet-deflection (i.e. impulse) type; and curved-bladed tub mills, forerunners of what were later ambiguously called reaction turbines. It is to be emphasized that these were at first not constructed of iron by mechanics but of wood by millwrights, worthy successors of Oliver Evans. Little theory was used, aside from attributing the action of the tub mills to centrifugal force, and each fabricator independently developed his own designs. The most successful of these were probably Austin and Zebulon Parker of Zanesville, Ohio, about whom little else seems to be known.

In France, on the other hand, Claude Burdin and his pupil Benoit Fourneyron had been experimenting since the early Twenties with vertical-axis turbines of iron, and in the Thirties Fourneyron was able to patent his outward-flow design and to manufacture and sell a number of operating units with efficiencies that were claimed to be as high as 80%. The *Journal* of the Franklin Institute carried articles on the French machines in 1839, 1840, and 1842. But the design spirit was already in the air, for in 1838 Samuel B. Howd of Geneva, New York, had patented an inward-flow wheel, and again in 1842 an outward-flow wheel which (because of its proper utilization of centrifugal force!) he considered to be superior. Howd apparently constructed no wheels himself but licensed millwrights to do so, and quite a number of inexpensive units were put into operation. In 1843 Ellwood Morris translated Arthur Morin's French work on waterwheels with vertical axis, and according to Francis he built two of them near Philadelphia. Uriah Boyden, who had had a rather varied engineering career, in 1844 designed for the Appleton Company of Lowell an improved Fourneyron outward-flow turbine of 75 horsepower with an efficiency (determined through use of an improvised Prony brake) of 78%. This was followed two years later by three units of 190 horsepower each and still higher efficiencies; a noteworthy addition of Boyden's was an outlet diffuser in the form of slightly flaring coaxial disks yielding a twofold increase in the circumferential exit section and a 3% increase in turbine efficiency.

In the late 1840's the Proprietors acquired the regional rights to the original Howd patent and to those of Boyden. Francis, by then chief engineer, built in 1847 a model ''centre-vent'' (i.e. inward-flow) wheel similar to Howd's. Though its efficiency was not high, two years later several inward-flow wheels of 230 horsepower apiece were constructed from his design for the Boott Cotton Mills, and tests indicated peak efficiencies of nearly 80%. He also had four outward-flow units fabricated in 1851 for the Suffolk and Tremont Mills according to Boyden's design but without diffuser. All of these units are described in Francis' book. Though he and Boyden belittled the mathematical approach, they did follow the Carnot principle of shock-free entrance to and minimum-velocity exit from the runner, carefully shaping the guide vanes and runner blades according to the plotted streamlines. To this extent the Francis wheels were an improvement over those of Howd, just as Boyden's were over those of Fourneyron. To only a negligible degree, however, did they resemble the so-called Francis turbines of today. At the outset they utilized purely radial-flow runners, and they possessed neither the familiar scroll case nor the draft tube of modern units. The spiral scroll case (invented by the Parker brothers in the late 1820's) finally came into use in the early 1850's, but the flaring draft tube (a uniform one had been used by Austin Parker in 1833 to make the unit more accessible) was not introduced till the 1860's and then for a time was forgotten. Although both Boyden and Francis eventually increased the outlet depth of their runners, the mixed-flow type of blade was really developed at North Chelmsford, Massachusetts, in 1857 by Asa Methajer Swain (1830-1908), previously a patternmaker in the Lowell Machine Shops, by the rather crude process of literally cut-and-try. A variant known as the American wheel was patented the following year, and with the further blade-shape contributions of John B. McCormick (1834-1924) around 1870 it became the popular forerunner of the modern mixed-flow unit. Why the name of Francis continues to be associated with it presumably stemmed initially from the widespread attention attracted by his book and then from the resulting adoption of this designation by the German and Swiss firms which led in its scientific development later in the century.

The centrifugal turbine's pumping counterpart (first proposed by Leonardo da Vinci) was introduced in the States in 1818 by an unknown inventor. Now called the Massachusetts pump, variants appear to have been used in New York City in 1830, 1838, and 1844, and a patent was obtained on a similar design by William Draper Andrews (1818-1896) of Massachusetts in 1846. However, centrifugal pumps were not produced commercially in this country much before the last quarter of the century. Positive-displacement devices, on the other hand, date from Alexandrian times, and it has already been noted that steam-driven units of this type were used in the water supply of Philadelphia early in the century. Apparently a major difficulty still lay in the matter of valving—for example, in the operation of boiler feed pumps on steamboats, which had to stop operating at canal locks and so lost their prime. The man who overcame this problem was Henry Rossiter Worthington (1817-1880) of New York, the son of a millwright, who became a skilled draftsman while working in his father's establishment. In 1840 he entered a competition for the design and construction of a steam-driven boat to be used on the Erie Canal, in the course of which he invented the first automatic direct-acting feed pump and patented it in 1844. The boat that he built with his father's financial support was a mechanical success, but the New York Legislature soon canceled his license to operate it because of complaints by boatmen that it was driving them out of work. However, Worthington adapted his steam pump to other uses and began their manufacture through a company bearing his name. An improved unit was fabricated for the *SS Washington* in 1850, and in 1854 he built and installed his initial waterworks pumping system for Savannah, Georgia, in which three compound direct-acting engines supplied a total of nearly one million gallons of water per day. The following year Worthington developed a duplex piston-type water meter, the first to come into general use, and this led in 1857 to his major invention: the duplex direct-acting pump. His chief claim to fame, however, came from his first duplex compound pumping engine of waterworks size, which by 1836 was supplying Charleston, Massachusetts, with 5,000,000 gallons per day. Worthington was to become in 1880 one of the founding members of the American Society of Mechanical Engineers.

Attention was called in the foregoing chapter to the stimulating influence of the steamboat on river navigation and of the resulting efforts that were made to improve river navigability by dredging, removing snags, and installing crude training structures. On the smaller streams this could proceed without great ado, but on the Ohio and the Mississippi Rivers the scale was vast and the difficulties innumerable. From almost the outset this was the province of the U.S. Army Engineers, and as early as 1822 General Simon Bernard (1779-1839) and Lieutenant Colonel Joseph Totten (1788-1864) submitted a descriptive report that dealt with both rivers but emphasized the falls and subsequent bars of the Ohio. This was but the first of a steadily growing series of reports on the general subject. In 1841 W. A. Brooks published in England a related treatise on the formation of bars and other obstructions. In the Proceedings of the American Association for the Advancement of Science for 1848 there appeared an article by Andrew Brown on measurements of both discharge and sediment at Natchez, Mississippi; and in the same journal for the following year Lieutenant Robert A. Marr of the U.S. Navy wrote of similar but more comprehensive measurements at Memphis, Tennessee. The same year Charles Ellet Jr (1810-1862) submitted to the Smithsonian Institution a memoir on the physical geography of the Mississippi Valley, with recommendation of a reservoir system to improve navigation on the Ohio. In 1850 a report was made by Professor Caleb Goldsmith Forshey (1812-1881) to the Louisiana Legislature on the use of levees. A year later Ellet prepared for the War Department a report on methods of preventing overflows in the Mississippi Delta. A second series of observations was made by Lieutenant Marr in 1850-51, including discharge, temperature, evaporation, rainfall, and sediment concentration over a twelve-month period. The *Journal* of the Franklin Institute for 1857 contains papers on the improvement of the Ohio by Ellwood Morris and by Milnor Roberts. A critical review of the general navigation problem was published by David Stevenson first as an article for the *Encyclopedia Britannica* in 1858 and then as a separate treatise, certain American observations being criticized therein.

The foregoing is preliminary to discussion of a tremendous tome (some 600 7x12-inch pages) which appeared in 1861: *Report upon the Physics and Hydraulics of the Mississippi River,* by Captain Andrew Atkinson Humphreys (1810-1883) and Lieutenant Henry Larcom Abbot (1831-1927) of the Army Corps of Topographical Engineers. Not only did the references just cited stem from this work, but the authors stated that a great number of unreferenced reports existed in the files of the War Department. In an early section of the volume they followed the customary European practice of reviewing the previous literature. Therein a very comprehensive coverage of names, titles, and dates was given, but the initial assessment of the content of each item was almost naive in its vagueness—a situation that would be of less import were it not for the fact that a supposedly original pamphlet on the history of hydraulics published some 80 years later borrowed much of the historical material, including the naiveté. To Humphreys and Abbot's credit it must be noted that a subsequent section reviewed in great detail the relevant part of the source material—namely, existing methods of measuring velocity and discharge and of predicting channel resistance. The larger part of the volume presented a wealth of historical, geographical, and morphological information on the various divisions of the Mississippi Basin from headwaters to delta, much of which stemmed from the authors' own observations. Their measurements, to be sure, hinged largely on application of the rather antiquated double-float method, though some use was made of the propeller type of current meter devised in 1832 by Joseph Saxton. Throughout the book the authors reflected the growing belief of the Corps in the efficacy of levees and the uselessness of reservoirs for the control of floods. They were particularly unsuccessful in their purely hydraulic contribution. In the effort to develop an accurate method of predicting the resistance of any stream whatever, they presented a system of formulas reflecting (except for the effect of roughness) not only their own measurements but all available data in the international literature. They claimed thereby to have furnished

> crowning proof of the exactness of the new formulae as applied to water moving in natural channels. Joined to the two preceding tests, it establishes beyond reasonable doubt, first, that the same laws govern the flow of water in the largest rivers and in the smallest streams; second, that the new formulae truly express those laws; and, third, that the formulae heretofore proposed do not express them even approximately.

Other hydraulicians (notably Ganguillet and Kutter of Switzerland, the land of mountain torrents) claimed to have far less success with the method. Two positive effects seem to have resulted, however: succeeding empiricists (including Ganguillet and Kutter) sought even more determinedly to encompass all streams with their formulations, and their methods of doing so became steadily simpler.

Following Humphreys and Abbot's presentation, attention continued to be given to the country's rivers. Though Humphreys became in due time general and Chief of Engineers, he grew to be a rather bigoted proponent of the Corps' infallibility, not to mention the utter correctness of his and Abbot's report. Abbot, like Humphreys, took a prominent part in the Civil War and thereafter continued to work and write on various aspects of rivers, harbors, and canals—though invariably guided by the principles of his chief. Together, for instance, they belittled the telegraphic-indicating cup-type current meter developed by Daniel Farrand Henry (1833-1907) in 1868 as a "pretty toy" in comparison with their own double floats for velocity measurement. Ellet, very broad in his engineering interests, had already been retained by the War Department for planning the improvement and protection of the Mississippi Delta; in the Civil War he participated in both naval design and operations. The German-born Henry Flad (1824-1898) likewise saw duty in the Civil War, then served under Eads and Kirkwood, whose names will soon again be mentioned, and later developed a number of measurement methods as a member of the Mississippi River Commission. Perhaps the most productive engineer engaged on Mississippi River projects was the Hoosier James Buchanan Eads (1820-1887), who had a fairly long, highly varied, and extremely remunerative career. A builder of bridges (including the one at St. Louis that still bears his name, erected in the face of Humphreys' strong tactical opposition), ironclad warships, underwater salvage gear, and jetties, his consulting work took him to many parts of the world. His brochures *Improvement of the Mouth of the Mississippi River* (1874), *Physics and Hydraulics of the Mississippi River* (1876), and *Mississippi Jetties* (1879) aptly recorded his work and times. The second of these (the title is actually that of the U.S. Levee Commission report that he discussed) protested against what he considered the dogmatism of the Corps of Engineers in recommending flood alleviation through the opening of new outlets in the delta region and simultaneously increasing the levee elevation. It was Eads' contention that closing some of the existing outlets and introducing jetties in the main pass would so deepen the channel that the existing levee system could even be lowered. His perceptive remarks on sediment movement resulted in large part from his examination of many sections of river bottom on foot in one of his diving bells. The following quotation from the first title is typical:

> The popular theory advanced in many standard works on hydraulics, to wit, that the erosion of the banks and bottom of streams like the Mississippi, is due to the *friction* or *impingement* of the current against them, has served to embarrass the solution of the very simple phenomena presented in the formation of the delta of the Mississippi, because it does not explain why it is that under certain conditions of the water, it may develop with a gentle current, an abrading power, which, under other conditions, a great velocity cannot exert at all. A certain velocity gives to the stream

> the ability of holding in suspense a proportionate quantity of solid matter; and when it is thus charged it can sustain no more, and hence will carry off no more, and therefore cannot then wear away its bottom or banks, no matter how directly the current may impinge against them.

Eads was finally permitted to build the jetty system that he recommended and was wholly successful in clearing the South Pass.

Other hydraulic engineers continued on the water-supply projects that have formed a considerable part of this presentation. James Pugh Kirkwood (1807-1877) was a migrant to the United States from his birthplace in Edinburgh. At first a structural engineer, he later also participated in water-supply endeavors for New York and Boston. Of special note were his investigations of lead poisoning from distribution pipes (he was probably the first in America to use tar-coated water mains, laid in Boston in 1858), and of the possible pollution of rivers used for water supply. In 1868 Kirkwood was sent to Europe by the City of St. Louis to study methods of water purification. His book on the subject the following year advocated the use of sand filters, but his recommendations were not adopted by the city; at Poughkeepsie, New York, however, he designed and actually built the first American filter, in 1872-73. One of Kirkwood's contemporaries was John Cresson Trautwine (1810-1883) of Philadelphia; his many international projects included the Delaware Breakwater, the Cartagena Canal in Colombia, Puerto Rican and Canadian harbors, and studies for interoceanic railroads in Panama and Honduras; in the latter regard it is interesting to note that he also sought an interoceanic canal route across Panama but reported such a scheme to be impossible; it was he, moreover, who first published the long-lived *Civil Engineer's Pocket-Book.* Another Philadelphian, William Milnor Roberts (1810-1881), had worked with Canvass White on various canals, with particular attention to the utilization of inclined tracks instead of locks. After numerous canal and railroad projects, he changed his mind about the use of the inclines; if Renwick can be said to have started the practice, it was Roberts who ended it. He also was involved in the improvement of the Ohio River (on which he wrote books in 1856 and 1857), the Mississippi Delta, and the Philadelphia Water Works.

William Jarvis McAlpine (1812-1890) of New York City learned railroad and canal engineering under John Jervis. He succeeded Jervis as chief engineer of the eastern division of the Erie Canal at the age of only 24. He later became involved in the water supply of Brooklyn and Albany, and in 1851 was employed by the water commissioners of Chicago for similar purposes, completing a pumping and distributing system from an intake crib in Lake Michigan by 1854. He thereafter consulted on the water-supply problems of Rochester, Buffalo, San

Francisco, Montreal, Norfolk, Philadelphia, New York, and Toronto. He was also engaged on various railroad, bridge, harbor, and river projects, including consultation on the Iron Gate region of the Danube River in the Balkans. Equally notable among the water suppliers was a native of Baltimore, Ellis Sylvester Chesbrough (1813-1886), sometimes called the father of American sanitary engineering. While he played no part in advancing the chemical treatment of water, he was well aware of the dangers of pollution. With almost negligible schooling, he learned the civil-engineering profession under various railroad engineers in the east, advanced to the post of chief engineer and then commissioner of the Boston Water Works, and thereafter (1855) moved to Chicago to become engineer of its Sewerage Commission. After a study tour of Europe the following year, he planned and supervised the tremendous task of raising Chicago's main streets and buildings so that newly installed sewers would drain toward Lake Michigan, and then constructed a 2-mile tunnel out into the lake to provide—for a time—a supply of uncontaminated water.

During the first half of the 19th century several attempts were made to form a society of civilian engineers. The first of these, in Atlanta in the 1830's, came to naught. The second, in Baltimore in early 1839, attracted 40 participants from 11 states, by whom Benjamin Latrobe was elected president. An organizing Committee of Seventeen met at Philadelphia later in the year, drafted a constitution, and proposed the name American Society of Civil Engineers; however, only seven of the original 40 approved the draft, and the movement soon died. Less than a decade later, however, the Boston Society of Civil Engineers was founded. Four years after that—in 1852—a meeting was called in the office of the Croton Aqueduct Department "for the organization, in the city of New York, of a Society of Civil Engineers and Architects." One of the sponsors was James Laurie (1811-1875), an engineer of Boston who had helped organize the BSCE, and he was chosen as the first president. After three years of activity, a twelve-year period of lethargy set in, and not till just after the Civil War was interest resumed. At that time James Kirkwood became the second president. Under his leadership a Committee on Publication was appointed; the name of the Society was changed to its present form; John Jervis (one of the previous Committee of Seventeen) was elected to honorary membership; and the first volume of Transactions was published (1872) and the Norman Medal established. Other hydraulic engineers already mentioned who later served as president were McAlpine (also an honorary member), Chesbrough, and Francis (also an honorary member of the ASCE as well as past president of the BSCE).

In the foregoing pages several references have been made to the Civil War. An event of that same period which must also be noted was the passage by Congress in 1862 of the Morrill Land Grant Act; this was to have a profound effect on American engineering education. The early influence of the French *Ecole Polytechnique* on the West Point curriculum has already been emphasized. Counterparts of the German *Technischen Hochschulen* were eventually to be found in such schools as the Rensselaer Polytechnic Institute (1824), and the English establishment of engineering faculties as integral parts of their universities was matched by Harvard (1847) and Yale (1852). American state universities, led by Michigan in 1852, followed suit, but it was the land-grant colleges of agriculture and mechanic arts that really made engineering education available to the masses; fully 70 of these colleges (Cornell University among them) were established during the decade immediately following passage of the Act before the country was even a century old. Perhaps the mean level of education was lowered thereby, but an immensely practical sort of engineering graduate who learned by doing in shop and field was produced—a worthy successor to the product of the Erie School.

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PROCEEDINGS

BOSTON SOCIETY OF CIVIL ENGINEERS SECTION

AMERICAN SOCIETY OF CIVIL ENGINEERS

Minutes of Meetings

ANNUAL MEETING OF SECTION

April 13, 1976 — The 128th Annual Meeting of the Boston Society of Civil Engineers (the second meeting of the Boston Society of Civil Engineers Section following the merger of BSCE with the Massachusetts Section of the ASCE) was held at the New England Aquarium in Boston. The meeting was called to order at 3:30 P.M. by President Charles A. Parthum.

The reading of minutes of previous meetings was waived, the President noting that these minutes would be published in the *Journal*. The Secretary announced that the following members of the Boston Society of Civil Engineers become eligible today for life membership in the Section: — S. Albert Kaufmann, Philip C. Rutledge, and William E. Stanley. He also announced the names of those who had attained life membership this year in the American Society of Civil Engineers and thereby also become life members of the Section: — Fozi M. Cahaly, Leo Casagrande, Paul D. Davis, Philip J. Janvrin, John H. Manning, Joseph E. Tisdel, and Robert W. Vose.

At the Board of Government Meeting on June 16, 1975, Grant Asfour was accepted as a Member of BSCES, having applied prior to the merger. John L. Grady was elected to the grade of Affiliate. At the Board of Government Meeting on January 19, 1976, Douglas Prentiss was elected an Associate Member, having applied prior to the merger.

The Secretary also read the names of members who had died during 1975-1976: — John Brindley, John L. Doherty, George R. Higgins, Simon Kirshen, Alfred Lockerbie, John Matte, Ernest L. Spencer, Howard M. Turner.

The Secretary summarized the Annual Reports of the Board of Government and the Secretary. The Treasurer presented his report for the partial fiscal year May 1, 1975 through September 30, 1976, noting that he had appended to his written report Treasurer's statements through March 31, 1976, to present a more current picture.

Annual Reports for the Auditors, the *Journal* Editor and the Forum were presented, as well as for the following committees: Action, Advertising, ASCE/AGC Liaison, Associate Member Forum, Constitution and Bylaws, Thomas R. Camp Fund, Clambake, Continuing Education, Dinner Dance, Disadvantaged Youth, John R. Freeman Fund, History and Heritage, Ralph W. Horne Fund, Intersociety Committee on Engineering Professionalism, Investment, Key Man, Membership, Nominating, Program and New Quarters, Publications, Student Chapter, BSCES/MCIC Liaison. It was VOTED "that these reports be accepted and placed on file."

The Annual Reports of the Technical Groups were requested by the President, and the following were presented: Computer, Construction, Environmental, Geotechnical, Hydraulics, Structural, and Transportation. It was VOTED "that these reports be accepted and placed on file." The President stated that the reports of the committees and Technical Groups will be published in the *Journal*.

The Tellers of the Election, Paul Bourque and William Zoino, reported on the results of the balloting, and in accordance therewith, the following were declared to have been elected officers of BSCES/ASCE for the coming year:

President	Bertram Berger
Vice President (2 years)	Howard Simpson
Secretary	Edward B. Kinner
Treasurer	Saul Namyet
Directors (2 years)	Maurice Freedman
	Frank E. Perkins

Because of an error on the ballot, Nominating Committee Members will be elected at a future date.

President Parthum then presented his address entitled, "Two Hundred Years and More of Engineering in the United States."

The meeting was adjourned at 5:30 P.M. to reconvene following dinner and a Marine Show aboard the Discovery.

President Parthum called the meeting to order again at 8:00 P.M. Following introduction of the head table guests and officers, the President called on Secretary, Edward B. Kinner, to assist in the awarding of prizes and certificates. The Secretary announced the following prize awards, which were in turn presented by the President:

Award: Desmond Fitzgerald Medal
Recipient: K. Peter Devenis
Paper: "The Proposed Charles River Project"

Award: Clemens Herschel Prize
Recipient: Gary A. Tasker
Paper: "A Comparison of Methods for Estimating Flood Peaks on Streams in Massachusetts"

Award: Clemens Herschel Prize
Recipient: George F. Sowers
Paper: "Engineering Approach to Responsibility for Unexpected Problems in Foundations"

Award: Geotechnical Group Award
Recipient: Gary S. Brierley
Paper: "Rock Weathering and Soil Formation"

Award: Hydraulics Group Award
Recipient: Robert W. Kwiatkowski and David R. Campbell
Paper: "Engineering the Bear Swamp Project"

President Parthum then presented certificates of appreciation to Joseph F. Willard for his services as Secretary of BSCE for two years and Treasurer of BSCES/ASCE for two years, and to Peter J. Riordan for his services as Editor of the Forum for the past three years.

The Secretary read the names and brief biographies of those who had attained ASCE Life Membership this year and the President presented certificates to those present. He also read the names and biographies of those who had attained BSCES Life Membership and the President presented a certificate to the new Life Member present.

President Parthum introduced Mr. Leland J. Walker, President-Elect of ASCE as speaker of the evening. Following Mr. Walker's presentation the President introduced the officers of the BSCES Section for the coming year, and then turned the meeting over to the new President, Bertram Berger. President Berger outlined his goals for his term of office, and then presented a certificate of appreciation to retiring President Parthum.

President Berger then adjourned the meeting.

One hundred ninety-five members and guests attended the dinner and the meeting.

TECHNICAL GROUPS MEETINGS HELD

(For Details see Annual Reports in This Issue)

Computer Group

February 4, 1976 — Panel discussion on selection of computer hardware by engineering firms.

March 3, 1976 — Paper on computerized graphical information systems. Election of officers for 1976-1977.

Construction Group

February 18, 1976 — Paper on procedures for preparing a joint venture bid for a heavy construction project. This was also an official meeting of the BSCE Section.

March 10, 1976 — Joint meeting with Geotechnical Group. Paper on construction of the North River Pollution Control Project. Election of officers for 1976-1977.

Environmental Group

March 31, 1976 — Paper on a leachate control program for Saco, Maine. Election of officers for 1976-1977.

Geotechnical Group

February 12, 1976 — Joint meeting with New England Chapter, Association of Engineering Geologists. Papers on a remote sensing technique for hydrology and site selection.

March 10, 1976 — Joint meeting with Construction Group (see above). Nominations of officers for 1976-1977.

Hydraulics Group

February 25, 1976 — Papers on the Metropolitan Boston Water Transmission and Distribution Study. This was also an official meeting of the BSCE Section.

March 24, 1976 — Paper on Electric System Planning for Pumped Storage hydroelectric power. Election of officers for 1976-1977. This was also an official meeting of the BSCE Section.

Structural Group

April 7, 1976 — Panel discussion on structural specifications. Election of officers for 1976-1977.

Transportation Group

February 23, 1976 — Executive Committee conference with representatives of Mystic Tobin Bridge Authority.

March 17, 1976 — Talk on Park Plaza Project, Boston.

ANNUAL REPORTS

REPORT OF THE BOARD OF GOVERNMENT 1975-1976

To the Boston Society of Civil Engineers Section,
American Society of Civil Engineers

Pursuant to the requirements of the By-Laws, the Board of Government presents its report of the year ending April 13, 1976.

The following is a statement of membership in the Section:

Honorary	10
Assigned ASCE members	2006(Feb. 29, 1976)
Subscribers:	
Members	1393
Associate Members	516
Student Chapters	9

Summary of Additions

New Members	17
New Associate Members	76

Summary of Loss of Members

Deaths	8
Resignations	20
Dropped	27

Life Memberships

Life Members	214
Members becoming eligible April 13, 1976	10

Honorary Membership is as follows:

John B. Babcock 3rd	elected	January 2, 1969
Charles O. Baird, Jr.	elected	January 2, 1969
Arthur Casagrande	elected	February 1, 1975
Herman G. Dresser	elected	November 5, 1975
Ralph W. Horne	elected	February 1, 1965
Karl R. Kennison	elected	February 7, 1951
George R. Rich	elected	March 19, 1973
Frederick N. Weaver	elected	February 1, 1965
John A. Volpe	elected	January 29, 1968

The following members have been lost through death:

John Brindley	January 1976
John L. Doherty	1975
Simon Kirshen	October 1975
Alfred Lockerbie	August 1975
John Matte	1975
Ernest L. Spencer	October 1975
Howard M. Turner	May 1975
George R. Higgins	June, 1975

MEETINGS OF THE SECTION

October 22, 1975	Joint with Geotechnical Group - "Evaluation of Several Geotechnical Predictions", speaker, Prof. T. William Lambe
November 19, 1975	Joint with Computer Group - "Computerized Technology Today", speakers, Kenneth A. Goff and Steve G. Lyons
December 17, 1975	Joint with Structural Group - Influences of Mechanical/Electrical/Plumbing Systems on design of Structures", speaker, Marvin Mass
January 28, 1976	Joint with Transportation Group Annual Meeting - "Transportation Futures", speaker, Lt. Governor Thomas P. O'Neill
February 18, 1976	Joint with Construction Group - "Preparation of Estimates for Major Heavy Construction", speaker, David Malone
March 23, 1976	Joint with Hydraulics Group - "Electrical System Planning for Pumped Storage Hydroelectrical Power," speaker, Jack C. Howe
April 13, 1976	Annual Meeting of BSCE Section ASCE - Address of retiring BSCES President Charles A. Parthum. Guest Speaker: Leland J. Walker, President-Elect ASCE

MEETING PLACES AND ATTENDANCE

Date	Place	Attendance
October 22, 1975	Harvard University	80
November 19, 1975	Mass. Institute of Technology	25
December 17, 1975	Mass. Institute of Technology	17
January 28, 1976	Anthony's Pier Four Restaurant	70
February 18, 1976	Red Coach Grill	28
March 23, 1976	Mass. Institute of Technology	24
April 13, 1976	New England Aquarium	200

The Technical Groups of the Section also held many other meetings during the year. Annual reports of the various groups were presented at the Annual Meeting of the Section and are published in the Journal.

PERMANENT FUND*

The Permanent Fund was established under the By-Laws, Article 10, and is the recipient of all money received as entrance fees. Under certain circumstances income from the Permanent Fund may be transferred to the Current Fund. However, no such transfer was made this year. The Treasurer's report gives details of the year's transactions. Book value of the fund as of September 30, 1975, was $77,122.34.

*Details regarding the value and income of these funds are given in the Treasurer's Report.

FUNDS ESTABLISHED BY GIFT OR BEQUEST TO THE BOSTON SOCIETY OF CIVIL ENGINEERS*

JOHN R. FREEMAN FUND. In 1925 the late John R. Freeman, a Past President and Honorary Member of the Boston Society of Civil Engineers, made a gift to the Society of securities which were established as the "John R. Freeman Fund". The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to the hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to the Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, a report of which would be presented to the Society. Total charges against this Fund through the fiscal year ending September 30, 1975, were $184.18.

EDMUND K. TURNER FUND. In 1916 the Society received a bequest of $1000 from Edmund K. Turner, a former member, the income which is to be used for Library purposes. Charges against the Fund through the fiscal year ending September 30, 1975, were $9.66.

ALEXIS H. FRENCH FUND. The Alexis H. French Fund, a bequest of $1000 was received in 1931 from the late Alexis H. French, a Past President of the Society. The income of this fund is "to be devoted to the Library of the Society". Charges against the Fund through the fiscal year ending September 30, 1975, were $9.54.

CLEMENS HERSCHEL FUND. This Fund was established in 1931 by a bequest of $1000 from the late Clemens Herschel, a Past President and Honorary Member of the Society. The income from this Fund is "to be used for presentation of prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgement." Charges against this Fund through the fiscal year ending September 30, 1975, were $36.51.

DESMOND FITZGERALD FUND. The Desmond Fitzgerald Fund, established in 1910 by a bequest of $2,000 from the late Desmond Fitzgerald, a Past President and Honorary Member of the Society, provided that the income from this Fund shall "be used for charitable and educational purposes." The Board voted on April 13, 1964 to use the income of this Fund to establish a Boston Society of Civil Engineers' Scholarship in Memory of Desmond Fitzgerald, and that it be given to a student in Civil Engineering at Northeastern University. Charges against this fund through the fiscal year ending September 30, 1975, were $95.79.

Subsequent to September 30, 1975, it was voted to accept the recommendation of the Committee at Northeastern University, that the current scholarship award of $200 be divided equally between David J. Crispin and David E. Deans. Presentation was made at the 1976 Student Chapter Night meeting of the Society held at the University of Lowell on February 26, 1976.

EDWARD W. HOWE FUND. This Fund, a bequest of $1000, was received in 1933 from the late Edward W. Howe, a Past President of the Society. No restrictions were placed on the use of this bequest, but the recommendation of the Board of Government was "that the fund be kept intact, and that the income be used for the benefit of the Society or its members." Charges against this fund during the fiscal year ending September 30, 1975, were $10.54.

WILLIAM P. MORSE FUND. This Fund, a bequest of $2,000, was received in 1949 from the late William P. Morse, a former member of the Society. No restrictions were placed on the use of this bequest, but the recommendation of the Board of Government was "that the fund be kept intact, and the income be used for the benefit of the Society and its members." Upon recommendation of the Committee appointed by the President, the Board voted on April 5, 1954 "to appropriate from the income of this fund a Scholarship to be known as the Boston Society of Civil Engineers Scholarship in Memory of William P. Morse, and that it will be given to a Civil Engineering student at Tufts University." Charges against this Fund through the fiscal year ending September 30, 1975, were $16.46.

Subsequent to September 30, 1975, it was voted to accept the recommendation of the Committee at Tufts University, that the award scholarship of $200 be given to Cornelius P. Cronin, Jr. Presentation was made at the 1976 Student Chapter Night meeting of the Society held at the University of Lowell on February 26, 1976.

FRANK B. WALKER FUND. This Fund, a bequest of $1000, was received in 1961 from Mary H. Walker, wife of Frank B. Walker, a Past President of the Society. No restrictions were placed on the use of this bequest, but the recommendation of the Board of Government was "that this fund should be kept intact and the income be used for the benefit of the Society and its members." Charges against this fund during the fiscal year ending September 30, 1975, were $4.76.

RALPH W. HORNE FUND. This Fund, a bequest of $3,000, was received June 29, 1964, from the Directors of Fay, Spofford and Thorndike, Inc., the income from which shall be devoted to a prize or certificate to be awarded annually to a member designated by the Board of Government to have been outstanding in unpaid public service in municipal, state or federal elective or appointed posts; or in philanthropic activity in the public interest. Members of BSCES only are eligible for the Award. Charges against this Fund during the fiscal year ending September 30, 1975, were $14.12.

THOMAS R. CAMP FUND. This Fund, a bequest of $10,000, was received January 15, 1971, from the Directors of Camp, Dresser and Mckee, Inc., to establish the "Thomas R. Camp Fund", the income to be used to support an annual Thomas R. Camp lecture or lectures on outstanding recent developments or proposed or completed research in the sanitary engineering field. The income from the fund, over and above that needed to support the annual lecture should be added to the fund, but could be used otherwise at the discretion of the Board of Government of the Boston Society of Civil Engineers Section of the American Society of Civil Engineers. Charges against this Fund during the fiscal year ending September 30, 1975, were $34.84.

LECTURE FUND. The Lecture Fund was established in 1969 for the purpose of providing money for special lectures sponsored by the Society. The book value of this Fund at the end of the fiscal year was $5290.93. Charges against the Fund during the fiscal year ending September 30, 1975, were $15.84.

KARL R. KENNISON FUND. This fund is comprised of two irrevocable trusts established in behalf of the Society by Karl R. Kennison. These trusts consist of shares of the Massachusetts Fund, the Massachusetts Company, Inc., trustee. On April 5, 1976, these trusts included the following:

Trust#4315	Market Value - $3,712.73
Trust#4444	Market Value - $5,386.34

After Mr. Kennison's death the net income shall be paid to the Society for a Hydraulic Lectureship Fund to be used for various public lectures on this subject, and the Board may withdraw the principal on written demand or make such changes in the use of the Fund as it may determine are warranted.

PRIZES

A number of prizes and awards are recommended for presentation at the Annual Meeting. For the list of awards and recipients, refer to the minutes of the Annual Meeting.

COMMITTEES

The usual special committees dealing with the activities and conduct of the Society were appointed. The reports of the committees were presented at the Annual Meeting April 13, 1976.

The Board wishes to express its appreciation of the excellent work done by the officers of the Groups and by the Committees of the Section.

Charles A. Parthum
President

BOSTON SOCIETY OF CIVIL ENGINEERS SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

Report of the Secretary

FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1975

The following is a statement of cash received by the Secretary and of the expenditures approved by the President in accordance with the budget adopted by the Board of Government.

		EXPENDITURES	RECEIPTS
1. OFFICE ACCOUNT			
Rent and Services		$ 2,684.76	
Gross Salaries		5,100.00	
Social Security, Sales and other taxes.		586.91	$ 0.51
Stationery, Printing and Postage		3,515.97	
Committee Expenses		50.00	
Miscellaneous		153.60	606.56
Capital Costs		0.00	
2. MEETINGS ACCOUNT			
Annual Meeting & Dinner Dance		5,112.16	4,090.49
Technical Groups		7,166.06	1,088.00
3. PUBLICATIONS ACCOUNT			
Journal		5,366.60	
Forum		3,238.12	
Ads - Journal & Forum			2,150.00
Sales of Journal			967.50
Soil Mechanics			419.50
Reprints		240.60	511.25
Miscellaneous		66.43	
4. OTHER			
Dues			21,599.50
Reimbursement from ASCE National			0.00
Transfer 1/2 Income Continuing Education			872.50
Balance from 1974 Bills Payable Reserve			1,211.94
		$33,281.21	$33,517.75
Reserve for 1975 Bills Payable		236.54	
	Totals	$33,517.75	$33,517.75

Entrance Fees to Permanent Fund = $520.00

The above receipts have been paid to the Treasurer whose receipt is noted on bank statements held on file. The Secretary holds cash amounting to $30.00 to be used as a fixed fund for cash on hand.

Respectively submitted,
Edward B. Kinner, Secretary
April 13, 1975

BOSTON SOCIETY OF CIVIL ENGINEERS SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

Report of the Treasurer

For The Fiscal Year March 1, 1975 to September 30, 1975

FINANCIAL STANDING

The financial standing of the Section is summarized in the following four tables which accompany this report. The tables represent conditions as of the close of business on September 30, 1975.

TABLE I	Condensed Statement of Condition (Assets, Liabilities and Funds.)
TABLE II	Condensed Statement of Income and Expenditures, Distribution of Funds.
TABLE III	Portfolio of Investments.
TABLE IV	Income and Yield from Investments.

SOCIETY INVESTMENTS

The Boston Safe Deposit and Trust Company continues to provide us with investment management and custodian services for the portfolio of securities owned by the Section, and has furnished us with a certified audit of the list of securities.

The Investment Division of the Boston Safe Deposit and Trust Company reviews our portfolio of securities periodically. The general policy for handling the portfolio continues to be reasonable income consistent with maintenance of principal, including reasonable growth rate. During the year an interest bearing account was opened for the deposit of cash income from securities.

AUDIT

The Auditing Committee has reviewed the Treasurer's account book, bills paid by the Treasurer, receipts from the Secretary, the Savings Bank Passbooks, the Checkbook, and the list of investments of the Section. The information contained in this report has been verified.

INVESTMENT FUNDS INCOME ACCOUNT (CASH)
(Boston Safe Deposit & Trust Co., Custodian)

	Debit	*Credit*	*Balance*
Balance March 1, 1975			$7,915.63
Custodian Service Charge	$ 553.46		
Transfer to Int. Bearing Acct.	12,026.08		
Dividends from stock		$5,115.46	
Interest from Bonds		$1,320.30	
Total	$12,579.54	$6,435.76	
Balance September 30, 1975			$1,771.85

INVESTED INCOME ACCOUNT (INTEREST BEARING)
(Boston Safe Deposit & Trust Co., Custodian)

This new account is cash available for investment, but draws interest rather than being idle. Transfers are made from the cash income account by the custodian.

	Debit	Credit	Balance
Balance March 1, 1975			$ 0.00
Transfer from Cash Account		$12,026.08	
Interest to 9-30-75		123.34	
Total	$ 0.00	$12,109.42	
Balance September 30, 1975			$12,109.42

INVESTMENT FUNDS PRINCIPAL ACCOUNT
(Boston Safe Deposit & Trust Co., Custodian)

	Debit	Credit	Balance
Balance March 1, 1975			$482.99
Balance September 30, 1975			$482.99

SAVINGS ACCOUNT
(First Fed. Savings & Loan Assn. of Boston)

This account is used for cash available for investment and for excess balance in checking account, providing income while available for operating expenses.

	Debit	Credit	Balance
Balance March 1, 1975			$3,646.09
Interest		$108.32	
Balance September 30, 1975			$3,754.41

SAVINGS ACCOUNT
(Union Warren Savings Bank)

This account is money available for Student Loans. (former Mass. Section)

	Debit	Credit	Balance
Balance March 1, 1975			$2,955.63
Interest		$92.73	
Total	$ 0.00	$92.73	
Balance September 30, 1975			$3,048.36

CURRENT FUND ACCOUNT

This is the operating account of the Section. The account is provided with a balance of $3,000 at the beginning of the fiscal year, to insure that operations may be carried on until regular income is received.

	Debit	Credit	Balance
Balance March 1, 1975			$3,000.00
Office Expense	$12,091.24*		
Meetings Expense	12,278.22*		
Publications Expense	8,911.75*		
Received from Secretary		$31,433.31*	
Transfer ½ Income Contin. Ed. Acct.		872.50	
Credit for 1974 Bills Payable		1,211.94	
Reserve for 1975 Bills Payable	236.54		
Total	$33,517.75	$33,517.75	
Balance September 30, 1975			$3,000.00

*The membership and others interested are referred to the report of the Secretary for a detailed breakdown of the income and expense of the Current Fund.

PERMANENT FUND

The Permanent Fund receives income from its prorated portion of interest and dividends from investments, and pays its portion of service charges to the Custodian Bank.

Receipts from entrance fees are credited to the principal of this fund.

	Debit	*Credit*	*Book Value*
Book Value March 1, 1975			$74,113.85
Custodian Service Charges	$229.32		
Interests & Dividends		$2,762.68	
Entrance Fees		520.00	
Total	$229.32	$3,282.68	
Book Value September 30, 1975			$77,167.21

The Permanent Fund share of income from interest and dividends was approximately 41% and it is anticipated that next year's share will remain the same.

JOHN R. FREEMAN FUND

The Freeman Fund also receives income from investments and pays its portion of service charges. The cost of the Freeman Lecture is paid from this fund.

	Debit	*Credit*	*Book Value*
Book Value March 1, 1975			$59,526.48
Custodian Charges	$184.18		
Interest & Dividends		$2,218.93	
Total	$184.18	$2,218.93	
Book Value September 30, 1975			$61,561.23

THOMAS R. CAMP FUND

The Camp Fund receives income from investments and pays its portion of service charges. The costs of the Camp Memorial Lecture are paid from this fund.

	Debit	*Credit*	*Book Value*
Book Value March 1, 1975			$11,255.55
Custodian Charges	$34.84		
Interest & Dividends		$419.57	
Total	$34.84	$419.57	
Book Value September 30, 1975			$11,640.28

BORING DATA FUND

No expenditures were made from this fund during the year.

Balance March 1, 1975	$1,576.11
Received from Book Sales	19.70
Balance September 30, 1975	$1,595.81

OTHER ASSETS

The Section owns no real estate, and rents its office space. It owns office furniture and equipment. The value of this furniture and equipment is not included in this report.

OTHER FUNDS

The members are referred to the Report of the Board of Government for information concerning the remaining funds, and for their purposes.

Table II gives a summary of Income, Receipts, and Expenditures of all funds.

Respectfully Submitted
Joseph F. Willard, Treasurer

TABLE I

CONDENSED STATEMENT OF CONDITION
ASSETS — LIABILITIES AND FUNDS
September 30, 1975

ASSETS

	BOOK VALUE		MARKET VALUE	
	9-30-75	2-28-75	9-30-75	2-28-75
First National Bank of Boston				
(Checking Acct.)	$ 6,541.42	$ 2,964.11	$ 6,541	$ 2,964
Suffolk-Franklin (NOW)	1,339.35	—	1,339	—
Boston Safe Dep. & Tr. Co.				
(Custodian Acct.)				
Bonds	52,684.69	52,684.69	37,227	37,896
Stocks	118,832.23	118,832.23	126,366	121,871
Cash — Custodian Acct.	2,254.84	8,398.62	2,255	8,399
Invested Income Acct.	12,149.42	—	12,150	—
First Fed. Sav. and Loan				
Assn. of Boston	3,754.41	3,646.09	3,755	3,646
Union Warren Savings Bank	3,048.36	2,955.63	3,048	2,956
Cash	30.00	30.00	30	30
Total Assets	$200,634.72	$189,511.37	$192,711	$177,762

LIABILITIES AND FUNDS

Permanent Fund	$ 77,167.21	$ 74,113.85	$ 73,860	$ 69,246
John R. Freeman Fund	61,561.23	59,526.48	58,924	55,616
Edmund K. Turner Fund	3,225.22	3,118.63	3,087	2,914
Desmond Fitzgerald Fund	5,715.02	5,794.80	5,473	5,414
Alexis H. French Fund	3,190.07	3,084.63	3,054	2,882
Clemens Herschel Fund	2,060.44	2,021.59	1,972	1,889
Edward W. Howe Fund	3,524.81	3,408.30	3,374	3,184
William P. Morse Fund	5,300.10	5,318.81	5,073	4,969
Frank B. Walker Fund	1,591.35	1,539.65	1,523	1,438
Ralph W. Horne Fund	4,720.86	4,564.82	4,517	4,265
Lectures Fund	5,294.03	5,117.05	5,068	4,783
Thomas R. Camp Fund	11,640.28	11,255.55	11,142	10,516
SUB TOTAL Invest. Funds	$184,990.52	$178,864.66	$177,067	$167,116
Contin. Education Fund	$ 1,158.70	$ 286.20	$ 1,159	$ 286
Boring Data Fund	1,595.81	1,576.11	1,596	1,576
Current Fund	3,000.00	3,000.00	3,000	3,000
Secretary's Change Fund	30.00	30.00	30	30
Student Loan Fund	4,286.98	4,194.25	4,287	4,194
Current Fund - Res. for Bills Payable	236.54	1,211.94	236	1,212
Bills Payable - With. from wages, etc.	704.95	348.21	705	348
Group Lecture Funds Balance	4,631.22	—	4,631	—
TOTAL LIABILITIES AND FUNDS	$200,634.72	$189,511.37	$192,711	$177,762

TABLE II
CONDENSED STATEMENT OF INCOME AND EXPENDITURES — DISTRIBUTIONS OF FUNDS
Fiscal Year March 1, 1975 through September 30, 1975

FUND	BOOK VALUE	INCOME AND RECEIPTS			EXPENDITURES			BOOK VALUE
	Mar. 1, 1975	*Interest Dividends*	*Receipts*	*Transfers to Funds*	*Custodian Service Charges*	*Expend-itures*	*Transfers from Funds*	*Sept. 30, 1975*
Permanent Fund	$ 74,113.85	$2,762.68	$ 520.00		$229.32			$ 77,167.21
John R. Freeman Fund	$ 59,526.48	$2,218.93			$184.18			$ 61,561.23
Edmund K. Turner Fund	3,118.63	116.25			9.66			3,225.22
Desmond Fitzgerald Fund	5,794.80	216.01			17.94	$ 277.85		5,715.02
Alexis H. French Fund	3,084.63	114.98			9.54			3,190.07
Clemens Herschel Fund	2,021.59	75.36			6.26	30.25		2,060.44
Edward W. Howe Fund	3,408.30	127.05			10.54			3,524.81
William P. Morse Fund	5,318.31	198.25			16.46	200.00		5,300.10
Frank B. Walker Fund	1,538.65	57.36			4.76			1,591.25
Ralph W. Horne Fund	4,564.82	170.16			14.12			4,720.86
Lectures Fund	5,119.05	190.82			15.84			5,294.03
Thomas R. Camp Fund	11,255.55	419.57			34.84			11,640.28
SUB TOTAL Investment Funds	$178,864.66	$6,657.42	$ 520.00		$553.46	$ 508.10		$184,990.52
Contin. Education Fund	286.20		1,745.00				872.50	1,158.70
Boring Data Fund	1,576.11		19.70					1,595.81
Student Loan Fund	4,194.25	92.73						4,286.98
Current Fund	3,000.00		31,433.31	872.50		33,281.21		3,000.00
Current - Res. for Bills*	1,211.94			*		*		236.54
Secretary's Change Fund	30.00							30.00
Bills Payable - with., etc.	348.21		704.95			348.21		704.95
Group Lectures (Untransferred)	—		7,350.00			2,718.78		4,631.22
Total	$189,511.37	$6,760.15	$41,772.96	$872.50	$553.46	$36,856.30	$872.50	$200,634.72

*Reserves included in Current Fund

TABLE III
PORTFOLIO OF INVESTMENTS

BONDS

	BOOK VALUE		MARKET VALUE	
	9-30-75	3-1-75	9-30-75	3-1-75
Assoc. Invest. Co. 5⅛-79, Deb.	$ 6,000	$ 6,000	$ 5,062	$ 4,868
Flintkote Co. 4⅝-81, Deb.	10,450	10,450	7,650	8,262
Florida Power Corp. 3⅛-84, 1st. Mort.	1,018	1,018	609	610
Florida Power Corp. 3⅞-86, 1st Mort.	5,038	5,038	2,938	3,038
Georgia Power Corp. 3⅜-77, 1st. Mort.	5,154	5,154	4,331	4,087
Marine Midland Corp. 3⅜-77, 1st. Mort.	5,000	5,000	3,025	3,381
Montreal Quebec Imp. 6%-87, Deb.	10,075	10,075	7,500	7,425
Orange and Rockland 6½-97, 1st. Mort.	9,950	9,950	6,112	6,225
Total	$52,685	$52,685	$37,227	$37,896
PREFERRED STOCK				
International Tel. & Tel.	$ 1,534	$ 1,534	$ 5,350	$ 5,457
COMMON STOCK				
American Tel. & Tel.	$ 4,332	$ 4,332	$ 11,469	$ 12,594
Clark Equipment Co.	12,287	12,287	10,550	11,000
General Motors Corp.	9,131	9,131	8,500	6,630
Boise Cascade	9,802	9,802	3,872	2,610
Illinois Power Co.	11,591	11,591	5,750	5,500
Int. Business Machines	11,803	11,803	11,860	13,577
McGraw Edison Co.	14,211	14,211	7,500	5,150
B. F. Saul Real Estate Invest. Trust	10,500	10,500	1,562	1,750
New England Electric System	7,505	7,505	6,399	6,086
Newmont Mining Corp.	12,549	12,549	12,062	10,562
Exxon	1,977	1,977	17,500	15,475
Texaco	1,516	1,516	11,092	12,331
Warner Lambert Pharm. Co.	9,937	9,937	12,800	13,050
W. R. Grace & Co.	156	156	100	99
Total	$117,297	$117,297	$121,016	$116,414
SAVINGS ACCOUNTS				
First Fed. Sav. & Loan Assoc.	$ 3,755	$ 3,646	$ 3,755	$ 3,646
Union Warren Sav. Bank	3,048	2,956	3,048	2,956
Total	$ 6,803	$ 6,602	$ 6,803	$ 6,602
CASH				
First Nat. Bank of Boston (Checking)	$ 6,541	$ 2,964	$ 6,541	$ 2,964
Bos. Safe Dep. & Tr. co. (Custodian Acct.)	2,255	8,399	2,255	8,399
Bos. Safe Dep. & Tr. Co. (Invested)	12,150	—	12,150	—
NOW Account (Sufolk-Franklin	1,339	—	1,339	—
Secretary's Change Fund	30	30	30	30
Total	$ 22,315	$ 11,393	$ 22,315	$ 11,393
Grand Total	$200,634	$189,511	$192,711	$177,762

TABLE IV
INCOME AND YIELD FROM INVESTMENTS

	Estimated Income	*Yield On Current Market Value*
BONDS 19.7%		
Assoc. Investment Co.	$ 307.50	6.1%
Flintkote Co.	462.50	6.1
Florida Power Corp. 3⅛-84	31.25	5.1
Florida Power Corp. 3⅞-86	193.75	6.6
Georgia Power Corp.	168.75	3.9
Marine Midland Corp.	250.00	8.4
Montreal Quebec Imp.	600.00	8.0
Orange & Rockland	650.00	10.6
Total	$2,663.75	7.2%
PREFERRED STOCK 2.8%		
Int. Tel. & Tel.	$ 481.50	9.1%
COMMON STOCK 64.2%		
Am. Tel. & Tel.	$ 850.00	7.4%
Clark Equip. Co.	640.00	6.1
General Motors Corp.	408.00	4.8
Boise Cascade	113.10	2.9
Illinois Power Co.	550.00	9.6
Int. Business Machines	441.00	3.7
McGraw Edison Co.	480.00	6.4
B.F. Saul Real Estate Invest. Tr.	0.00	0.0
New England Electric System	637.24	9.9
Newmont Mining Corp.	800.00	6.6
Exxon	1,060.00	6.1
Texaco	991.20	9.0
Warner Lambert Pharm Co.	368.00	2.9
W.R. Grace Co.	6.40	6.4
Total	$7,344.94	6.1%
SAVINGS ACCOUNTS 13.3%		
First Fed. Sav. & Loan	220.00	5.5%
Union Warren	165.00	5.5
Suffolk-Franklin "NOW"	300.00	5.0
Bos. Safe Deposit - Invested Income Acct.	660.00	5.5
Total	$1,345.00	5.4%

TOTAL YIELD FROM INVESTMENTS ESTIMATED 6.3%

ANNUAL REPORTS OF COMMITTEES

ANNUAL REPORT OF THE ACTION PROGRAM-PROFESSIONAL PRACTICE COMMITTEE, 1975-1976

The Action Program-Professional Practice Committee derives from the combination of the Action Program Committee of the Massachusetts Section ASCE and the Professional Practice Committee of BSCE. This is the first full year of operation of the combined committee. Following recommendations of our preceding committees, the committee was organized with representatives from the technical groups. Members for the year 1975-1976 were as follows:

William S. Zoino	Committee Chairman/Board of Government Representative
Frank Killilea, Jr.	Construction Group
Robert A. Wells	Computer Group
Peter Knowlton	Environmental Group
David Thompson	Geotechnical Group
Dominic D'Eramo	Structural Group
Maurice Freedman	Transportation Group
Ara Shestinian	General Membership
Howard Perkins	General Membership/Advisor Professional Practice
Rubin Zallen	General Membership/Advisor Action Program

The committee members were very active over the past year, particularly in areas requiring interprofessional contact between the engineering societies and state government. Major activities of the Committee were as follows:

1. The Committee held meetings with the Massachusetts Society of Professional Engineers (MSPE); the Consulting Engineers Council of New England (CECNE); the Massachusetts Association of Land Surveyors and Civil Engineers (MALSE); and the State Board of Registration of Professional Engineers, for the purpose of making recommendations to the Governor on qualified appointments to the Board of Registration of Professional Engineers and Land Surveyors. Response was received from the Governor's office and the Secretary of Consumer Affairs that the recommendations of BSCES were considered. To date, two of our recommendations were followed and two are pending.
2. In conjunction with the Geotechnical Group, the Committee sponsored a meeting on professional practice. This was the January 21, 1976 meeting with William Shannon of Shannon & Wilson as principal speaker, on professional liability and loss prevention programs for a consulting firm. The meeting was held at Harvard University and was attended by 120 members and guests. Mr. Shannon's talk included case histories of professional liability problems. Discussers included Charles A. Parthum, Woodrow W. Wilson, and William McTigue. The organizing committee consisted of David Thompson, Frank Killilea, and Charles Flavin; William Zoino was the moderator.
3. The Committee represented the Board of Government at a February 24, 1976 meeting of the Construction Materials Safety Board of the State Building Code Commission. Recommendations were made to the Commission on the accreditation of concrete testing laboratories as outlined by the Board of Government. Our action was taken in concert with the Massachusetts Concrete Industry Board (MCIB).
4. The Committee worked with Maurice Freedman of the Transportation Group to support the December 5, 1975 Conference on Massachusetts Growth and Development Policy held at the Parker House. Governor Dukakis was the keynote speaker.
5. The Committee corresponded with Governor Michael Dukakis concerning the retention of the office of State Geologist. Unfortunately, the Governor did not follow our strong voice of support. The office of State Geologist will not be continued.
6. The Committee made recommendations to the Commissioner of the Massachusetts Department of Commerce and Development for replacement of the professional engineer

member on the State Industrial Finance Board. This appointment is still pending.

The Committee recommends that the succeeding committee continue liaison with interprofessional groups and in particular kep abreast of proposed regulations and activities of the State Building Code Commission, and legislative activities that may affect engineers during the forthcoming year.

Respectfully submitted,
William S. Zoino, Chairman

ANNUAL REPORT OF ADVERTISING COMMITTEE, 1975-1976

The advertising committee has continued to renew advertisements in the *Journal* to a satisfactory degree. Efforts to significantly increase advertising in the Forum have not been successful to date. A revamping of the Forum rates to conform more closely to those of the *Journal* has been recommended.

Respectfully submitted
Robert M. Fitzgerald, Chairman

ANNUAL REPORT OF THE ASCE/AGC LIAISON COMMITTEE, 1975-1976

The Joint Committee held long meetings, up to three hours each, on March 18, April 15, May 15, September 18, October 16, November 20, and December 18, 1975; and on January 15 and February 19, 1976. A meeting is scheduled for March 18, 1976.

The primary matter considered in these meetings has been a review of the NSPE's Standard General Conditions of the Construction Contract (1974 Edition). Our intent is to eventually recommend this document for use by members of BSCES with certain changes as agreed upon in the Joint Committee.

In addition, matters of current interest to the two societies were discussed. The item of major interest and effort has been our efforts to block the attempts to require a mechanical filed sub-bid on Massachusetts Public Works jobs. The other major subject was the attempts being made by some contractors and suppliers to subvert the "or equal" clause in Massachusetts Public Work jobs, and substitute materials of construction other than those specified.

Respectfully Submitted
W. W. Whilson
BSCES Co-Chairman

ANNUAL REPORT OF ASSOCIATE MEMBER FORUM, 1975-1976

This year, activities of the AMF were drastically curtailed due to a lack of participation. As in past years, the group has not been able to attract new members. Part of the problem has been the feeling that the group does not have a purpose. Next year, the AMF Steering Committee plans to distribute a questionnaire to all of the younger members of BSCES which will seek their comments for proposed activities and solicit their participation.

The AMF was successful this year in sponsoring its annual clambake, attended by approximately 200 people. In addition, members of the AMF Steering Committee continued to participate on other BSCES committees.

Respectively Submitted,
David L. Freed, Chairman

ANNUAL REPORT OF AUDITING COMMITTEE, 1975-1976

The Auditing Committee met with Mr. Joseph Willard on March 23, 1976.

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers Section, American Society of Civil Engineers, and we have compared the bank statement of securities held by the Boston Safe Deposit and Trust Company with the enumeration submitted by the Treasurer. We found them to be in order and to account accurately for the Section's Funds.

Respectfully submitted,
Anthony J. DiSarcina and Charles H. Flavin

ANNUAL REPORT OF THOMAS R. CAMP FUND COMMITTEE 1975-76

In lieu of selecting one speaker for the annual Thomas R. Camp Lecture the committee, in cooperation with the Environmental Group, sponsored a series of twelve lectures on waste water treatment and disposal and designated them as the Thomas R. Camp Lecture Series. The lectures were held every Tuesday evening at Massachusetts Institute of Technology from January 13 to March 30, 1976. Details as to speakers and attendance are covered in the annual report of the Environmental Group.

Respectively Submitted,
Leo F. Peters, Chairman

ANNUAL REPORT OF CLAMBAKE COMMITTEE, 1975-1976

The annual clambake turned out to be a complete success this year after its cancellation the previous year. The event was held on July 31, 1975, at Middlesex Fells in Stoneham, Massachusetts. Approximately 200 people attended the bake. Woodman's Inc. of Essex, Massachusetts catered a four course meal, topped off by lobster and chicken. The bake started off with a social hour at 4:30 followed by the meal at 6:00.

Respectfully Submitted,
David L. Freed, Chairman

ANNUAL REPORT OF CONSTITUTION AND BYLAWS COMMITTEE, 1975-1976

During the past year, in response to several inquiries by the President, the committee reviewed and reported to the Board of Government on the interpretation of portions of the Constitution and Bylaws.

Respectfully submitted,
Max D. Sorota, Chairman

ANNUAL REPORT OF THE CONTINUING EDUCATION COMMITTEE, 1975-1976

The Continuing Education Committee again offered the professional engineers refresher course in the Spring and Fall of 1975. Both sessions were well received.

The committee served as host to the ASCE National Continuing Education Committee in its session on "Operating a Consulting Firm" held in Boston, April 18-19, 1975.

Continued and expanded programs are anticipated for the coming year.

Respectfully submitted,
Ronald E. Sharpin, Chairman

ANNUAL REPORT OF DINNER DANCE COMMITTEE, 1975-1976

The 14th Annual Dinner Dance was held at the 57 Restaurant on November 29, 1975. One hundred forty-four members and guests enjoyed the dinner and dance to the music of Baron Hugo's Orchestra.

The 15th Annual Dinner Dance has been scheduled at the same location for October 23, 1976.

Respectfully submitted,
Frank J. Cullati, Chairman

ANNUAL REPORT OF DISADVANTAGED YOUTH COMMITTEE, 1975-1976

General Information:

The 1975-76 BSCES Disadvantaged Youth Committee was composed of the following members:

Richard J. Scranton, Chairman
Leroy M. Cahoon
Walter J. Hickey
Robert F. Pelletier
Bruce Tobiasson

Activities:

The major activity of the committee during the past year has been continuation of a program begun last year by which "Disadvantaged Youth" would be employed by local civil engineering firms.

At the close of last year's activities, several job commitments had been obtained from Boston area firms. Entry level positions (but, with the promise of further development and commensurate advancement) were provided by the following firms and filled by candidates obtained by the committee:

Camp, Dresser & McKee, Inc.
CE Maguire Inc.
Chas. T. Main Inc.
Parsons, Brinckerhoff, Quade & Douglas, Inc.
Whitman & Howard Inc.

The candidates who filled these positions were located through the United States Veterans Administration and the Opportunities Industrialization Center of Boston (OIC). All five positions were obtained through the pilot program initiated last year during which our proposal was sent to ten firms.

Continuing this program during 1975-76, a modified proposal (see Enclosure #1) was sent to fifty-five additional civil engineering firms in the Boston area. Although support for our program was expressed by many firms, economic conditions prevented most from participating. The enclosure describes the history, design and rationale thoroughly. The following two firms, however, did agree to participate:

Badger Corporation
Schoenfeld Associates, Inc.

The Disadvantaged Youth Committee is seeking to provide candidates for these positions.

Comments:

The committee has recommended that BSCES attempt to establish a cooperating network of committees such as ours from the many local professional societies representing other engineering disciplines. By pooling committed job opportunities it appears possible for OIC to run a training program in basic technical skills for candidates, thus relieving some the present training burden from participating firms.

Respectfully submitted,
Richard J. Scranton, Chairman

(Editor's Note: the enclosures mentioned are not being published because of their volume, but copies may be obtained from the Chairman.)

ANNUAL REPORT OF JOHN R. FREEMAN FUND COMMITTEE, 1975-1976

The Committee, at its November 13, 1975 meeting, awarded Hunter Rouse the first Freeman Hydraulics Prize, $2,000, for his new book, *Hydraulics in the United States, 1776-1976.* Chapters of the book will be published in successive issues of the *Journal*, beginning with the April 1976 issue, and a hardcover edition of the entire book will be published by the Iowa Institute of Hydraulic Research in 1976.

Jonathan French's paper, *Flow Approaching Filter Washwater Troughs,* was given an Honorary Mention citation and is being published in the January 1976 *Journal.*

On November 18, 1975, the Society broadly distributed a Press Release announcing the award and the fact that Prizes will be considered every year for exceptional papers submitted and received by the end of June. Papers must concern hydraulic engineering. A thesis should be presented, its historic development traced, its theoretical basis explained, detailed practical examples of its application given, and pitfalls it might help to avoid cited. Originality is sought but superior presentation of the state-of-the-art is perfectly acceptable. Quality of illustration and editing is important.

The Committee is considering additional applications of the Freeman Fund revenue and seriously invites suggestions from Members and the profession at large.

Respectfully submitted,
Lee Marc G. Wolman, Chairman

ANNUAL REPORT OF HISTORY AND HERITAGE COMMITTEE, 1975-1976

At the start of the year, one site in our area had just been designated as a National Historic Civil Engineering Landmark, and two more were pending; the latter two have since been designated. The presentations for all three of these sites were the work of Simon Kirshen who stepped down from the chairmanship of the committee after many years of valuable service. Mr. Kirshen continued on the committee but passed away on October 23rd last.

On October 21, 1975, the Lawrence Experiment Station received the plaque marking it as a National Historic Civil Engineering Landmark at ceremonies attended by officials of the Commonwealth, ASCE and BSCES.

On April 1st, the presentation ceremonies for the Granite Railway will take place in Quincy, and on July 2nd at North Adams for the Hoosac Tunnel with ceremonies in which Canadian as well as ASCE and BSCES officials will participate. Gary S. Brierley of the Committee is in charge of arrangements relating to the Hoosac Tunnel.

For all three Landmarks, slide presentations are being prepared for ASCE to be part of its slide program on National Historic Civil Engineering Landmarks nationally.

Work has started on the nominations of additional important engineering sites in our area, in recognition of their significance in the history of civil engineering, but even more as a tribute to the eminent engineers who created these pioneering works.

Respectfully submitted,
H. H. Holly, Chairman

ANNUAL REPORT OF RALPH W. HORNE FUND COMMITTEE, 1975-1976

This is the Tenth Annual Report of the Ralph W. Horne Fund Award Committee which was formed in 1964 when the Boston Society of Civil Engineers received from Fay, Spofford & Thorndike, Inc., a grant of $3,000 to finance recognition of an individual member of the Society having been outstanding in unpaid public service in municipal, state or federal elective or appointive posts, or in philanthropic activity in the public interest.

Although the Award was publicized in the FORUM, no nominations have been received which meet all qualifications for the Award, in the opinion of the Committee. Therefore, the Committee has no recommendations to make for a recipient this year.

We urge that members of the Society come forward with nominations during the coming year.

Respectfully submitted
Harl P. Aldrich, Chairman

ANNUAL REPORT OF INTERSOCIETY COMMITTEE ON ENGINEERING PROFESSIONALISM, 1975-1976

This committee was active for the first part of the year. It accepted National ASCE's standard grade descriptions for engineering personnel which are compatible with those of the US Department of Labor Bureau of Labor Statistics (BLS) and the National Society of Professional Engineers (NSPE). Work toward such a standardization was initiated by our group in 1974 through the efforts of R. Lawrence Whipple, now of National ASCE, a former member of this committee.

In March 1975, a state agency issued a letter to engineering firms stating that cost-of-living salary adjustments to personnel on cost plus contracts would not be approved. In practice this denied the right of consultants to give merit increases. The policy inhibited the program of this committee to implement a schedule of improved salary levels adopted and recommended by the American Society of Civil Engineers and National Society of Professional Engineers. Both of the national organizations supported the activities of this section.

As a result, the efforts of this committee came to a complete halt and very little activity followed. Many firms and agencies formed groups to overturn the "no-raise" policy, but to no avail. The committee is planning to reorganize and try to exert proper influence so that the proposed program of engineers' compensation can be realized.

Respectfully Submitted,
Bertram Berger, Chairman

ANNUAL REPORT OF THE INVESTMENT COMMITTEE, 1975-1976

During the past year no changes in the securities owned by the Section have been made. An interest bearing account has been opened for us by the custodian for the deposit of cash income from the securities. The Boston Safe Deposit and Trust Company continues to be custodian of our account.

Following the recommendation of the Investment Management Review Committee, the membership of the Investment Committee has been increased to five. The other recommendations of the Review Committee should be followed during the coming year.

Respectfully submitted,
Joseph F. Willard, Chairman

ANNUAL REPORT OF JOURNAL EDITOR, 1975-1976

As stated in an announcement in the *Journal* issue of April 1975, there was no issue bearing the date of January 1975. Hence, Volume 62 started with the issue of April 1975 and continued with the issues of July and October 1975 and January 1976. Volume 63 will start with the issue of April 1976.

I started work as your new editor with the July 1975 issue, and still have much to learn about the business. I would appreciate suggestions about general appearance, format, type face, etc.

Solicitation, review, and acceptance of technical papers is a concern of the Technical Groups and of the Publications Committee. I think we can all take pride in the quality of papers being published, but efforts must continue to keep them coming.

We hope soon to begin installment publication of the book-length paper that won the John R. Freeman prize award in 1975. Another new idea that we are trying to work out is the publication of a membership directory.

As of the April 1976 issue we shall have had three cancellations of professional cards in the last year (out of 51) and the loss of one and one-quarter pages of other advertising (out of five) without any replacements. Subscriptions from non-members are holding even at about 300.

Respectfully submitted,
Edward C. Keane

ANNUAL REPORT OF KEY MAN COMMITTEE, 1975-1976

The Key Man Committee acts as a rapid line of communication between the Society and its members in local firms. Its primary purpose is to remind members of upcoming meetings or events of the Society.

At present there are 65 firms or institutions with key men tied into the committee and the effectiveness in boosting attendance at society functions appears to be quite satisfactory.

Respectfully submitted,
Donald F. Dargie, Chairman

REPORT OF BSCES REPRESENTATIVE TO THE MASSACHUSETTS CONSTRUCTION INDUSTRY COUNCIL

The MCIC organized a task force to study the reasons for poor economic growth of the construction industry in Massachusetts. Specifically, the funds available for projects were to be identified, along with any bottlenecks which prevented the projects from moving ahead at a reasonable rate.

The task force was broken up into a number of committees. The writer was appointed chairman of the committee to study funding of Environmental Protection Agency (EPA) projects.

Our committee identified approximately $400 million dollars of unobligated EPA funds which would have to be obligated by September, 1977, or the state would lose the money. There are more than enough projects available to use the funds, however, plans must be devised to insure that all phases of these projects move along as rapidly as possible. The state has adopted a priority list of projects, also back-up projects. Monitors were assigned to the projects in order to track their progress.

Recommendations made by our committee relative to reducing the bottlenecks on the projects were:

1. Action must be taken to reduce the time used by state and EPA personnel to review and approve the projects.
2. The state is deficient in manpower required to carry out the necessary reviews and should increase the staff.

3. We concurred with the establishment of a priority list of projects, and monitors to keep them moving.

Respectfully submitted,
Warren H. Ringer
BSCES Representative to MCIC

ANNUAL REPORT OF MEMBERSHIP COMMITTEE, 1975-1976

The Membership Committee focused its efforts during this year on executing the dual membership program developed by the merger of BSCE with Massachusetts Section ASCE.

The admission of applicants as affiliate members, although allowed by the BSCES Constitution, has stirred concern within the Board of Government. In order to encourage all applicants to become members of National, the membership Committee Chairman has been directed by the Board of Government of BSCES to ask each affiliate applicant if he or she has considered joining ASCE, prior to recommending an affiliate Membership Application.

No active membership drive was undertaken. Applicants were either references from National or had obtained applications on their own initiative from BSCES headquarters.

A section membership promotional program, such as an "office rep" campaign, should be developed during this coming year.

Respectfully submitted,
Paul J. Bourque, Chairman

ANNUAL REPORT OF NEW QUARTERS COMMITTEE, 1975-1976

Earlier this year the Boston Society of Civil Engineers Section combined its office staff with that of the Consulting Engineers Council of New England. This resulted in a saving of $3,000 to $5,000 per year on operating costs of the two organizations. Also it provides complete coverage of the offices by a full time secretary and the Executive Director.

Over the last six months BSCES-CECNE representatives have been meeting with the Mass. Society of Professional Engineers staff with a view to combining quarters. The organizations have requested from their respective building managements proposals on future rentals, cost of building services, improvements, etc., length of leases, escalation clauses, etc., for rental space almost doubling what each now occupies (approximately 2000 S. F.). Also it has made contact with other building managers within the city. The committee is hopeful that this might be the beginning of centralizing many engineering society operations in one location.

Respectfully submitted,
Bertram Berger, Chairman
Charlotte Dalrymple, BSCES Executive Director

ANNUAL REPORT OF NEWSLETTER COMMITTEE, 1975-1976

During the past year, quarterly publication of the newsletter *The FORUM* was continued; however, one was a joint issue. Issues published since the previous annual report were as follows:

Volume	Number	Number of Pages	Date
6	2 & 3	12	April/July 1975
6	4	6	November 1975
7	1	12	February 1976

The Newsletter Editorial Board consisted of Peter J. Riordan, Editor, and David H. Treadwell, Lewis Edgers, Thomas A. Joyce, Robert M. Fitzgerald and Paul Bourque, Contributing Editors.

The complete publication of the FORUM was handled by Copley Business Service, Inc., Boston for all issues. This included typesetting, composition, printing, and mailing. These services were provided in an expeditious manner.

Messrs. Bourque, Joyce, and Fitzgerald will continue as members of the Editorial Board for the coming year and Mr. Bourque has been recommended as Editor and Chairman of the Newsletter committee. It is considered essential however that new members be appointed to the Board to assist Mr. Bourque for the coming year.

Respectfully submitted,
Peter J. Riordan

ANNUAL REPORT OF NOMINATING COMMITTEE, 1975-1976

The 1975 - 1976 Nominating Committee carried out its business for the year in meetings on August 8, 1975 and January 22, 1976 and through continuing telephone conferences and correspondence throughout the year. The Committee acted on endorsement of six nominees for National Committees, nominations for the 1976 - 1977 BSCES slate of officers, and preparation of papers for submittal next year of a nominee for ASCE Honorary Membership. Edward B. Kinner was nominated to replace Lee N. Worth in the position of Secretary of BSCES. Mr. Worth resigned his office because of his move to Texas.

The Committee's endorsements were as follows:

National Committees

Thomas K. Liu	Programs for Professional Sessions
Ronald C. Hirschfeld	Interchange Between Education and Practice
Richard Scranton	Student Services
Henry Poydar	Technician and Technology Education
Joseph D. Guertin	Registration of Engineers
Charles A. Parthum	Standards of Practice

For BSCES 1976 - 1977 Officers

President:	Bertram Berger
Vice-President:	Howard Simpson (2 yr)
Secretary:	Edward B. Kinner
Treasurer:	Saul Namyet
Director:	Maurice Freedman (2 yr)
Director:	Frank Perkins (2 yr)

For Nominating Committee

Peter J. Riordan
Rubin Zallen
John Christian
Kenneth Leit
Leo Peters
Saul Cooper

The 1976 - 1977 Nominating Committee will be comprised of the following individuals:

Charles A. Parthum
Thomas K. Liu
Max D. Sorota
Ronald C. Hirschfeld
Steve J. Poulos
R. Lee Dye
Rodney Plourde

(Plus three new members to be elected in the Spring of 1976)

For the Committee,
Joseph D. Guertin, Jr. Clerk

ANNUAL REPORT OF THE PROGRAM COMMITTEE, 1975-1976

This was the second year the Program Committee functioned. This committee coordinates the activities of the Technical Groups and other special committees regarding meeting dates; joint meetings with technical groups, other societies and agencies; expenditures; and committee reports.

The committee is also responsible for the activities of the following:

Key Man — Chaired by Donald F. Dargie
Dinner Dance — Chaired by Frank J. Cullati
Clambake Committee — Chaired by David L. Freed
Annual Meeting Committee — Handled This Year by BSCES Office.

The Program Committee activities this past year were productive. The Technical Group meetings functioned as scheduled with little conflict with other societies and groups. Besides the regular Technical Group meetings which were scheduled meetings every Wednesday, the following additional lectures and meetings were held:

- Environmental Group: 12-Lecture Series on "Wastewater Treatment and Disposal."
- BSCES: 11-Lecture Series, "Professional Engineers Refresher Course."
- BSCES, Co-sponsor with Boston Transportation Group: May 15, 1975, "Transportation for Handicapped and Disadvantaged."
- BSCES, Co-sponsor with Others: September 22, 1975, a Course on "Cost Engineering."
- BSCES, Co-sponsor with Engineering Societies of New England and Other Societies: December 4, 1975, "Engineering Careers Night."
- BSCES: December 5, 1975. Participated in seminar on "Massachusetts Growth and Development" (Chairman Maurice Freedman).
- Geotechnical Group, Co-sponsor with Association of Engineering Geologists: February 12, 1976, "Geotechnical Group Forum."
- BSCES, Co-sponsor with MIT: February 19, 1976, "Mathis Memorial Lecture."
- BSCES, Co-sponsor with ESNE, MSPE and Other Societies: February 26, 1976, Seminar on "American Ingenuity" at Engineer's Week Luncheon.
- BSCES, Co-sponsor with BTG and American Insitute of Planners: April 8, 1976, Seminar at Pier 4 on "Paratransit and Demand-Responsive Systems."

A successful clambake and a dinner dance were held, as reported elsewhere.

This year, as in the past, the Key Man Committee came to the rescue of scheduled but undersubscribed meetings. This committee has been the salvation of many meetings where the mailed notices did not generate enough response.

Respectfully Submitted,
Bertram Berger, Chairman

ANNUAL REPORT OF PUBLICATIONS COMMITTEE, 1975-1976

The following is the Annual Report of the Publications Committee, April 1975 to March 1976.

Papers Received	10
Papers Rejected	2
Papers Accepted, Published or in Press	5
Papers Under Review	3

Volume 62 of the *Journal* contained seven technical papers, one presidential address, a copy of the Constitution and Bylaws of the BSCES/ ASCE, two memorials, and the usual proceedings and annual reports.

It appears that the number and general quality of papers submitted for publication in the JOURNAL are not consistent with the overall excellent level of activity of the Technical Groups. If the JOURNAL is to continue to have technical merit, members of the Technical Groups will have to make a greater effort to solicit papers, especially from speakers at their meetings. However, papers do not have to be presented before the Section to be eligible for publication. Moreover, the Board of Government has agreed to publish as a Committee Report the text of reports and recommendations made by any Technical Group or task committee to a public agency so that an official record will be made of the transaction.

Respectively Submitted,
Charles C. Ladd, Chairman

ANNUAL REPORT OF THE STUDENT CHAPTER COMMITTEE, 1975-1976

The Student Chapter Committee, under the leadership of Chairman, Stan Rossier had a very successful year as evidenced by this report and the copies of the notes of meetings. Committee members included:

Daniel Donahue
Lewis Edgers
Daniel Maciborski
Richard Scranton
Stanley Rossier
Paul Trudeau
Mark Zuberek

In addition to regular business which includes Student Awards, Student Loans and correspondence with the ASCE Student Chapters in Massachusetts, the Committee sponsored a Student Chapter Caucus on November 4, 1975 at MIT, and a Student Night dinner meeting at the University of Lowell on February 26, 1976.

The Student Chapter Caucus drew together over 30 representatives from eight of the nine Student Chapters in the BSCES area. Dr. Ronald Hirschfeld, past President of the Massachusetts Section of the ASCE presented a talk entitled "Why ASCE?". Dr. Hirschfeld concluded that the main reason for ASCE Student Chapters is to provide communication between the students and the profession. His presentation touched on many items that the Student Chapter could undertake and contained much fuel for thought for the discussion period which followed.

Communication was the theme and the goal of this first Student Chapter Caucus, and communication was attained, at least in terms of introducing the students to the Student Chapter Committee, and through us, the Boston Section. The Caucus made the Student Chapters aware of the existence of the Boston Section and an easy route (i.e. the Student Chapter Committee) for tapping some of its resources for Student Chapter activities. The Student Chapters were informed that articles regarding Chapter activities could be published in the *Forum,* the newsletter of BSCES/ASCE, as a means of communicating successful Chapter activities to each other and to the profession. Northeastern University has already taken advantage of this suggestion as evidenced by the article, "Community Awareness Among Northeastern University Civil Engineers", published in the March 2, 1976 issue of the *Forum.* The Student Chapter Committee hopes to see similar articles published from the Student Chapters in the future.

The Committee also sponsored a Student Night dinner at the University of Lowell on February 26, 1976. Stan Rossier presented the *BSCES Student Awards* for 1975 to the following persons:

Kenneth M. Strzepek	Massachusetts Institute of Technology
Charles N. Faulstich	Merrimack College
John Driscoll	Northeastern University - Div. A

Arthur Franz	Northeastern University - Div. B
Lawrence A. Kaner	Southeastern Mass. University
Michael C. Loulakis	Tufts University
Richard A. Randlov	University of Lowell
Richard A. Hassett	Wentworth Institute
Robert Medeiros	Worcester Polytechnic Institute

Charles Parthum, President of BSCES, presented the *1976 BSCES Student Loans,* consisting of $1,000 each, to David R. Jones and Keat Soon Chew, both members of Northeastern University's Student Chapter. Mr. Parthum also presented the *BSCES Scholarship in Memory of William P. Morse* to Cornelius P. Cronin, Jr. of Tufts University, and the *BSCES Scholarship in Memory of Desmond Fitzgerald* to David J. Crispin and David E. Deans of Northeastern University. John Cusack, ASCE District Director, presented the ASCE *Daniel Mead Award* to Michael C. Loulakis of Tufts.

"Unionism and Civil Engineers" was the topic of the principal speaker at Student Night. Nearly 200 students and engineers travelled to Lowell to hear Mr. Robert L. Patterson of Stone & Webster Management Consultants, Inc. speak on this controversial subject. The essence of the speech was that civil engineers should look not toward unions, but rather to develop a stronger professional association to represent civil engineers, for example, ASCE. Mr. Patterson pointed out clearly that in a union, civil engineers would lose their individuality. Mr. Patterson answered questions from the audience, and in some instances, solicited help from ASCE members in the audience in responding. It is at the point that the Student Chapter Committee feels they should express concern over the unfavorable image of ASCE which was presented to the students at Student Night by representatives of ASCE National. In their responses to student's questions regarding ASCE policies, they appeared defensive, unbending in their views, and unwilling to accept suggestions. The Student Chapter Committee feels that a more enlightened, concerned, and responsive attitude should be fostered. It must be remembered that representatives of ASCE national are rarely encountered by students. The Student Chapter Committee is attempting to open channels of communication with the civil engineering students, and the performance of supposedly well informed ASCE personnel that those of us at Student Night witnessed can only serve to close them.

In 1976 the Student Chapter Committee hopes to sponsor another Caucus in early fall, followed by a meeting or meetings in which a panel of representatives of ASCE national would be available to answer questions about, and hopefully interest students in, ASCE.

Respectfully submitted,
Paul Trudeau - Secretary
Student Chapter Committee

ANNUAL REPORTS OF TECHNICAL GROUPS

ANNUAL REPORT OF COMPUTER GROUP, 1975-1976

The Computer Group held four meetings during the current year. All of the meetings were held at the Ralph M. Parsons Laboratory for Water Resources and Hydraulics, M.I.T., and were called to order by the Chairman, Jekab Vittands.

October 1, 1975 — The guest speaker was Mr. Richard T. Rigby of Metcalf & Eddy, Inc. Mr. Rigby spoke of his experience on a project for the New Haven Parking Authority involving the application of a minicomputer as the central control element in a real time parking revenue system. The project involved the design of a control system to serve five separate parking facilities in downtown New Haven in which traffic would be controlled, revenues accounted for, and records on traffic and revenue generated.

November 19, 1975 This was also an official meeting of the BSCE Section. Mr. Robert Kinner, Section Secretary, announced the designation of two new National Historical Civil Engineering Landmarks: the Middlesex County Canal and the Lawrence Experiment Station. The guest speakers were Mr. Kenneth Goff and Mr. Steve Lyons, both of the Stone & Webster Engineering Corporation. Mr. Goff spoke on the various ways in which a computer system with a centralized data base and user access through terminals is used to assist in the management of projects. The techniques used include the use of historical data, the use of "fill-in" reports, exception reporting, and both graphical and COM generated reports. Mr. Lyons discussed the use of microfilm techniques and computerized indices for the documentation of large projects, such as a checklist of required documents, retention periods, lists of documents received, and procedures for the receipt of documents. Attendance, 20.

February 4, 1976 — The topic was the selection of computer hardware by engineering firms. The speakers were Mr. Larry Vance of Fay Spofford & Thorndike, Mr. John McCormack of Camp Dresser & McKee, and Mr. Neal Mitchell of Mitchell Systems, Inc. Mr. McCormack spoke of CDM's attempts to define the system requirements for a new computer to replace their overworked IBM 1130. Mr. Vance outlined the evolution of the IBM 1130 at FST from a minimum configuration machine to a large core, large capacity disk system involving multiple vendors. Mr. Mitchell talked of the use of WANG 2200's (5 systems) for a broad spectrum of engineering and office management functions in his organization. Attendance, 18.

March 3, 1976 — The final meeting of the year. Officers for 1976-1977 were elected, as follows:

Chairman	Lewis H. Holzman
Vice Chairman	James N. Jackson
Clerk	Salvatore Mazzotta
Member Executive Committee	Robert A. Wells, Jr.
Member Executive Committee	Joseph F. Willard
Member Executive Committee	Jekabs P. Vittands

The speaker for the evening was Mr. Robert Wells of Multisystems, Inc. Mr. Wells spoke on the subject of computerized graphical information systems and described the GRAPHITI system developed by his firm for computer aided drafting. It currently runs on a Digital Equipment PDP 11/70, though it has been designed to be machine independent. The system incorporates the concept of merging several independently prepared drawings, such as a floor plan, plumbing layout, and duct layout. Attendance, 15.

Respectfully submitted,
James N. Jackson, Clerk

ANNUAL REPORT OF THE CONSTRUCTION GROUP, 1975-1976

The Executive Committee this year consisted of the following:

Chairman	Laimonis Rieksts
Vice Chairman	Renwick Chapman
Clerk	Norman Bennett
Member	Samuel E. Rice, 3rd
Member	Joseph B. Kerrissey, Jr.
Member	Frank J. Killea, Jr.

The construction group held the following meetings during the past year:

November 5, 1975 — A luncheon meeting was held at the Red Coach Grill, Stanhope Street, Boston, Mass. with 35 persons in attendance. Mr. James Roop of Franki Foundation Company spoke on "Slurry Wall Foundation for 60 State Street Office Building".

January 14, 1976 — A luncheon was held at the Red Coach Grill, Stanhope Street, Boston, Mass. with 45 members and guests in attendance. Mr. Bruce Boleyn of RESCO, a joint venture of DeMatteo Construction Company and Wheel Abrator-Frye, Inc., spoke on the operation of a plant for extracting energy from solid waste.

February 18, 1976 — This was also an official BSCES meeting. It was held at the Red Coach Grill. Mr. Edward Kinner, Secretary of BSCES, was introduced and conducted the official business portion of the meeting. The guest speaker, Mr. Dave Malone, Chief Estimator for Perini Corporation spoke on the procedures used to prepare a joint venture bid for a heavy construction project. Twenty-eight members and guests attended.

March 10, 1976 — A joint meeting with the Geotechnical Group was held at Pierce Hall, Harvard University. There were approximately 35 members in attendance. Mr. Joseph Healey, Project Manager Perini North River Associates, spoke on the construction of the first phase of the North River Pollution Control Project.

The following officers were nominated for 1976-1977. Elections will be held at the first regular business meeting in the fall.

Chairman	Norman Bennett
Vice Chairman	John Sullivan
Clerk	Steve Walker
Member Executive Committee	Laimonis Rieksts
Member Executive Committee	Samuel E. Rice, 3rd
Member Executive Committee	Joseph B. Kerrissey, Jr.

Respectively submitted,
Norman Bennett, Clerk

ANNUAL REPORT OF THE ENVIRONMENTAL GROUP, 1975-1976

The Executive Committee this year consisted of the following members:

Chairman:	Leo F. Peters
Vice-Chairman:	Paul A. Taurasi
Clerk:	Frederic C. Blanc
Members:	Clifford W. Bowers
	Peter B. Knowlton
	Warren H. Ringer
	Benjamin J. Fehan

The Environmental Group will have held three meetings during the 1975-1976 year as follows:

June 4, 1975 — This meeting was the annual outing which consisted of a tour of the Medfield Wastewater Treatment Plant. After the field inspection the group met at Cornetta's Iron Horse Restaurant in Norwood. Mr. Eliot F. Tucker of Weston & Sampson Engineers gave a presentation on the design and construction of the Medfield facility. Attendance, 35.

November 12, 1975 — The Environmental Group met at the Playboy Club in Boston. Mr. Gerald Conklin of Dufresne and Henry Engineering was the speaker (substituting for Mr. M.A. Donnelly of the same firm). Mr. Conklin presented a lecture titled "Changes in Sewer System Evaluation Surveys" in which he gave the audience an overview of methods and procedures for conducting infiltration and inflow studies and sewer evaluation surveys. Attendance, 32.

March 31, 1976 This meeting will be held at Purcell's Restaurant in Boston. Mr. William H. Parker III and Mr. James Atwell of the Edward C. Jordan Co., Inc. will be the speakers. The topic is "A Leachate Control Program for Saco, Maine".

This is the annual meeting for the Environmental Group. The Nominating Committee of the Environmental Group has placed in nomination the following names for the Executive Committee for the coming year to be voted at this meeting:

Chairman	Paul A. Taurasi
Vice-Chairman	Frederic C. Blanc
Clerk	Clifford W. Bowers
Member	Peter B. Knowlton
Member	Warren H. Ringer
Member	Benjamin J. Fehan

(Later note: Attendance was 30 at above meeting.)

During the winter of this year the Environmental Group is conducting the "Thomas R. Camp Lecture Series on Wastewater Treatment and Disposal". Some 167 registrations were received for the entire series and the attendance at individual lectures has varied from 41 to 144 persons. The following dates, topics and speakers comprised this series:

Lecture #1:	Tuesday,	January 13, 1976
	Subject:	Comparison of Air and Oxygen Activated Sludge Systems
	Speaker:	A.A. Kalinske, Vice President Camp, Dresser, & McKee, Inc.
Lecture #2:	Tuesday,	January 20, 1976
	Subject:	Pretreatment of Industrial Wastes
	Speaker:	Brian L. Jeans, Chief Operations & Maintenance Municipal Treatment Plants Mass. Division of Water Pollution Control
Lecture #3:	Tuesday,	January 28, 1976
	Subject:	Treatment of Wastes by Contact with Natural Soil Systems
	Speaker:	William J. Bauer, Chairman Bauer Engineering, Inc. Chicago, Illinois
Lecture #4:	Tuesday,	February 3, 1976
	Subject:	Nitrogen and Phosphorous Removal
	Speaker:	Dr. Richard L. Woodward, Vice President Camp, Dresser, & McKee, Inc.

Lecture #5:	Tuesday,	February 10, 1976
	Subject:	Fundamental Principals and Mechanics of Gravity Sludge Thickening
	Speakers:	Dr. Donald Dean Adrian Department of Civil Engineering University of Massachusetts Peter Kos Environmental Technology Specialist Dorr-Oliver, Inc.
Lecture #6:	Tuesday,	February 17, 1976
	Subject:	Heat Treatment and Incineration of Wastewater Sludge
	Speaker:	Guerin E. Carlson Whitman & Howard, Inc.
Lecture #7:	Tuesday,	February 24, 1976
	Subject:	Disposal of Hazardous Wastes and Waste Oil
	Speaker:	Donald L. Corey, P.E., General Manager Montvale Laboratories, Inc.
Lecture #8:	Tuesday,	March 2, 1976
	Subject:	Chemical Stabilization of Sludge
	Speaker:	Dr. Tsuan Hau Feng Department of Civil Engineering University of Massachusetts
Lecture #9:	Tuesday,	March 9, 1976
	Subject:	Utilization of Activated Carbon for Wastewater Treatment
	Speaker:	Dr. John J. Cochrane Department of Civil Engineering Northeastern University
Lecture #10:	Tuesday,	March 16, 1976
	Subject:	Filtration of Wastewater
	Speaker:	Stephen L. Bishop, Vice President Metcalf & Eddy, Inc.
Lecture #11:	Tuesday,	March 23, 1976
	Subject:	Instrumentation and Control of Wastewater Treatment Facilities
	Speakers:	Walter H. Brown, J. Richard Feibleman, Jon M. Currie, Keith D. Pigney Instrumentation Department Metcalf & Eddy, Inc.
Lecture #12:	Tuesday,	March 30, 1976
	Subject:	Control and Treatment of Combined Sewer Overflows
	Speaker:	Richard Field Chief, Storm and Combined Sewer Section A.W.T. Research Laboratory Environmental Protection Agency Edison, N.J.

Respectfully submitted,
Frederic C. Blanc, Clerk

ANNUAL REPORT OF THE GEOTECHNICAL GROUP, 1975-1976

The following are the officers of the Geotechnical Group for the 1975-1976 year:

Stiles Stevens	Chairman
William Zoino	Vice Chairman
Peter Taylor	Clerk
David Thompson	Member
Alton Davis	Member
Allen Gass*	Member

*Allen Gass resigned due to leaving the Boston area.

The group held the following meetings during the past year:

May 14, 1975 — Underplanning foundations — A presentation by three speakers: Mr. James Nelson of Spencer, White and Prentis; Dr. F. A. Baris of Warren - Fondedele; and Mr. George Tamaro of ICOS. Moderator, Eric O'Neill of Franki Foundation Company.

October 22, 1975 — Evaluation of Several Geotechnical Parameters. A lecture by Professor T. W. Lambe, Massachusetts Institute of Technology. Attendance 80. This was a joint meeting with the main society.

December 10, 1975 — Design and Construction of Tarbela Dam in West Pakistan. A lecture by Mr. Kalman Szalay, Tippets-Abbett-McCarthy-Stratton Engineers Inc.

January 21, 1976 — Loss Prevention Programs for Consulting Engineers — A lecture by Mr. William L. Shannon of Shannon and Wilson, followed by a panel discussion. The panel consisted of Mr. Charles Parthum, Mr. William McTigue and Mr. Woodrow Wilson. The moderator for this meeting was Mr. William Zoino. This was a joint meeting with the Action Program Committee.

February 12, 1976 — Remote Sensing Technique for Hydrology and Site Selection — A presentation in three parts by Mr. Gerald Moore, U.S.G.S. Sioux Falls Data Center, Mr. Leo Eichen, Dames and Moore, and Dr. Stephen Alsup, Goldberg-Zoino. The meeting Chairman was Mr. J. Guertin. This was a joint meeting with the New England Chapter, Association of Engineering Geologists.

March 10, 1976 — North River Pollution Control Project. A lecture by Mr. Joseph Healy, Project Manager, Perini North River Association. This was a joint meeting with the Construction Group.

A lecture series committee under the Chairmanship of Stanley Rossier has developed a program for the fall of 1976 on the subject of lateral earth pressures. The committee consists of the following:

Stanley Rossier, Chairman	Herbert Einstein
Robert Vallee	Lewis Edgers
William Roberds	Richard Simon
Walter Jaworski	John Sewall
Douglas Gifford	Robert D'Andrea
Alton Davis	Peter Wroth
Asaf Qazilbash	

Based on attendance at recent meetings, it has become evident that our meeting announcements are not reaching non-members in the construction industry. It is recommended that consideration be given to some method of informing this potentially large audience of coming meetings.

Respectfully,
Peter K. Taylor
Clerk

ANNUAL REPORT OF THE HYDRAULICS GROUP, 1975-1976

The following meetings were held during the past year:

November 25, 1975 — Guest speakers Mr. Richard Reardon and Mr. Stephen Parker of the U. S. Army Corps of Engineers made a joint presentation of the Dickey-Lincoln School Lakes Hydroelectric Project. The talk dealt with the origin, features and power scoping studies of the Project. The meeting was held at the Ralph M. Parsons Laboratory at MIT. Attendance: 41.

January 29, 1976 — This scheduled meeting was not held due to severe illness in the speaker's family. Because this situation developed at the last minute, no alternate speaker could be had. The intended speaker, Mr. James T. Price of the Water Systems Development Branch of TVA, was to speak on Impact of Dam Failures on Nuclear Power Plants.

This unfortunate situation illustrated the desirability of scheduling alternate speakers for the intended talk whenever possible. Every effort will be made in the future to effect this.

February 25, 1976 — Guest speakers Mr. Thomas Baron of the Metropolitan District Commission and Mr. William Howard of Camp, Dresser and McKee gave a presentation on the Metropolitan Boston Water Transmission and Distribution Study. The talk included a discussion on the design criteria for the system, and elaborated on the development of a computer simulation model for the entire MDC water system, and its application in evaluation of the existing system adequacy, as well as developing future needs. The meeting was held at the Ralph M. Parsons Water Resources Laboratory at MIT. Attendance: 20.

March 24, 1976 — This meeting was the official BSCES meeting for the month of March. Nominations and election of officers of the Hydraulics Group for the 1976-77 term were held. The results were as follows:

Chairman	Edward Dunn - CE Maguire, Inc.
Vice Chairman	William Darby - Northeastern University
Clerk	Thomas Doucette - Mass. Water Resources
Executive Committee Members	Richard DiBuono - Corps of Engineers
	Reynold Hokenson - Chas. T. Main Inc.
	Oscar Donati - Corps of Engineers

Mr. Edward Kinner, Secretary of BSCES, made announcements concerning activities and business of the Society. His announcements included mention of the ASCE public information film to be presented on TV and the scheduled dedications of Civil Engineering Landmarks.

The presentation for this evening was given by Mr. Jack C. Howe, Project Mechanical Engineer of Chas. T. Main, Inc. The subject was Electric System Planning for Pumped Storage Hydroelectric Power. The talk covered the criteria for a pumped storage site, the studies undertaken to optimize the amounts of installed power and storage capacity of a pumped storage development, and the electric system operating advantages of pumped storage over other kinds of peaking power plants. The meeting was held at the Ralph M. Parsons Water Resources Laboratory at MIT. Attendance: 24.

Respectfully submitted,
Edward P. Dunn
Clerk

ANNUAL REPORT OF THE STRUCTURAL GROUP, 1975-1976

The Executive Committee this year consisted of the following members:

Chairman	Hans William Hagen
Vice Chairman	Lawrence H. Ogden
Clerk	Frank J. Heger
Member, Executive Committee	Frank Davis
Member, Executive Committee	Richard Foley
Member, Executive Committee	Kentaro Tsutsumi

The following meetings were held by the Structural Group:

April 8, 1975 — Dr. Mark Fintel, Director of Engineering Services, Portland Cement Association, spoke on Earthquake Design of High Rise Concrete Structures. He compared the performance of shear wall structures and frame structures in recent earthquakes, and briefly presented the current theories of design and research programs being sponsored by the PCA. The meeting was held at MIT's Center for Advanced Engineering Studies. Attendance 100.

October 15, 1975 — Mr. E. Alfred Picardi, Senior Vice-President and Director of Perkins & Will in Washington, D. C., presented the 1975 T. R. Higgins lecture of AISC at MIT's Center for Earth Sciences. Mr. Picardi described a unique structural system which he conceived and implemented with his team of engineers and a support group at MIT in the design of the Standard Oil of Indiana Building. The system features new design concepts and details that resulted in economy in the weight, fabrication, and erection of the structural steel for the 89-story building. Attendance 80.

December 17, 1975 — Mr. Marvin Mass, PE, Senior Partner, Consentini Associates, New York, Chicago, and Cambridge, spoke on the influence of mechanical, electrical and plumbing systems on structural design. He briefly presented the requirements of these systems and indicated some of the problem areas confronting the building design team. The meeting was held at MIT's Center for Advanced Engineering Studies. Attendance 17.

February 11, 1976 — A panel discussion on Quality Control in Construction was presented at the MIT Center for Advanced Engineering Studies. The panel consisted of Panel Moderator, Mr. Frank Davis, Sales Manager, West End Iron Works; Mr. Rubin M. Zallen, Principal, Rubin M. Zallen Associates, representing the consulting engineer; Mr. Phillip R. Jackson, President and Secretary, Jackson Construction Co., representing the contractor; and Mr. Ara Shrestinian, Vice-President, Thompson & Lichtner Co., representing the inspection agency. Each panel member presented a ten minute outline of how its profession attempts to achieve quality construction. Attendance 25.

April 7, 1976 — A "Structural Specification Critique" was held at the Spofford Room, MIT. Moderator, Richard A. Foley. Panelists, Richard Johnson of A. O. Wilson Structural Company, Herman G. Protze of Herman G. Protze, Inc., and Walter Rosenfeld, Jr. of the Architects Collaborative.

This was the annual meeting of the Group. Officers for 1976-1977 were elected, as follows:

Chairman	Kentaro F. Tsutsumi
Vice Chairman	Frank J. Heger
Clerk	Franklin B. Davis
Members, Executive Committee	Richard A. Foley
	James M. Becker
	Kenneth B. Wiesner

Besides the regularly scheduled meetings, the Structural Group, in cooperation with the Massachusetts Institute of Technology, also sponsored an Earthquake Design Lecture Series which was held at MIT. The series of seven lectures dealt with the practical nature of earthquake design with special emphasis on the application of the seismic provisions of the 1975 Massachusetts State Building Code. Approximate attendance was 300. The lectures are briefly described below.

October 21, 1975 — Prof. Kentaro Tsutsumi, Professor of Civil Engineering, Tufts University, described the various responses of buildings to seismic forces and how to apply the Building Code provisions when analyzing a structure.

October 28, 1975 — Dr. Frank J. Heger, Principal, Simpson Gumpertz & Heger Inc., spoke on the general behavior and response of regular reinforced and post-tensioned cast-in-place concrete systems to earthquake forces and some of the detailing necessary to achieve ductility in the structure.

November 4, 1975 — Prof. José M. Roesset, Professor of Civil Engineering, Massachusetts Institute of Technology, lectured on the dynamic analysis of structures and gave examples of when and how to use dynamic analysis in building design.

November 12, 1975 — Prof. Robert V. Whitman, Professor of Civil Engineering, Massachusetts Institute of Technology, discussed soil properties and how they affect the design of foundation systems and the structure as a whole.

November 18, 1975 — Mr. Henry J. Degenkolb, President, H. J. Degenkolb & Associates, Engineers, described the general behavior and response of structural steel systems to earthquake and how to determine applicable design criteria and proceed with the design of structural steel systems.

November 25, 1975 — Mr. James E. Amrhein, Director of Engineering, Masonry Institute of America, spoke on the various types of masonry systems, their behavior and response to earthquake forces, and the criteria required for design of masonry structures.

December 2, 1975 — Mr. Robert F. Mast, President, ABAM Engineers, Inc., presented the effects of seismic forces on prefabricated construction systems such as precast/prestressed concrete and how to design these systems to resist those forces.

In addition to the above meetings the Executive Committee met on several occasions to discuss the Massachusetts Construction Industry Board's "Recommended Regulations for the Control of Structural Work During Construction", and to organize the above-mentioned Earthquake Design Lecture Series.

Respectfully Submitted,
Frank J. Heger, Clerk

ANNUAL REPORT OF THE TRANSPORTATION GROUP, 1975-1976

The following is a synopsis of the Transportation Section's activities over the past 15 months. In previous years, the Transportation Section's officers served from January to January as opposed to the April to April term of the other sections. Effective this year, the term of our officers will be in conformance with the other sections.

February 19, 1975 — Annual meeting and election of officers; also an official meeting of BSCES. Chairman Rodney Plourde turned the gavel over to Bertram Berger, Vice President of

BSCES, for the purpose of conducting a vote on proposed By-law amendments. The vote was unanimous in favor of these amendments.

Mr. Plourde then took back the gavel and received nominations of officers for the 1975-1976 term. The following slate was nominated and elected unanimously:

Chairman	Maurice Freedman
Vice Chairman	Marvin W. Miller
Clerk	Robert J. McDonagh
Member	A. Russell Barnes, Jr.
Member	Leo F. DeMarsh
Member	Donald M. Graham
Member	Rodney P. Plourde

The guest speaker was Mr. Frederick R. Salvucci, Secretary of the Executive Office of Transportation and Construction. The subject of Mr. Salvucci's remarks was "The Future Transportation Policies of Massachusetts." This meeting took place at Nick's Restaurant. Attendance 92.

March 4, 1975 — Executive Committee Luncheon held at Kevin's Wharf. Plans and policies for the coming year were discussed and prepared.

March 19, 1975 — This was a combined meeting with the Computer Group. The Computer Group used this time to conduct its election of officers.

The subject of the meeting was "Computerized Systems - Highway Surveillance/Street Traffic Control." Chairman Maurice Freedman turned the meeting over to Stanley T. Siegel who acted as moderator of a panel discussion with Kay Krekorian, Deputy Chief Engineer, Massachusetts Department of Public Works, and Alfred Howard, Director, Transportation Planning, Boston Redevelopment Authority. This meeting was held at the Playboy Club. Attendance 90.

May 15, 1975 — This was a combined meeting with the Boston Transportation Group. Chairman Bruce Campbell of the BTG called the meeting to order and then turned it over to Chairman Maurice Freedman. Mr. Russell Barnes, BSCES representative to the Joint Regional Transportation Committee for the Boston Region (JRTC) gave a report of activities. Mr. Freedman then introduced Mr. Thomas C. O'Brien, Special Needs Coordinator for the MBTA, who gave an address on the subject "Transportation for the Handicapped and Disadvantaged". This meeting was held at the Three B's Restaurant. Attendance 75.

October 29, 1975 — Chairman Maurice Freedman called the meeting to order and introduced the speaker, Mr. Robert R. Kiley, Chairman, MBTA. As the new head of the MBTA, Mr. Kiley discussed the problems he expects to face and his opinion on how to handle some of them. The meeting was held at the Red Coach Grill. Attendance 111.

December 9, 1975 — Chairman Maurice Freedman introduced Mr. Francis R. Sholock, Location and Survey Engineer, Massachusetts Department of Public Works, who was the speaker. After presenting his department's concept of a means of reconstructing the Central Artery by depressing it, Mr. Sholock opened the meeting to general discussion. This was a luncheon meeting at the Red Coach Grill. Attendance 145.

January 28, 1976 — Annual meeting and election of officers; also an official meeting of BSCES. Chairman Maurice Freedman called the meeting to order and then conducted some BSCES business. Mr. Freedman then received nominations of officers for the 1976-1977 term.

The following slate was nominated and elected unanimously:

Chairman	Marvin W. Miller
Vice Chairman	Robert J. McDonagh
Clerk	A. Russell Barnes, Jr.
Member	Leo F. DeMarsh
Member	Donald M. Graham
Member	Maurice Freedman

The gavel was then turned over to the new Chairman, Marvin W. Miller. His first act as Chairman was to introduce the guest speaker, Lt. Governor Thomas P. O'Neill, III. The Lt. Governor discussed his views of Transportation Futures and his role in advancing them. This dinner meeting was held at the SS Peter Stuyvesant, Anthony's Pier Four Restaurant. Attendance 70.

February 23, 1976 — Executive Committee luncheon at Kevin's Wharf. Plans and policies for the coming year were discussed. Russ Barnes, our representative to the JRTC, has requested that someone else be given the opportunity to serve. It was decided that from now on the immediate past chairman of the Transportation Group will fill this position.

At the conclusion of the meeting, representatives of the Mystic Tobin Bridge Authority addressed us on the proposed toll structure changes being considered. It was the Board's opinion that we should not be involved in management or monetary matters but rather only in concepts pertaining to our expertise.

March 17, 1976 — Chairman Marvin W. Miller called the luncheon meeting to order and introduced the speaker, Stuart Forbes, Project Director, Boston Redevelopment Authority. Mr. Forbes outlined the past history of the Park Plaza Project and then presented the current thinking. This meeting was held at the Red Coach Grill. Attendance 30.

Respectfully submitted,
Marvin W. Miller, P.E.
Chairman

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Committee Chairmen, 1976-1977

Committees	*Chairman*
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ADVERTISING	John P. Hurney
ANNUAL MEETING	Howard Simpson
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ASSOCIATE MEMBER FORUM	David L. Freed
AUDITING	William S. Zoino and Paul J. Bourque
CONSTITUTION AND BYLAWS	Max D. Sorota
THOMAS R. CAMP FUND AWARD	Paul A. Taurasi
CLAMBAKE	David L. Freed
COMPUTER GROUP AWARD	Lewis H. Holzman
CONSTRUCTION GROUP AWARD	Norman W. Bennett
CONTINUING EDUCATION	Ronald E. Sharpin
DINNER DANCE	Frank J. Cullati
DISADVANTAGED YOUTH	Richard J. Scranton
ENVIRONMENTAL GROUP AWARD	Paul A. Taurasi
FITZGERALD-HERSCHEL AWARD	Charles C. Ladd
JOHN R. FREEMAN FUND	Lee M. G. Wolman
GEOTECHNICAL GROUP AWARD	William S. Zoino
HISTORY AND HERITAGE	H. Hobart Holly
RALPH W. HORNE FUND AWARD	Harl P. Aldrich
HYDRAULICS GROUP AWARD	Edward P. Dunn
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INVESTMENT	Saul Namyet
KEY MAN	Robert M. Fitzgerald
MASSACHUSETTS CONSTRUCTION INDUSTRY COUNCIL REPRESENTATIVE	William E. Mackey, Jr.
MASSACHUSETTS ENGINEERS COUNCIL REPRESENTATIVE	David E. Thompson
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NEWSLETTER EDITOR	Paul J. Bourque
NOMINATING	Max D. Sorota and Ronald C. Hirschfeld
OPERATIONS MANUAL	Edward B. Kinner
PROGRAM	Howard Simpson
PUBLIC RELATIONS	Kenneth A. Smith
PUBLICATIONS	Charles C. Ladd
STRUCTURAL GROUP AWARD	Kentaro Tsutsumi
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TASK FORCE ON YOUNGER MEMBERS	Anthony DiSarcina
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