Technology Review

May, 1964

Sailing Champion, Page 27



The Scientific Origins Of Modern Engineering

By George R. Harrison, Page 15





ack in the days

when roadways were drained poorly if at all, street gutters could get rather messy. Wheels and hooves sloshing through presented a major hazard to feminine silks and satins...so the gentleman walked on the curb-side of the pavement to avert disaster to his lady's finery as best he could. Gentlemen walk on the outside to this day, though the need for this kind of protection has lessened, at least a little.

Customary...for reasons of protection

A custom among knowing cable buyers now almost a reflex, like walking on the outside—is specifying Kerite for protection that endures. Many, many miles of Kerite cable installed 40, 50, even more years ago, are still in service today and functioning perfectly. Many more miles installed since reflect design improvements, the most advanced techniques of manufacture and long term testing, to keep time-proved Kerite cable the most thoroughly up-to-date. Some customs may persist beyond the reasons for them. But the reason for buying Kerite is more valid today than ever: long-term economy through cables that last and last. The Kerite Company—30 Church Street, New York 7, New York.





How to add 200,000 kw fast ... and keep costs down

Stone & Webster Engineering Corporation recently completed the design and construction of Unit No. 4 at Tampa Electric Company's Gannon Station. Brought on the line ahead of schedule and at a lower cost than preceding units, the new installation will bring the station's capability to some 635,000 kw. Construction for Unit

growth in this area.

No. 5 is now under way to keep pace with rapid

without sacrifice of reliability result in low construc-

Gannon's simplicity and refinement of design



tion expense. Self-supporting dual flow traveling screens and complete stainless steel condenser water boxes contribute to reduction of maintenance charges. Efficiencies from effective equipment arrangement and optimum use of space result in lower fixed charges and operating expense. Stone & Webster's skill and expe-

rience in the power field includes steam, hydro and nuclear generation, and EHV transmission systems.

We should like an opportunity to discuss your next engineering project.

1889 1964 75th ANNIVERSARY STONE & WEBSTER Engineering Corporation New York - Boston - Chicago - Houston - San Francisco - Los Angeles - Seattle - Washington D.C.

New York • Boston • Chicago • Houston • San Francisco • Los Angeles • Seattle • Washington, D. C. Stone & Webster Engineering Limited London • Stone & Webster Engineering S. A.-Paris • Stone & Webster Engineering N.V.-Amsterdam Stone & Webster Canada Limited - Toronto • Associated Nucleonics, Inc.-Garden City, N.Y.





Lincoln Laboratory of the Massachusetts Institute of Technology conducts a program of general research in selected areas of advanced electronics with emphasis on applications to national defense and space exploration. The program in *Re-entry Physics* consists of theoretical and experimental investigations of the electromagnetic effects associated with the passage of hypervelocity objects through the atmosphere. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. Lincoln Laboratory, Massachusetts Institute of Technology, Box 28, Lexington 73, Massachusetts. Solid State Physics Information Processing Radio Physics and Astronomy Radar Design Control Systems Space Surveillance Techniques Re-entry Physics Space Communications A description of the Laboratory's work will be sent upon request.



ROBERT CAPRANICA, a young researcher from Bell Telephone Laboratories, is studying the croaking of frogs in an artificial lily pond at M.I.T. His novel communication research project is described in the article on page 31 this month.

TECHNOLOGY REVIEW is published monthly from November to July inclusive, on the 27th day of the month preceding the date of issue, by the Alumni Association of the Massachusetts Institute of Technology. All correspondence regarding its editorial contents, subscriptions, advertising, and changes of address should be addressed to:

> Room 1-281, M.I.T., Cambridge, Mass. 02139

The Review's publisher and editor is Volta Torrey; business manager, R. T. Jope, '28; assistant to the editor, Ruth King; and class news editor, Roberta A. Clark. Editorial consultants are J. J. Row-lands, Francis E. Wylie, and John I. Mattill. Members of its staff are Joyce Skinner and Maxine Kenny.

Officers of the Alumni Association of M.I.T are: Robert H. Winters, '33, President; Donald P. Severance, '38, Executive Vice-president; F. Leroy Foster, '25, and Samuel A. Groves, '34, Vice-presidents; and Frederick G. Lehmann, '51, Secretary.

An annual subscription to Technology Review is \$4 in the U.S., \$4.50 in Canada and elsewhere, and a single copy, 60 cents. Three weeks must be allowed to effect a change of address, for which both the old and the new address of the subscriber should be given.

Contents are copyrighted, 1964, by the Alumni Association of M.I.T. Requests to reprint material from The Review should be addressed to the editor, Room 1-281, M.I.T.

The office of publication is 10 Ferry St., Concord, N. H., where The Review is printed by The Rumford Press. Second-class postage is paid at Concord, N.H.

POSTMASTER: Please return undeliverable copies to The Rumford Press, 10 Ferry St., Concord, N.H. Edited at the Massachusetts Institute of Technology Volume 66, Number 7

Contents

The Cover shows Joe Duplin (second from right) in a world championship race on the Gold Cup Course on Lake Michigan. The man hanging over the side is Lowell North, who was a three-time world champion.

Individuals Noteworthy

Institute Professor, Emeritus, Norbert Wiener's death, and other news of the M.I.T. Faculty and its Alumni.

The Scientific Origins of Modern Engineering

George R. Harrison, Dean Emeritus of the School of Science, discusses an issue raised by a previous article in The Review—in an article drawn from a talk in Cleveland.

The Soil Challenges M.I.T.

Professor T. William Lambe, '44, explains the geologic column and foundation problems on the Institute's campus.

Students, Materials, and Science

Professor Robert A. Smith, a physicist from Britain, discusses his work in a tape-recorded interview.

New Books

Norbert Wiener's last book, God and Golem, Inc., points out moral traps that are posed by automata.

The Sailing Champion M.I.T. Men Watch

George W. Smith, '26, tells how he met Joe Duplin and why sailing appeals to M.I.T. men.

The Trend of Affairs

Brief reports on what M.I.T. men are saying and doing about a great variety of current problems.

Communication in a Lily Pond

Samuel Jay Keyser describes the use of electronics to explore an ancient but challenging system.

Institute Yesteryears

Items that were news at M.I.T. long ago, as they were recalled by the late H. E. Lobdell, '17.

Alumni Examine Tomorrow's Edge

Nelson Lees, '53, reports on a regional seminar concerned with education, science, and engineering.

Structural Mechanics of Textiles

Modern engineering ideas will be presented in special summer programs at the Institute.

May, 1964

4

15

19

23

26

27

29

31

34

35

38

Individuals Noteworthy

Norbert Wiener: 1894-1964

ONE of the world's most productive and admired mathematicians, Institute Professor, Emeritus, Norbert Wiener, died in Stockholm last March 18 while visiting friends at a hearing aid laboratory.

Prosthetic devices that involve both human and mechanical systems of communication and control fascinated Professor Wiener in recent years. He had inspired and taken part in efforts to improve artificial hands and limbs. He also had thought much about hearing aids, especially after noting the music at a Boston performance of the Russian circus last year, and he hoped that ways could be found to enable more deaf people to hear.

Professor and Mrs. Wiener left Cambridge last January 20 soon after he received the National Medal of Science from President Johnson in Washington. They had gone to the University of Amsterdam, which planned to make him an honorary professor of medicine, and from there to Norway and Sweden. He expected to lecture at the Swedish Royal Institute in Stockholm, and to go later this year to the Spring School of Cybernetics in Naples and the Institute for Advanced Study in Mexico City.

Professor Wiener enjoyed his many trips abroad and took pride in being welcome and at home virtually everywhere. He rarely admitted just how many languages.he knew, but they included Chinese, and he seemed capable of instantly recalling in detail nearly all of the world's great literature.

Mathematical irregularities were his scientific specialty and he strove to formulate procedures to minimize them and thus bring nature's random movements together in a harmonious whole. He credited the motion of the waves in the Charles River with having inspired his development of analytical techniques applicable in both electrical engineering and the examination of brain waves. He founded the science of cybernetics, named it, encouraged its use for benign purposes, and denounced military and commercial applications of it which he considered ignoble.

His last book, God and Golem, Inc., finished last summer in Sandwich, N.H., dealt with the impingement of cybernetics on religion. The creation of machines capable of learning and reproducing themselves will give us no rest from thinking, but will subject us to sins no different than simony and sorcery, he believed, and this book was a final plea to others to "render unto man the things which are man's and unto computers the things which are computer's." The Mayor of Cambridge carried a copy of it with him to Rome this spring to present to the Pope.

Professor Wiener's fame for his mathematical work was rivaled by that brought to him by his amazing versatility, his personality, and his cordiality. Both his technical and nontechnical works were widely quoted, and *The Human Use of Human Beings* modified a popular image of "the scientist." Representatives of all the world's great communication media sought him out, and nearly always left his company feeling that they had touched the sleeve of greatness.

His life story was well known. He told it in two books, *Ex-Prodigy* and *I Am a Mathematician*. Born and bred, as he said, to the scholar's trade, he was graduated from Tufts at the age of 14 and received his doctorate in philosophy from Harvard when he was 18. Throughout his life he defended the right of gifted children to privacy, but he made no secret of his own suffering.

After postgraduate study at Cambridge, England, at Göttingen, in Copenhagen, and at Columbia University with such men as Bertrand Russell, G. H. Hardy and John Dewey, he taught briefly at Harvard and the University of Maine. He also tried reporting for the Boston Herald and writing for the Encyclopedia Americana. He was accepted into the armed services during the first world war, after repeated efforts to enlist, and assigned to the Aberdeen Proving Grounds. Then he came to M.I.T. as an instructor in 1919, and became assistant professor in 1924, associate professor in 1929, professor in 1932, Institute professor in 1959, and emeritus in 1960.

Throughout his 45 years at the Institute, he was noted for the length of the equations he put on (Continued on page 6)



Assistant Professor Norbert Wiener working at his M.I.T. desk in the 1920's.









STRUCTURE	1. Dupont Athletic Center	2. Burton-Conner Dining Hall
ARCHITECT	Anderson Beckwith & Haible	William Hoskins Brown Assoc.
ENGINEERS	Severud-Elstad- Krueger Assoc.	Hayden, Harding & Buchanan
GENERAL CONTRACTOR	George A. Fuller Company	Kirkland Constr. Company
RANKI UNITS	215 cased	47 cased shaft
TRUCTURE	3. Parking Facilities	4. Married Students Quarters
RCHITECT	Parking Develop- ment Co. Carlton N. Goff	Hugh Stubbins & Assoc.
NGINEERS	Maurice A. Reidy	Wm. J. LeMessurier
ONTRACTOR	John F. Griffin Company	Wexler Construction
RANKI UNITS	174 uncased	102 uncased



Franki Foundations at M.I.T.

Problem

One of the major problems encountered by Massachusetts Institute of Technology as it expands its facilities to meet the increasing demands of the Space Age, is the selection of safe and economical foundations. The campus is underlain, typically, by about 20 feet of fill and peaty silt, a crust of sand and gravel of varying thickness, and the deep deposit of soft blue clay common to much of the Boston area.

At the David Flett du Pont Athletic Center (No. 1) it was decided to support the building on the crust. Since the sand layer varied from 8 to 12 feet in thickness, piles were subject to the objection that they might "punch through" to the clay, and an excavated caisson foundation would have to bear the heavy and indeterminate cost of large-scale dewatering.

Solution

The Engineers decided to investigate the Franki system of displacement caissons or pressureinjected footings, because of Franki's unique ability to forge a footing with 140,000 ft.-lb. blows at a predetermined depth in the top of the sand layer, creating both an expanded base and a large zone of densified sand, thus improving the natural "mat" action of the crust. They found that Franki was prepared to guarantee satisfactory installation of the caissons at a fixed lump sum price, eliminating contingencies for extra length or dewatering.

The Engineers' final design involved 215 Franki caissons, in groups of 2 to 6 units, carrying individual loads of 65 to 80 tons. The controlling factor was of course the stress applied to the clay, and the number and spacing of the caissons at each column was so arranged as to keep that stress relatively constant, and within the limit of 1 ton per sq. ft. generally accepted for soft Boston Blue Clay.

A load test to double design load in the most critical area, where the sand stratum was only 8 feet thick, (net settlement 0.24") proved the safety of the design.

Results

The du Pont Athletic Center has now been in service for four years, and the design assumptions have been fully confirmed.

In the meantime the Institute and its various professional consultants, listed at left, have specified Franki guaranteed lump-sum-price foundations on the Burton-Conner Dining Hall (No. 2), the large Parking Facility at Main & Vassar Streets (No. 3), and on the four low-rise buildings of the Married Students Quarters complex (No. 4), now being dedicated. Unit loads on these structures ranged up to 120 tons per caisson.

Franki is proud to have been able to contribute to the growth of this dynamic educational institution.

N



Literature — This series of job high-lights, as well as other descriptive literature, will be sent to you upon request to Franki Foundation Com-pany, 103 Park Ave., New York. Literature -This

Individuals Noteworthy

(Continued from page 4)

blackboards and the speed with which he erased them. Professor Yuk-Wing Lee, '27, Associate Professor Amar G. Bose, '51, and other former students produced one of Norbert Wiener's last mathematical books for him (*Nonlinear Problems in Random Theory*) from tape recordings and 400 snapshots of his blackboard taken while he was giving what was to have been five and turned out to be 15 lectures.

Despite his poor eyesight, he read and worked swiftly, and often found time to stroll the corridors, chat in a foreign language with a student, philosophize with a colleague, and discuss the day's biggest headline with a friend. He called many an old friend "boss."

The way the world turns, and the rigidity of most men's thinking in all countries, sometimes depressed Professor Wiener and his jests often were bitter. But he enjoyed bridge, the movies, and small

A Story Professor Wiener Often Recalled

NORBERT WIENER told W. W. Jacobs' story about "The Monkey's Paw" to many interviewers.* In "God and Golem, Inc.," he summarized it, in these words:

"In this tale, an English working family is sitting down to dinner in its kitchen. The son leaves to work at a factory, and the old parents listen to the tales of their guest, a sergeant-major back from service in



talk about national and world affairs.

The anecdotes about him are endless. Some of the stories that have been told and re-told are apocryphal and others resulted from his nearsightedness and his intense concentration on major rather than trivial matters. Yet he, too, enjoyed the stories.

"We respected him," said President Julius A. Stratton, '23, in the report of his death sent to the Faculty, "not alone for his productive and creative mind, but equally for his warmth of understanding and for his humanity."

Professor Wiener is survived by his wife, two daughters, his mother, a brother, and two sisters.

Honored in Milan

THE Polytechnic Institute of Milan, Italy, honored Provost Charles H. Townes of M.I.T. and its own Professor Giulio Natta, winner of this year's Nobel Prize in Chemistry, at ceremonies in the La Scala Opera House on April 3 commemorating the 100th anniversary of the founding of the Institute. **Electronics Conferees**

PROFESSOR Wayne B. Nottingham, who will retire this year, was honored at a dinner on March 26 by former students attending the 24th annual Physical Electronics Conference that he has arranged for them. John F. Waymouth, Jr., '50, of Sylvania Electric Products, Inc., will organize and conduct future such by-invitation-only conferences with the assistance of a committee consisting of Professor Edward A. Coomes, '38, of Notre Dame University; Andrew R. Hutson, '54, of Bell Telephone Laboratories; David B. Langmuir, '35, of Space Technology Laboratories, and John M. Houston, '55, of General Electric Research Laboratories.

Attendance at the very special alumni gatherings that Professor Nottingham started in 1935 has been limited to 250, and unlimited, spontaneous discussion has been permitted, to encourage the maximum exchange of knowledge among men concerned with physical electronics. (Continued on page 8)

the Indian army. He tells them of Indian magic and shows them a dried monkey's paw, which, he tells them, is a talisman which has been endowed by an Indian holy man with the virtue of giving three wishes to each of three successive owners. This, he says, was to prove the folly of defying fate.

"He says that he does not know what were the first two wishes of the first owner, but that the last one was for death. He himself was the second owner, but his experiences were too terrible to relate. He is about to cast the paw on the coal fire, when his host retrieves it, and despite all the sergeant-major can do, wishes for $\pounds 200$.

"Shortly thereafter there is a knock at the door. A very solemn gentleman is there from the company which has employed his son. As gently as he can, he breaks the news that the son has been killed in an accident at the factory. Without recognizing any responsibility in the matter, the company offers its sympathy and $\pounds 200$ as a solatium.

"The parents are distracted, and at the mother's suggestion, they wish the son back again. By now it is dark without, a dark windy night. Again there is a knocking at the door. Somehow the parents know that it is their son, but not in the flesh. The story ends with the third wish, that the ghost should go away.

"The magic of automation, and in particular the magic of an automatization in which the devices learn, may be expected to be similarly literal-minded. If you are playing a game according to certain rules and set the playing-machine to play for victory, you will get victory if you get anything at all, and the machine will not pay the slightest attention to any consideration except victory according to the rules. If you are playing a war game with a certain conventional interpretation of victory, victory will be the goal at any cost, even that of the extermination of your own side, unless this condition of survival is explicitly contained in the definition of victory according to which you program the machine."

^{*}It appeared in *The Lady of the Barge* (Dodd, Mead & Co.) and in *Modern Short Stories*, Margaret Ashmun, Ed. (Macmillan Co., 1915).

Ball valves for airborne and support applications

8 inch full ball valve. Hermetically sealed for zero leakage. Secondary seal has low leakage rate of 15 cc Freon per minute at 900 psig. Handles nitrogen tetroxide. 12 inch segmented ball valve. Leakage rate of 30 cc gaseous nitrogen per minute at 54 psig. Handles RP-1. 17 inch segmented ball valve. Flows 40,000 gallons per minute of liquid oxygen. Leakage rate is 328 cc gaseous nitrogen per minute at 185 psig.

11/1557039666666666

Garrett-AiResearch ball valves can be designed to handle all liquid missile fuels and oxidizers, both cryogenic liquids and gaseous forms, from -425°F to +400°F. Sizes are programmed from 2.5 to 50 inches in diameter. • In applications calling for large diameter valves and/or low pressure, a segmented ball is utilized; for small diameter and/or high pressure uses, a full ball is used. The seals are stationary.
Technical superiority, reliability and minimum seal wear are achieved by using simplified actuation devices.
A significant number of moving parts are eliminated and weight is reduced. • The ball valve line is the

newest addition to a complete line of AiResearch precision valves,

including both butterfly and poppet types.





AIRESEARCH MANUFACTURING DIVISIONS

LOS ANGELES 9, CALIFORNIA • PHOENIX, ARIZONA

Individuals Noteworthy

(Continued from page 6)

New Professors

Provost Charles H. Townes has announced the promotion of the following members of the M.I.T. Faculty to the rank of professor:

Robert L. Halfman, '44, and James W. Mar, '41, Aeronautics. Cecil E. Hall, '48, Biology. Herbert O. House, Chemistry. Abraham J. Siegel, Economics. Edward W. Merrill, '47, Chemical Engineering.

Murray Eden, Marvin L. Minsky, George C. Newton, Jr., '41, and John M. Wozencraft, '51, Electrical Engineering.

Henry M. Paynter, '44, Mechanical Engineering.

Gregory Tucker, Humanities.

Edward H. Bowman, '46, and Edgar H. Schein, Industrial Management.

Nesmith C. Ankeny, Louis N. Howard, and Hartley Rogers, Jr., Mathematics.

Ali Javan, Arthur K. Kerman, '53, George F. Koster, '48, Louis S. Osborne, '50, and Irwin A. Pless, Physics.

Associate Professors

MEMBERS of the M.I.T. Faculty promoted to the rank of associate professor this spring were:

Myron A. Hoffman, '51, and Gordon C. Oates, Aeronautics.

Henry A. Millon, Architecture. Justin E. Kerwin, '53, Naval Ar-

chitecture.

Glenn A. Berchtold, Glen E. Gordon, Gordon G. Hammes, William R. Moore, and Walter R. Thorson, Chemistry.

Ernest F. Bisbee, Jerome J. Connor, Jr., '53, John F. Kennedy, and Charles C. Ladd, '55, Civil Engineering.

Robert G. Gallager, '57, James W. Graham, '52, Paul E. Gray, '54, Irwin M. Jacobs, '57, William T. Peake, '51, and Paul L. Penfield, Jr., '60, Electrical Engineering.

Thomas B. Sheridan, '59, Mechanical Engineering.

David D. Lanning, '63, Nuclear Engineering.

William F. Pounds, Barnard E. Smith, Andrew C. Stedry, and William P. Travis, Industrial Management.

Michael Artin, and W. Gilbert

Strang, '55, Mathematics. Marcus Karel, '60, Nutrition. George Bekefi, William Bertozzi, '53, Jerome I. Friedman, and Lawrence Rosenson, Physics.

Honors to Professors

THEOS J. THOMPSON, Professor of Nuclear Engineering, was one of five named by the Atomic Energy Commission to receive Ernest O. Lawrence Memorial Awards this year. . . Professor Arthur T. Ippen has been appointed to the advisory board of the U.S. Army Coastal Engineering Research Center. . . Professor Robert V. Whitman, '49, received a 1963 Structural Section Award from the Boston Society of Civil Engineers.

Wilson Fellows

EIGHT M.I.T. students won Woodrow Wilson fellowships this spring for a year of graduate study next fall. They were Ned J. Block, Douglas T. Browne, Kenneth H. Kaiser, Tehmau Kan, Bernard Shiffman, Eugene R. Speer, Jr., Gordon S. Wassermann, and Alan D. Weinstein.

Honorable mention was given Michael L. Burton, Maurice A. Finocchiaro, David F. Freeman, Lita L. Markley, John D. Nagle, Martin T. Poe, 3d, and Donald C. Shapero. (Continued on page 46)





Staten Island Advance office and printing plant. William Ginsberg Associates, Engineers

"Roughly what would such a building cost?"

We are often asked this question by executives who want facts before making any commitments.

Based on current projects, we can give you a reliable estimate—also information on the type of construction most suitable, and time required for completing the project.

> W. J. BARNEY CORPORATION Founded 1917 INDUSTRIAL CONSTRUCTION 101 Park Avenue, New York Alfred T. Glassett, '20, President

MEASURES 75,000 MILLION MEGOHMS!

The Mid-Eastern 710V Megatrometer is the only unit accurate enough for laboratory research yet simple enough for use by production personnel. It permits exceptionally accurate measurements in testing volume resistivity under various environments, and in the analysis of the effects on insulating, semiconductor and other materials of humidity, surface leakage, ion migration, moisture content, nuclear radiation, test potential variation, mechanical stress and temperature.

Because of its safety and simplicity of operation, the 710V is ideal for production testing, incoming inspection and quality control of resistors, capacitors, transducers, integrated circuits and entire electronic assemblies.

The 710V offers the following exclusive advantages:

- Wide measuring range-140K to 7.5 x 10¹⁶ Ohms.
- Continuously variable test potential from 0 to 1500 volts D.C.
- Completely self-contained, no additional equipment needed.
- Direct reading-no nulling required.
- Built-in 10 megohm 0.2% calibration standard.
- Excellent resolution of measurement -8 decade resistance range.



PRICE: \$1995.00

Volume Resistivity Jig, Teflon Extension Cables, Faraday Chamber are available as accessories

Also Certified Resistor Standards up to 10 million Megohms, traceable to Nat. Bur. of Stds.

Please write for detailed specification sheets.

