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Harry H. Goode, System Engineer

Harry Goode was born in New York City 1 July 1909. The vigor and the alertness to intellectual challenge that characterized his whole life provided very early the motivation and drive that made a university education possible, in the face of difficulties that would have discouraged a lesser spirit. His bachelor's degree in history from New York University, granted in 1931, came just at the beginning of the depression years. During some of those years he was employed as statistician for the New York City Department of Health, for which he became statistician-in-charge in 1941. At other times, like many other young men in those difficult times, he turned informal talents to advantage—he found himself a good shoe salesman; he was for a while a part-time editor; and he not infrequently played a dance-band saxophone for both pleasure and profit.

To another the Department of Health statistical work might have seemed routine, but to him nothing was ever routine. He discovered, for example, a large number of cases of advanced illness which could have been corrected had the patient seen a doctor earlier. Because of a shortage of physicians available for the department's work, the patients had been unable to see a doctor sooner. By elementary statistical techniques (he would never use sophisticated mathematics where elementary or heuristic techniques would suffice) he was able to show conclusively that the effectiveness of the department would be greatly increased if the physicians would see more people and spend less time with each. His recommendations to this effect were not well received because of the risk of an occasional wrong diagnosis. A lesson from this experience he never forgot: that systems have people and people have prejudices.

During this period his characteristic breadth of interest and motivation toward tangible value for society in anything he might do directed his attention to engineering. He attended night school at Cooper Union and graduated with a Bachelor of Chemical Engineering degree in 1941. This educational venture, combined with his experience as a statistician, brought the realization that for him the enduring intellectual challenge would be in applied mathematics, which he then began to study at Columbia University, receiving the M.A. degree in 1945. He started a doctoral dissertation in statistics under Abraham Wald (on the distribution of noncentral *t*), but the evident importance of the scientific and professional work that was by then engaging his attention drew him away from work for the doctorate, which he ultimately bypassed completely, in that his achievements without the degree carried him far beyond the accomplishments of most people who hold it. These later achievements suggest that, at least in Harry Goode's life, the wide range of intellectual interests covered in his three distinct and contrasting experiences of higher education, together with his exposure to human and social problems in the New York City Department of Health, provided a richness of early experience of much greater value in preparing him for a life work in systems study than could have come from any intensive concentration in a narrow specialty.

Between 1943 and 1945 he and another young mathematician, Leonard Gillman, were the principal staff of a special project for Tufts College for the Navy's Special Devices Center. Their work, in an office in New York City, would today be called "operations research," but that term was not yet in wide use. For example, they set up a scoring system for a gunnery trainer and included the concept, sophisticated for that time, that the value of a hit late in the run should be less than that of one early in the run because the gunner might not survive. Goode and Gillman were an enormously effective team, producing in two years over 100 memoranda and a major treatise on pursuit courses and the mathematics of guidance and interception, which appeared as a 250-page book.

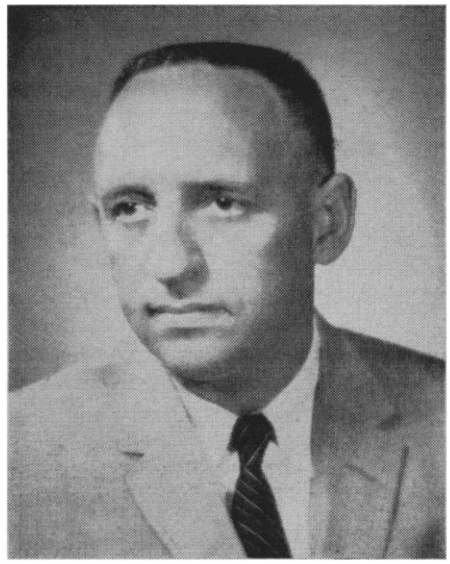
After the war Goode joined the staff of the Navy's Special Devices Center, where he rose rapidly through successive responsibilities to be head of the Special Projects Branch. His work during this period was on flight control simulation and training, aircraft instrumentation, antisubmarine warfare, weapon system design, and computer research. He was among the first to see the great importance computers were to have, and he was instrumental in initiating several major projects, including the Typhoon computer (the world's largest analog computer) and the Whirlwind computer at Massachusetts Institute of Technology, the first truly high-speed digital computer. Understanding the power of computers, he began at this time to formulate some of the principles of what he later called "system engineering," although he later broadened the system approach considerably beyond the computer.

At the beginning of 1950 he came to

the Aeronautical Research Center (later Willow Run Laboratories) of the University of Michigan as head of the System Analysis and Simulation Group. In 1951 he became chief project engineer, and in 1952, director of the Center. This Center, which doubled in size to 600 people under his direction, was a research and development organization interested principally in guided missile systems, which were "systems" in the fullest sense of Harry's definition of the word. Among the many projects on which the Center was engaged at this time (some of them are still classified) was the study that led ultimately to development of the Bomarc missile. His major work was the study of air defense systems which led ultimately to the Air Defense Integrated System (ADIS) Project. This project was Harry's own brain child and represented the embodiment of his ideas on system design. It emphasized the desirability of the evolutionary system design process as distinct from a long leap into techniques of the future; the desirability of designing a system for the environment which would exist at the time the system was installed rather than for the environment existing at the time of the design; and the necessity for having men rather than machines at certain key spots in the system when the system input is not wholly predictable. Harry first achieved national prominence in his unsuccessful fight for the adoption of ADIS.

During these years his thinking about systems had given rise to several articles, including one called "Simulation, Its Place in System Design," which was published in 1951. Shortly afterward he circulated among a few friends a memorandum entitled "First Rough Draft of the Approach to the Introduction," in which he proposed a joint book on systems analysis. The memorandum stated, "Let me note here that I think each of us will gain considerably by attempting to write this book whether we succeed in doing it or not. First, I know of no book in systems on the subject. Second, I believe the subject is not well defined in anyone's mind, but, in so far as I have been able to determine, better here [at Willow Run] than anywhere else. Third, what we write ought to be of help to someone else undertaking this kind of work."

The outline presented in the memorandum was very rough by his own later standards, and he quite underestimated the magnitude of the task. In



Harry H. Goode

1954, however, he was asked to be a part-time professor of electrical engineering at the University of Michigan and to teach a course which he called "Large-Scale System Design." This gave him an opportunity to formalize his thinking about systems, and simultaneously with the organizing of this course he undertook, with a coauthor, the writing of the systems book. This occupied two years and was completed in 1956; the book, *System Engineering*, was published by McGraw-Hill in 1957. It has subsequently been translated into French and Japanese. Harry regarded this book as perhaps his most important achievement. It classified and regularized systems and the system design process and helped to make respectable the new discipline of system engineering. It is now widely recognized that the design, analysis, and evaluation of large-scale and complex systems require techniques and a viewpoint different from those needed for components or simple devices. It was these techniques on which Harry was an expert and this viewpoint of which he was a past master.

In 1955 he resigned his administrative duties at the Willow Run Laboratories in order to take up full-time teaching duties as a professor of electrical engineering of the University of Michigan; the next year he became also professor of industrial engineering. He insisted on being allowed to teach elementary courses in electrical circuits as well as his own graduate courses. Thus he started out to learn this new field—electrical engineering—from the bottom up. At first he missed some of the atmosphere of his important administrative position and complained to a friend and colleague that he did not have as much "gain" as formerly. The friend, who understood his analogy to an amplifier, pointed out that he had as much "gain" as before but that now he was "reactance coupled" instead of "resistance coupled." He learned this lesson well and was soon able to maneuver in the university environment to achieve the many ends which he sought—for example, the setting up of a degree program in management sciences. Although he was a vigorous organizer, his undertakings were always completely selfless, never directed toward the building of a personal empire.

In 1958 he served for a year as technical director of the Systems Division of the Bendix Corporation, maintaining a part-time appointment at the University of Michigan so that he could continue to teach his new course. He then returned to full-time duties in the university's department of electrical engineering. His duties there included teaching, his own research, supervision of doctoral candidates, and involvement in many of the university's sponsored research projects.

He also found time for much work as consultant, although he could not fulfill the many demands for his services. Besides serving many commercial and industrial organizations in this capacity he served the United States Government as consultant to the National Bureau of Standards, the Post Office Department, and the Appropriations Committee of the House of Representatives. He was also chairman of the Committee on Advanced Reconnaissance (Committee WS-117L) of the Air Force. He also gave his time generously to the profession, serving as a member of the administrative committee of the professional group on electronic computers of the Institute of Radio Engineers (IRE) and as a member of the computer advisory committee of the Society of Automotive Engineers and assisting in the work of the committee on feedback controls of the American Institute of Electrical Engineers (AIEE).

His most important professional-society service was as chairman, during recent years, of the National Joint Computer Committee, formed by the AIEE, IRE, and ACM (Association for Computing Machinery), and as this committee's representative on a similar international committee. He had an important part in drawing up the charter under which these three societies joined to form a new American Federation of Information Processing Societies, linked closely with an international federation similarly named. In 1959 he was one of a group of eight Americans who toured Soviet computer establishments at the invitation of the Soviet Academy of Sciences.

His many papers touched upon statistics, simulation and modeling, vehicular traffic control, and system design. But through his work his principal research efforts were concerned with reaching a better understanding of large-scale systems. In 1959 he agreed to collaborate on a book with chapter headings such as "Historical and social developments of systems," "General system theories and classifications," "Types of systems," "Descriptions of systems," "Characteristics of systems," and "Modes of solutions for system design problems." However, he soon realized that the subject of systems was not yet sufficiently advanced to allow preparation of such a book, and he directed his attention to the preparation for the McGraw-Hill Book Company of a system engineering handbook. The work he started on this project will be carried through to completion by his friends and associates.

In 1931 Harry married Elsie Guggenheim. Their first child, Lisa, was born in 1943, and their second, Erica, in 1953. They were an unusually closely knit group; in spite of his many research and professional activities, he always found time to devote to his family.

On 30 October 1960 Goode's very fruitful life came to an abrupt end in a traffic accident. Fittingly, the memorial service held two days later was conducted in an auditorium in which he had often lectured, located on the campus of the university to which he gave so much.

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Science in the News

Problems in Political Tactics: Tax Proposals for Education; Congress and Science Policy

A tax credit proposal to encourage private contributions to education was introduced last week by Congressman Carroll D. Kearns (R.-Pa.). The proposal is similar to ones endorsed in recent years by the AAAS, the Association of American Colleges, the National Planning Association, and the U.S. Chamber of Commerce.

The proposal is also similar to a number of measures introduced in the current Congress by conservatives, who see the approach as a way to increase support for education without the direct involvement of the Federal Government. Congressman Kearns, for example, suggested that his proposal might reduce the need for federal appropriations by "as much as $2 or $3 billion if private gifts of that amount were forthcoming." On this reasoning Kearns believes his proposal would make unnecessary most of the Administration's program for higher education.

The way the Kearns proposal and related proposals would work is that instead of offering taxpayers only a deduction from their taxable income for educational gifts, it would offer them the option of a direct deduction from their tax bill of a set proportion of their gifts, in this case 91 percent. This means that a low-bracket taxpayer can give $100 to his alma mater at a cost to himself of only $9; the proposal would make it possible for the taxpayer with a modest income to give to education at as little out-of-pocket expense to himself as the taxpayer in the over $400,000 a year income class.

Hopefully, this would lead to a great increase in private giving. In the extreme case, a man who contributes $100 a year to education, and who does not itemize his deductions (that is, who takes the standard 10 percent deduction) is now giving the entire $100 out of his own pocket. If the Kearns proposal went through, he would, in theory at least, increase his giving to $1000 in order to maintain his out-of-pocket expense of $100. Of course, he would also be free to continue giving only $100 and pocket the $91 as a tax windfall.

The Administration has taken no position yet on the bill or others similar to it, and probably will take none unless it is forced to: that is, unless the House Ways and Means Committee, which must initiate Congressional action on bills involving taxation, decides to hold hearings on the bills.

In the recent past such proposals have been quietly buried in the calendar of pending legislation, the fate of the great majority of the thousands of bills introduced every session. If the proposal is taken seriously enough by the Ways and Means Committee to schedule hearings, then the Administration will have to take a position, which will almost certainly be to oppose the bill.

Between 1952 and 1954 Congress doubled the allowable limit for tax deduction for philanthropic gifts from 15 percent to 30 percent of taxable income. Contrary to expectations, this produced no increase in giving. Different influences would be at work under the Kearns proposal, and it would surely produce some increase in giving, but whether it would be a substantial increase is uncertain. Tax rates have, after all, gone up enormously in the last 30 years, and therefore the inducement to tax-free giving has gone up enormously. Yet giving, as a percentage of taxable income, has remained constant at around 4 percent. Unless the increase under the Kearns proposal were more than marginal, the total