CHEMICAL HERITAGE FOUNDATION

ROBERT M. HAYES

Transcript of an Interview
Conducted by

Colin B. Burke

at

Los Angeles, California

on
26 February 2001

(With Subsequent Corrections and Additions)

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Oral History Program
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ROBERT M. HAYES

1926 Born in New York, New York on 3 December

Education

1947 B.A., mathematics, University of California at Los Angeles
1949 M.A., mathematics, University of California at Los Angeles
1952 Ph.D., mathematics, University of California at Los Angeles

Professional Experience

National Bureau of Standards
1949-1952 Mathematician

Hughes Aircraft Corporation
1952-1954 Technical Staff Member

National Cash Register Company
1954-1955 Applications Division

Magnavox Corporation
1955-1960 Head of the Business Systems Group

American University
1959-1960 Visiting Lecturer

Advanced Information Systems, Incorporated
1960-1962 President

University of Washington
1960-1962 Visiting Lecturer

Electrada, Incorporated
1960-1963 Vice-President and Research Director

University of California at Los Angeles
1954-1964 Adjunct Lecturer
1964 Professor, School of Library Services
1965-1970 Director, Institute for Library Research

1974-1989	Dean, Graduate School of Library Service, School of Library and Information Science
	Becker and Hayes, Incorporated
1969-1973	Vice-President
1993-1996	Vice President
	University of Illinois
1970	Windsor Lecturer
	White House Conference on Libraries and Information Sciences
1979	Advisory Council Member
	University of New South Wales
1979, 1993	Visiting Professor
	Japanese Universities
1987, 1994	Visiting Professor
	Loughborough University
1989	Visiting Professor
	Online Computer Library Center, Incorporated
1990	Consultant
	Khazar University
1994	Visiting Professor

Honors

1971	Best Information Science Book Award, ASIS
1985	Beta Phi Mu Award, American Library Association
1986	Professional Achievement Award, UCLA Alumni Association
1990	First Tezak Award, University of Zagreb, Croatia
1993	Award of Merit, American Library Association

ABSTRACT

Robert M. Hayes begins the interview with a discussion of his father's and his stepfather's affect on his life. He describes how he traveled frequently because of his stepfather's acting career, attending over sixteen different high schools before receiving his diploma. Hayes graduated from UCLA in 1947 with a B.A. in mathematics, and afterwards was drafted into the Navy. He recounts his acceptance into the Navy's V-12 program, and the courses he took for that program at the University of Colorado at Boulder. After the War, Hayes returned to UCLA, where he earned his M.A. in mathematics in 1949, and his Ph.D. in mathematics in 1952. While earning his Ph.D., Hayes worked on information science at the National Bureau of Standards. In 1952, he decided to move into industry, and was hired at Hughes Aircraft. He describes his work at Hughes, where he programmed a computer to fly an airplane. Further, he recounts his teaching responsibilities in UCLA's University-extension program, which he continued in parallel with his experiences at Hughes. In 1954, Hayes began working at the National Cash Register Company, and a year later he moved to Magnavox Research Labs. He discusses the important developments in information storage and retrieval at Magnavox, such as the Minicard and the Magnacard systems, and his realization that his efforts at Magnavox could be taught to students. Eventually, Hayes was teaching at locations all over the United States, including American University, the University of Washington, and Wright Patterson Air Force Base. In 1960, Hayes was invited to join the Electrada Corporation, which he did, as vice-president. Hayes relates how, soon after joining Electrada, he and John Postley created Advanced Information Systems as a subsidiary of Electrada. Hayes also explains why he became a fulltime professor at UCLA at that time, and discusses his roles in the formation of the School of Library Service and the Institute for Library Research. In 1969, Joseph Becker and Robert Hayes started Becker and Hayes Incorporated, with the purpose of creating an interlibrary network for the State of Washington. Hayes discusses the obstacles he and Becker overcame to accomplish that task, and goes on to recount his work with NCLIS and the SILC system. Hayes concludes the interview with his interpretation of the relationship between information science and library science, and the importance of libraries and librarians.

INTERVIEWER

Colin B. Burke had recently retired from the history department at the University of Maryland at Baltimore County and held a research fellowship at Yale University when he came to CHF. He spent his residency working on his book on the history of computer-based scientific information systems and related government policies, from the 1950s through the early 1990s. He received his Ph.D. from Washington University in St. Louis and currently serves as Associate Professor Emeritus at the University of Maryland. He also served as a Fulbright Scholar in Poland and as a Scholar-in-Residence at the National Security Agency.

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INTERVIEWER: Colin B. Burke

LOCATION: Los Angeles, California

DATE: 26 February 2001

BURKE: This is an interview with Robert Mayo Hayes conducted in Los Angeles, California on 26 February 2001. The interviewer is Colin Burke. Dr. Hayes, you were born in 1926. You've told me you had a very interesting childhood and family background. Would you tell us what you thought was special about that background, and how it might have shaped your career?

HAYES: It's hard to say how it shaped my career, but I was fortunate to have two fathers. I loved both of them. My mother and father divorced when I was about six, and my mother remarried. Bill [William Henry] Forrest, my stepfather, was my father for all intents and purposes for the remainder of my life. And though I saw my genetic father many times, it was Bill that raised me since I was six. He became an actor in Hollywood.

BURKE: You told me once that the [Great] Depression had a major impact upon your family life. Would you talk about that?

HAYES: Bill and my father, Dudley [Lyman] Hayes, had investments in the stock market during the late 1920s. Like many others, they were caught in the crash. They each knew what was going to happen and so they were selling short, but the nature of the process was that their timing was off by a couple of weeks, or whatever. I think the economic strain of the depression was the reason my parents divorced—as was frequently the case back then—for it brought things to a head. Actually, Bill and Dudley were very similar people; both were very moral. They were tall—each about six feet. Bill was six foot two. They were both highly well-educated. Bill went to Princeton [University] and Dudley was actually the president of the student body in his final year at USC—University of Southern California. He came out here [to California] from Michigan. Actually, he had been at the University of Michigan his first two years and then came to USC. Anyway, that's the history of my early years.

BURKE: Your stepfather was an actor and he traveled a lot. As a consequence, you went attended many schools before you received your high school diploma, correct?

HAYES: Yes. In fact, I had gone through the 16 schools before he became an actor. Until he came out here in 1937, he had to move around a lot to get work during the Depression years. So for 5 or 6 years we moved principally between New York and Detroit, where there were two kinds of jobs that he took—one was as an advertising model, posing for Arrow [Company] shirt ads and so forth. We have a copy of an old *Liberty Magazine* at home from 17 November 1945, with my father's photo on the cover (1). I don't know whether you remember *Liberty*, but it was like *Saturday Evening Post*. He also worked as an auto lecturer. During those years, the auto shows were a big marketing tool for the automotive industry. My stepfather would get up in front of an automobile and tell the audience about it—give them the spiel. So as he traveled from city to city with the auto shows, I enrolled in a local school to spend anywhere from 3 or 4 weeks to a couple of months at it. As a result, I attended around 16 or more schools before I graduated from high school.

When we came to California, my father joined the Pasadena Playhouse and acted in about 20 plays. Then, he finally broke into the motion-picture business and became a very well known character actor. As I mentioned to you in my notes, if you remember the *Rin Tin Tin* series on television, he was Major Swanson, who was the commandant of Fort Apache. He had a very successful career until the 1970's. From about 1940 until 1970 or 1975, he was very active.

BURKE: Why did you decide to attend UCLA [University of California at Los Angeles]?

HAYES: Money. UCLA was inexpensive. We lived 20 miles away in Granada Hills [California], and I could go to UCLA for free, essentially. It was a good school, although it was nothing like it is now. It is a world class institution today, but at that time it was just a good University.

BURKE: What drove your interest in mathematics?

HAYES: It's hard to say. As I mentioned to you in my notes, while in elementary school I thought that I would become a lawyer because my great-grandfather had been a judge in New York City. However, I changed my mind after I had read a book on law that I had checked out of the school library. At the beginning it talked about torts, and I didn't know what torts were. I should have got a dictionary and looked it up. For whatever reason, since I didn't know what a torts were, I thought, "The hell with it." [laughter] At that time, I was also becoming interested in mathematics, but it's hard to say why. I suppose that I was looking for the structure that mathematics embodies; that's its nature.

BURKE: Your math degrees, including a Ph.D., shine through your career. As far as I can tell, you're one of the first people who have sought to apply mathematical analysis and systems theory to library problems.

HAYES: That's incorrect. Robert Fairthorne was probably the first person to do that. You should have his name in your files. He was British, and a very weird guy in fact, as mathematicians tend to be. Very early on, Fairthorne was interested in using mathematical techniques in the library and information retrieval fields.

BURKE: His name is mentioned in many of the emerging histories of the information sciences.

HAYES: He is a very key figure.

BURKE: You served in the [United States] Navy during the War [World War II] for two years.

HAYES: Actually, one year, three months, and 23 days.

BURKE: You taught mathematics for the Navy eventually, right?

HAYES: Actually, no. That's an interesting story. I was drafted and went to boot camp. I'll have to back up a moment. I taught my first class at UCLA—this is the truth—as a freshman. I knew I would be drafted and I didn't want to volunteer, but I wanted to prepare as well as I could. So, in my first semester at UCLA I took a course on celestial navigation with the view that it would be valuable; especially because I hoped to get into the Navy, though I had no idea where I'd end up. Being drafted at that time you didn't have a choice; it just was a flip of a coin. I figured that if I had the celestial navigation in hand that that would give me a leg up. I was drafted, and, fortunately, down at Terminal Island where the induction took place, the Navy selected me. So I was sent down to boot camp in San Diego. The opportunity was still there to apply for the V-12 program. Now I don't know whether you recall what the V-12 was—but it was the program for training enlisted men in the Navy to become officers. So I applied for the V-12 program.

I can recall the interview by the board of assessment at boot camp, which consisted of a couple of commanders, the captain, and so on. They asked me only one thing—what was the first point of Aries—which is a key thing in celestial navigation. I gulped and proceeded to go into my lecture. I think my answer turned the trick because I was accepted in the V-12 program and sent to University of Colorado at Boulder, where I spent the rest of the War.

It was tough duty. While I was there I took regular college courses, including some mathematics courses, along with the required Navy courses. For whatever reason, the chairman of the mathematics department, who was also the instructor of my mathematics course, asked at the end of the class, "Bob, would you like to teach?"

I'm sorry. I have to back up a moment. I didn't tell the rest of the story. I took the course in celestial navigation under Professor Samuel Herrick, who was a renowned astronomer. Indeed, he is responsible for developing the equations that have since guided space travel. At the end of the course, Herrick asked, "Bob, would you like to teach?" I replied, "Yes, I would." And he said, "Alright. You'll be teaching next semester." So there I was, a freshman in my second semester at UCLA teaching the course on celestial navigation. Now, the students in the course were all in the V-12 program, so it was perfect preparation.

When I got to the University of Colorado, I took a course in mathematics and the chairman of the math department—a very renowned mathematician whose name I've forgotten—asked me at the end of the course, "Bob, would you like to teach?" For some reason or another, and I don't know what it was about me, professors saw me as a teacher. Indeed, teaching has been a part of my life since I was 16 years old, literally. So I was a teaching assistant at the University of Colorado only a year after I had taught as a teaching assistant at UCLA. Further, I was responsible for the class in each case. I wasn't serving as the usual teaching assistant to work with a particular section. I had the class and it worked beautifully.

BURKE: Then you returned to UCLA and finished your master's degree, right?

HAYES: I finished my B.A., M.A., and Ph.D. in math, all at UCLA.

BURKE: You ended up in a very exciting place in that period of time; the National Bureau of Standards [NBS] in the INA [Institute for Numerical Analysis] at the University. How did you get there?

HAYES: I was out of money when I got my master's degree, so I knew I needed a job. Since the Institute for Numerical Analysis had been established at UCLA, I went to them and asked for a job. They said, "There aren't any openings here, but there is an opening in Washington. If you're willing to go to Washington there will be a job for you there." So I agreed. It turned out that one of the professors who had been at the Institute for Numerical Analysis—they had a variety of people come in on brief appointments—was the famous mathematician Marc Kac. When he was returning to Cornell [University], he damaged his car out in the desert and had to take the train or fly back. So here I had the task of getting from Los Angeles to Washington and they asked, "Why don't you drive Marc Kac's car back." So I drove Marc Kac's car back for him and that was the means by which I got to Washington. I then took the car up to New York, where it was delivered to him.

In any event, I worked in Washington, DC for division 11, which was the mathematical-tables project. It included not only the SWAC [Standards Western Automatic Computer], which was the computer at UCLA, but also the SEAC, which was the Standards Eastern Automatic Computer located in Washington, DC. At that time, I worked on punch card equipment mostly,

not computers. However, I did work initially as the operator of a desk calculator. Periodically, I've been asked, "How does one get into the computer business?" I've replied, "You spend six months running a desk calculator. Why? Because that's what I had to do!" And so I ran a desk calculator. It was dull, but interesting. Then I had the responsibility for running a whole series of punch card operations.

My main task at division 11 was to run what are called Leontief matrices. The Leontief matrix is essentially an input/output matrix for economic assessment. One of its uses is in projecting what the requirements will be to meet identified objectives over time. The matrix shows the input necessary to produce a specified output. Hence, if you want to generate a certain output over time, you must first develop or pass the Leontief matrix over that time period, thereby learning the total input necessary to generate that output. So we just ran the Leontief matrices.

BURKE: So at that time it was a very practical, everyday application of emerging-systems analysis.

HAYES: Not really—but it was a very significant application of an economic model that has far-reaching importance. My task at that time was to run the punch cards that did the calculations.

BURKE: You ended up back at UCLA fairly soon, right?

HAYES: Yes. After about 6 or 9 months in Washington, they announced a fellowship program. I applied and was accepted in the fellowship, and so I returned to UCLA as a doctoral student with my expenses paid by the National Bureau of Standards. I also received a salary as a fellow to work at the Institute for Numerical Analysis, so my economic problems were over. It wasn't a big salary, but it was sufficient for my needs. I was living at home so my costs were quite minimal, but they were real.

BURKE: At that time, you were about twenty-two or twenty-three-years old, correct?

HAYES: Yes. That would have been in 1949 and so I was twenty-three-years old.

BURKE: You were a very young man. You got back to UCLA and completed your dissertation. Apparently, you met an awful lot of people who became major figures in modern programming and information science; like Walter [F.] Bauer. Is that the fellow?

HAYES: Yes, Walt Bauer.

BURKE: Those major figures were at the Institute for a long time, right?

HAYES: There were a number of people that came through the Institute. There are a couple of personal anecdotes that I'd like to mention, just for the fun of it. I was taught programming by Grace Hopper.

BURKE: For heaven sakes!

HAYES: Now the teaching was literally nothing. She taught a class. It was a one-day class on programming. She would give a lecture and then an assignment. So there I was sitting—and I remember this like it was yesterday—trying to figure out how to deal with the assignment, and she walked by me. I remember vividly her leaning over me and saying, "Remember—a command is a number that you can operate on as a number." Bang! Like that, it all came together and I knew exactly what to do. That's anecdote number one.

BURKE: Were you programming in binary at the time?

HAYES: Yes, in machine language.

BURKE: Boy, that's tough!

HAYES: Yes. We didn't have any advanced languages. We had an interpreter language, so that you could get around the necessity of binary encoding. Incidentally, the bootstrap for the SWAC was a set of physical toggle switches that you had to set. Then, when the power was turned on those toggle switches represented the initial commands that caused the bootstrapping of the operating program. So we had interpreters, but it was machine-language programming on the SWAC, and it was quite a discipline because the size of the memory was minuscule. So you had to do everything within a very limited memory—not only the program, but the data you were working on. We didn't have magnetic tapes. The data input was either punch cards or punch tape, and the data output was almost non-existent. It was a very primitive kind of programming environment.

BURKE: You began as one of the very first people in the country to work on the new electronic-digital computers, which was very important to your career.

HAYES: I don't know whether I was that much of a pioneer—I was just simply someone doing it.

The other anecdote has nothing whatsoever to do with my career. We had a variety of visiting faculty. We had UCLA faculty that had appointments at the Institute. We had a lecture series. We had distinguished speakers come and speak. I remember one time a very distinguished mathematician gave a lecture while I was sitting in the very back row. A couple of seats in front of me, off to the right side, sat a guy that looked my age and was wearing a slightly dirty tee-shirt. At some point in that very distinguished mathematician's lecture the student in the dirty tee-shirt got up, and in his Brooklyn "taxicab driver" accent—you know, "Dees, dem and dose," kinds of things—proceeded to raise a whole series of questions. Not so much in an attacking way but in a collegial way. I thought "how can that kid ask those questions?" I turned out that that kid was Richard [P.] Feynman. It was right at the time that he was doing his Nobel Prize winning work in quantum electrodynamics. Richard Feynman is one of the great figures of history and science, and there he was at that lecture.

BURKE: Next to you.

HAYES: Next to me.

[END OF TAPE, SIDE 1]

BURKE: NBS must've been quite an exciting place at that time.

HAYES: I mentioned the second anecdote to illustrate the nature of the people that in one way or another came through, lectured, or participated in the work. It was, as you suggest, a very exciting place to work.

BURKE: How many years did you spend at NBS? Were you there for about 3 or 4 years?

HAYES: Yes. I completed my Ph.D. in June or July of 1952. Then I left the NBS—not because I didn't like the NBS, but because I felt that I could make more income in industry. I applied for position at two companies—one was IBM [International Business Machines Corporation]. I was interviewed by Cuthbert C. Hurd himself here in Los Angeles.

BURKE: For heaven sakes.

HAYES: I also applied at Hughes Aircraft [Company]. I think that the reason that I selected Hughes—and I received essentially identical offers from both of them in terms of the financial arrangements—was because I simply wanted to stay in Los Angeles. If I joined IBM, the nature of IBM was that you had to move, and I'd been tied to Los Angeles for most of my life, essentially.

BURKE: You were married around that time as well, correct?

HAYES: No. I hadn't yet got married. I married shortly thereafter. The fact that I got the job made it possible for me to consider proposing and getting married.

BURKE: What were your jobs at Hughes? Was it the Hughes experience that started you into information processing?

HAYES: No. The Hughes experience was focused on programming a computer to fly an airplane. The result was a series of computer-controlled flights over Los Angeles with pilots in the plane. I was simply part of the team that worked on that project. The interesting problem about it is that you were dealing with sample data systems, in which you had to process data about the current status of the aircraft with sampling sensors.

BURKE: Yes.

HAYES: Sample data systems are fascinating problems. They run into very serious dynamics issues. The kind of dynamic systems that Norbert Wiener was concerned with were very real in that kind of an environment. So I worked on that project.

BURKE: You were also teaching at that time, correct?

HAYES: Yes. I had an adjunct appointment as a lecturer. Part of it was through the University-extension program and part of it was through the mathematics department. Basically, I taught courses on numerical analysis. Why did I do it? I enjoyed teaching, and that kept my hand in teaching even though I was in industry.

BURKE: Around 1954, you moved to the National Cash Register Company [NCR], which had just purchased one of the West Coast computer companies.

HAYES: Yes. They purchased Computer Research Corporation [CRC], which I think had been part of a division of Northrup [Aircraft Company], or some company like that—one of the aerospace companies. Don [Donald E.] Eckdahl was the head of CRC. You may know the history of CRC and Don Eckdahl. He was a fascinating guy.

BURKE: By the way, his papers are now at the NCR archives. If you get a chance sometime, they may be opened up in a couple of years. It might be fun for you.

HAYES: Yes. Anyway, CRC was founded by Don Eckdahl as a division of Northrup, but then it became independent. They designed a digital analog machine. In other words, you have analog computers, but the digital analog would represent the analog processes in a digital form. That was CRC. They were acquired by National Cash Register, and I joined them around that time because I wanted to get involved with business applications, if you will, rather than engineering applications. Indeed, I went from working with mathematical applications at the National Bureau of Standards, to working with engineering applications at Hughes, to working with business applications at NCR.

BURKE: You spent about a year there then, right?

HAYES: About a year and a half I would say.

BURKE: Then you moved to a fascinating company that we know little about at Magnavox [Corporation].

HAYES: Magnavox Research Labs. Now Magnavox was a very prestigious company in Fort Wayne, Indiana. They held the patents on the magnetic loudspeaker and produced high-quality radios, phonographs, and so forth. Magnavox Research Labs was established out here. It was headed by Ragnar Thorensen. Thorensen had been working with Harry [Harold D.] Husky at the Institute for Numerical Analysis. Thorensen setup Magnavox Research Labs to work on the application of digital computers in what we would now call the information field. Basically, it was in support of the intelligence community.

Magnavox Research Labs was a sub-contractor to Eastman Kodak [Company] on the development of the Minicard system, which was one of the early offshoots of a whole development related to Vannevar Bush‘s Memex machine. The rapid selector was the first attempt to realize Vannevar Bush‘s ideas. The Minicard was a second attempt. The basic contract was from the CIA [Central Intelligence Agency] and the [United States] Air Force, but

there were other contracts with NSA [National Security Administration] and the intelligence community.

BURKE: Magnavox put their proprietary name on it later with Magnacard, right?

HAYES: The Magnacard was a very different development.

BURKE: All right.

HAYES: The Minicard was purely a Magnavox Research Lab development. The idea was to have a small magnetic card that could be sorted and collated physically, so that you could do everything that you would do with a punch card, but it would be done with magnetic data and therefore would be erasable. I mostly focused on the sorting and collating aspects of the Minicard. The Magnacard was similar, and both systems worked in a utilitarian sense; meaning, how will we use this device and therefore what should it look like? What specifications are required to make the engineering designs consistent with the applications? The Magnacard was one of several parallel developments for mass storage at the time.

Now the one that succeeded was the magnetic disk. Incidentally, the magnetic disk is based on Jake [Jacob] Rabinow's idea. He worked for the National Bureau of Standards and first conceived of the idea for an array of disks as a storage medium in the 1950s. IBM [International Business Machines Company] first implemented Rabinow's idea in the mid-1950s. Parallel efforts for data storage were considered by NCR, where they thought of using magnetic strips; and of course, we at Magnavox Research Labs thought of using magnetic cards. Magnetic drums, of course, had been used for some time, but they were quite slow and had a very limited capacity. The objective was to develop media that had high-volumetric efficiency in terms of data storage.

BURKE: Were you interested in "the information problem" at that time?

HAYES: Exactly. Most important was the application to the kinds of problems encountered by the intelligence community. So I worked on that problem, drawing in part on the experience with Minicard, but looking at more dynamic kinds of data than the Minicard represented.

BURKE: You stayed at Magnavox quite a while.

HAYES: Five years.

BURKE: During that period, didn't you also visit Washington D.C. to teach for awhile?

HAYES: Yes. My task at Magnavox was to figure out how to apply the Minicard system. The obvious application, based upon the intelligence community's needs, was information retrieval. How do we retrieve information by a computer? How do we store information so that it can be retrieved? I knew nothing about that. Some of the ideas for information retrieval, such as superimposed coding, or Zatocoding, had arisen in the early 1950s and had intriguing implications for those that were technology-oriented. So, we had those kinds of techniques.

First, I needed to understand the systems for information storage and retrieval at that time. Therefore, I began assembling all of the examples of techniques for storing and retrieving information that were endemic, or at least were being created at the time. Among them was the Uniterm system created by Mortimer Taube of Documentation Incorporated, and Calvin [N.] Mooer's TRAC macro-processing language. I had to assemble and understand those systems and relate them to how the computer should process information. It's interesting to note that the people, for example, like those at Western Reserve University—Alan Kant and [James W.] Perry—were trapped intellectually in the kind of matching algorithms that were involved in superimposition and are represented in the rapid selector and in the Minicard system—namely, instead of using logical processing they looked for the matching.

BURKE: Do you mean the optical-matching process?

HAYES: Right. And they were trapped intellectually in the concept that that kind of process was <u>the</u> process. Having come from the computer field, I didn't examine the recorded data as it was recorded, but rather, I viewed it as data that needed to be processed. So I interpreted everything that was happening in that light, rather than in the way in which the technology had kind of forced them to think. Optical matching was inherent in what so many people were doing. It was also, incidentally, inherent in what Mortimer Taube's and Calvin Mooer's work because the light going through was exactly the superimposed coding that the pins went through. So you're basically conditioned to view the retrieval process as a simple kind of matching.

So, I had to put that stuff together in a way that made sense to me. As a teacher, I thought, "Wait a minute. What I'm doing is something that can be taught." So I went to UCLA, with which I had an extensive teaching relationship, and told someone in the University-extension program, "I have a two-week course that I want to offer. How can I do it?" He replied, "It sounds as though it would best be done as a short, two-week course. We can advertise it, and from what you've told me I believe we can get an audience for it." So I said, "Alright. I'll put together a short course—two weeks—and let's see where it goes."

That was in 1958. I think that was the first time I offered it. I had 60 students. Most of them came from Washington, but there were several from the aerospace industry here in Los Angeles as well. The course was two solid weeks of eight-hours-a-day lecturing in which I presented my story. I taught them what computer application to information storage and retrieval means. It was offered at UCLA five times, for five years. At the end of the first offering, I was asked to present the course at American University in Washington, DC, because they realized there was an audience for it. So I presented at American University three times. The Air Force asked me to give a special offering of the same course at Wright Paterson Air Force Base. Georgia Tech [Georgia Institute of Technology] asked me to give the same course, and the University of Washington, in Seattle, asked me to give the same course for three successive years.

BURKE: You had become a central figure by that time.

HAYES: I wouldn't say a central figure—but the teaching was, if you will, my key for opening the door. In the course I taught at American University, there were 200 students in the class. I can remember one of the things that I said was, "People do not use information to make decisions. Instead, they use information to support decisions they've already made." [laughter] The response from the audience was palpable. You could feel it because half of the people in the audience were from the CIA! I was sticking a dagger right into their hearts because we were right in the midst of <u>exactly</u> that kind of a process; that is, they were in the position of providing the information to support decisions that had already been made.

BURKE: Did you, by chance, meet Joe [Joseph] Becker at that time?

HAYES: Yes. Actually, I met Joe because of the contract work that Magnavox had with the intelligence community. Joe was in the intelligence community.

This reminds me of an interesting aside. One time, I was in Washington as part of that contract work and I was returning by bus to my hotel—the old Wardman Park Hotel in Washington, DC, just off Connecticut Avenue, North of the Calvert Street bridge. As we crossed the Calvert Street bridge, going North on Connecticut, I saw a sign off to the right that read, "Documentation Incorporated." I didn't know what Documentation Incorporated was. That was early on in the contract. Out of curiosity, I got off the bus and went into the building—it was about five o'clock in the evening. I asked the receptionist, "What is Documentation Incorporated?" She looked at me in shock and offered, "Why don't you ask Dr. Taube himself?" There was Mort Taube. So I asked him the same question, upon which he invited me into his office and we sat down and talked for the next three hours. It turned out that we were doing very similar kinds of work—I from the computer side and he from his side. That was the beginning of a friendship.

About six months later, he invited me to participate in a conference that he was putting on. The paper I had presented and details of the Magnacard system were some of the particulars published in that conference's proceedings. At that conference in 1957, Joe Becker and his boss, Paul [A.] Borel, approached me with a question. Paul Borel asked, "Bob, do you have any advice on how Joe can best learn about the computer field?" And I said, "Yes. UCLA Western Data Processing Center is developing a computer network. I think that's where Joe can get the best background." Joe was there about five months later.

BURKE: About that time, you changed jobs and were apparently a founder of Advanced Information Systems [AIS], which was allied with another kind of venture. Would you explain how that happened?

HAYES: Yes. A company called Electrada [Corporation] was formed by a very strange man named Homer [H.] Rhodes. Homer Rhodes had made quite a bit of money in a company called Hydro Air [Inc.], which held the patents on the anti-skid system for airplanes. For instance, a landing airplane faces the problem of skidding, and so the sample-data system to prevent skidding is a servo-mechanism that sampled the forces as the plane landed and controlled the brakes so as to avoid the skidding. As far as I know, all the modern planes have Hydro Air-type equipment in their landing systems. So, he made a lot of money won a lot of contacts in the aerospace industry. He convinced a remarkable set of businessmen, including the President of Lockheed [Martin Aeronautics Company], Robert Gross, and the President of Rexall [Sundown, Inc.], Justin Dart, to invest in Electrada.

Indeed, to goal of Electrada was to exploit developments in what we now call the information field. For whatever reason, they asked me to join them from Magnavox. I saw the offer as an opportunity to get in on the ground floor of a new company that obviously had a lot of prestigious money behind it, so I accepted it. Magnavox was quite disappointed. They had been very good to me, and I think I had been of value to them, but I couldn't pass up Electrada's offer.

So I went with Electrada, and brought with me a couple of contracts that Magnavox couldn't perform on without me being there. Magnavox was very generous in permitting me to take those contracts. Having joined Electrada as a vice president of research, I recommended taking the work I was responsible for at Magnavox and setting it up as a subsidiary of Electrada that operated as an independent company. It became Advanced Information Systems Incorporated, and from my standpoint it was a most successful operation.

BURKE: What was the main purpose of Advanced Information Systems?

HAYES: We did contract research and programming for information kinds of things. My partner, John [A.] Postley, whom I had invited to join me at Electrada, created Advanced Information Systems with me.

[END OF TAPE, SIDE 2]

BURKE: At Advanced Information Systems, you and John Postley worked on one of the first database management systems ever, among other things. Then in 1964, you became a fulltime professor at UCLA. Why did you make that choice?

HAYES: First of all, let's go back to the course that I taught on information storage and retrieval. I had the heretical idea, as far as computer people were concerned, that librarians knew what they were doing in information storage and retrieval. So I wanted to include a presentation of library techniques to computer people in the course. I went to Lawrence Clark Powell, the librarian at UCLA and the director of libraries. Of course, I was unaware that Powell hated technology. I bearded the lion in his den. I asked for an appointment. I met with him. I said, "Dr. Powell, I'm giving this course on information storage and retrieval and I would like to include in it a presentation about librarians' methods and techniques. Can you advise me?" He finally referred me to Andrew [H.] Horn. He and Andy Horn were creating, at that very moment, the School of Library Service.

Lawrence Powell became the founding dean, and Andy Horn was the associate dean. Further, Larry Powell was running the library and Andy Horn was creating the School. So I went to Andy Horn—I'd met him before, but I didn't know him well--and I said, "Andy, here's what I am doing. I'm giving this course. I want to have the techniques of librarians presented to the computer people. Can you help me?" He said, "Sure." So he participated. He presented library methods for one day of the course. That led to a continuing friendship that grew as the School developed. Powell and Horn asked me to teach a course, so I taught a course in the School periodically.

Now, that was all background to the creation of Hughes Dynamics [Company] in 1964. Hughes Dynamics had nothing to do with Hughes Electronics [Corporation], or the Hughes Aircraft Company. It was a subsidiary of the Hughes Tool Company. Much earlier, the Hughes Tool Company had to divest itself of its interest in the Aircraft Company because of chicanery that was going on. The Air Force was so dependent upon the Hughes Aircraft Company that they were in turmoil. Thompson [Products, Inc.], Ramo-Woolridge [Corporation], and TRW [Inc.] as the successor of those two companies, were created as a result of the turmoil that was happening at Hughes.

You should examine that story closely. Hughes Dynamics had nothing to do with the Hughes Aircraft Company. It was a subsidiary of the Hughes Tool Company. They acquired AIS from Electrada, and John Postley, the staff, and I became a part of Hughes Dynamics.

Initially, I was happy because the Hughes Tool Company had all the money we could possibly need. However, it became very evident within a month that Hughes Dynamics was going nowhere. They were driven by the internal and external politics of the Hughes Tool Company—the conflicts between the Mafia-type people at Hughes and the Mormons at Hughes.

The story is quite fascinating. Having realized that Hughes Dynamics was going nowhere, John and I asked ourselves, "What are we going to do?" John had been developing a relationship with Informatics [Inc.], and so he joined them. I had developed relationships with UCLA, and so I asked Larry Powell and Andy Horn, "How about it?" They consented, and that was it. I became a professor in what was then the School of Library Service.

BURKE: Was the School focused on teaching computer people about library stuff?

HAYES: No. The School had been focused on library studies. And although Larry Powell hated technology, he realized computer technology would be important. Andy Horn and Larry Powell entrusted me with the task of bringing that orientation to the School.

BURKE: In 1965, the School also founded fairly soon the Institute for Library Research.

HAYES: The Institute for Library Research was not founded by the School. It was founded by the University as a University-wide institute.

BURKE: Do you mean the University in terms of the entire California system?

HAYES: Yes. There were two branches of the Institute—one at Berkeley [University of California at Berkeley] and one at Los Angeles. That's one of the defining characteristics of the Institute. In the University, you have different types of organized research units. You have institutes, you have centers, and you have laboratories. An institute must be multi-campus or multi-disciplinary. A center can focus on a single discipline. The Institute was setup as a University-wide research institute with an office at Berkeley and an office at Los Angeles. Initially, the Institute's director was to be located at Berkeley. When the Institute was established they asked me to be involved because I was already getting grants and contracts.

As a matter of fact, when I joined the University I immediately began sending out proposals. From my experience at AIS, I thought I would be lucky if I received responses from one out of five. So I sent out about half-a-dozen proposals and I expected to get one or two of them accepted. I was just ecstatic when the first one was accepted; the same thing with the second one. When the six of them came in I was scared. I thought, "What am I going to do?" In any event, my success, and it was success, in getting grant funding led them to say, "Bob, why

don't you become the director of the Institute of Library Research." And so I did. We had an associate director at Berkeley, and that position was filled by [Melvin E.] Bill Maron, who had been at the Rand Corporation. Ralph [M.] Shoffner had worked for me at AIS, and since I was unable to get the appointment for him at UCLA, which both Maron and I agreed he needed, he went up to Berkeley; there, Bill Maron got Shoffner the appointment he needed. Shoffner was a key person—very important.

BURKE: Did you play an important role in the modernization of the California's university library systems? I know at that time they were moving towards research, there were new library demands, and they were getting federal money to help build.

HAYES: Right. The Institute was created for that purpose. As I said, Ralph played a very key role and was very important.

BURKE: Around 1969, you and Joseph Becker formed a consulting company.

HAYES: Yes. Becker and Hayes Incorporated.

BURKE: And very soon you published a book that some people recall as a foundation of information science.

HAYES: I doubt that. The first book was published in 1963, and was entitled, *Information Storage and Retrieval* (2). There's no doubt that it became a classic text. The book published in 1970 was entitled, *Handbook of Data Processing for Libraries* (3). That also was a very successful textbook. Joe and I had developed a very close working relationship and friendship over the years, and as soon as he came out to Los Angeles we began working together.

BURKE: Did he come to California to work at Rand?

HAYES: No. He was never at Rand, as far as I know. He was at the Western Data Processing Center, but was, in fact, working for the CIA. Becker was using Western Data to learn about network development and then play a key role in it later. Indeed, Joe was instrumental in the initiation of Educom [TS Inc.] and served as a president of Educom for a couple of years.

BURKE: UCLA was very tied to what became the ARPANET [Advanced Research Projects Agency Network]; an inductive prototype networking.

HAYES: Precisely. That was all happening at the Western Data Processing Center.

BURKE: And that's while Joe was there.

HAYES: Joe was right in the middle of it. He was very key, but quietly so. He was not a flamboyant figurehead, but he was very much there.

BURKE: What did Becker and Hayes do as a company?

HAYES: It started out as a consulting contract with the State of Washington on the development of a library network. That was at the time when the Library Services and Construction Act was encouraging each state to create a statewide network of libraries—multi-type networks involving academic libraries, public libraries, school libraries, and special libraries, in a cooperative structure. Our contract with the Washington State Library was very successful. It led directly to creating what became the Washington Library Network [WLN]. WLN was one of the first, along with OCLC [Online Computer Library Center] and RLN [Research Libraries Network]. They were all parallel bibliographic utilities. Our role was to provide the means of resolving the political problems caused by bringing libraries together and working with the State Library that our report led to directly.

BURKE: Would you like to talk about some of the political problems? What were they?

HAYES: There weren't political problems, necessarily—but we had to figure out how to bring people together. How do you bring together the diverse communities of academic and public libraries involved? Because there were university and community libraries that we had to unite, the question was, how do we do that? So our task was to resolve the politics of the situation.

BURKE: Around that time, you were also becoming increasingly involved in major decisions regarding information systems in the United States. You're on policy boards and I think that you did a contract job for the National Commission of Library Information Science [NCLIS].

HAYES: Yes. How can we rationalize the funding of a national library network? I believed that libraries should be funded with public funds, not fees. Libraries are public agencies that should be sharing resources for increased efficiency. They should be communicating with each other, and cooperating so that the individual libraries have their costs reimbursed rather than

suffer in participation. I called for federal and state funding of the costs incurred by the libraries in providing materials. That was a report.

BURKE: I've read part of your studies on the library loan systems (4).

HAYES: That was the SILC [System for Interlibrary Communication] system. It had the same objective, which was to develop a structure for communication that incorporated the accounting on which the funding could then be based.

BURKE: There was a public-sector/private-sector report out of NCLIS that I understand is very politically delicate.

HAYES: Yes.

BURKE: Nineteen eighty-two, was it?

HAYES: No. It was published in 1982, but it started in 1979 during the [Jimmy] Carter administration. It was completed at the beginning of the [Ronald] Reagan administration. It was a very successful taskforce. A very difficult problem that we faced was the view by the private sector that the federal government was competing unfairly with private information. Now, recognize that the networks and databases had been, in fact, created as a result of federal funding. Burt [Burton W.] Adkinson at the National Science Foundation had funded the Chemical Abstracts index.

BURKE: In several places I know.

HAYES: Right. The *Index Medicus* database was funded by the National Library of Medicine, and the ERIC [Educational Resources Information Center] system was funded by the Department of Education. So you had a huge federal investment. As the private sector was building its momentum on that, they felt that the government was competing with them. The prime example was Elsevir [Science Publishers] and *Excerpta Medica* that instituted lawsuits against the National Library of Medicine over *Index Medicus*. They continued to sue over the years, claiming the pricing policies were unfair because the pricing of *Index Medicus* did not include the costs of creating the database, whereas *Excerpta Medicus* had to recover those costs; hence, the competition was unfair. So there was a conflict as it was seen from the private sector, between government and the private sector, and we had to figure out how to resolve it.

The taskforce came out with a set of principles asserting essentially that government information should be made readily and openly available and that the costs for doing so should be the costs of access and reproduction purely. Those were positions which were totally at odds with the Reagan administration's agenda. They were totally against open access to information of any kind. In fact, at the meeting of the ARL [Association of Research Libraries], at which I presented the taskforce's report, a representative from the Office of Management and Budget explicitly said, "The administration is against open access to information."

BURKE: Were they even averse to giving private vendors a chance to buy that data at a nominal sum?

HAYES: Precisely. The taskforce concluded that government information should be readily available to anyone, including private sector companies that want to add value to it, market it, distribute it, and so on.

BURKE: Was the Reagan administration against even giving data out at cost?

HAYES: Yes. Ken [Kenneth] Allen, for example, asserted that we didn't want our enemies to get information about our economy. After that, I got up and said in response, "By preventing access to this information you're preventing industry in the United States from making necessary decisions about its future." They were totally against open access to information and that showed up in a variety of ways. They were also, however, totally against essentially free access to information. The right-wing economists' view is that the force of the marketplace should be the determinant; therefore, you should price things at what the traffic will bear.

So, the public-sector/private-sector taskforce was accepted by the National Commission [NCLIS], but not approved by the National Commission. Now, within the last year—as a matter of fact, within the past month—the public-sector/private-sector taskforce report has been reissued by the National Commission on Libraries and Information Science essentially as originally published, but with a new preface. The new preface says, "The principles identified in this report continue to be valid despite all of the technological developments that have taken place." It was a very good report. (5)

BURKE: I've read it several times. You were still teaching while all of this was happening.

HAYES: Of course.

BURKE: You were very instrumental in defining curricula for what became information science.

HAYES: I think that I played a role, yes.

BURKE: Was there something that you thought was essential or some things that were essential to defining information science *versus* library science?

HAYES: I do not and did not think that these were versus, and everything that I did had the objective of bringing the two pieces together. I saw them as complementary, as mutually supportive, and as mutually necessary. I felt that students in librarianship needed to know about computers and information science, not as a separate thing, but as an integral part of everything that they were doing. I see it as an integral part of cataloging. I see it as an integral part of reference. I see it as an integral part of library management. On the other side, however, I also see that information science in this field is not independent of librarianship. It is very dependent upon the institution and the institutional priorities and imperatives.

BURKE: My last question was motivated by my teaching experiences in some information science programs. When I got into that field, I found that it was only about general familiarity with computers, some technical file management questions, and nothing about the logic of organizing information. I think that was typical by the early 1980s.

HAYES: Yes.

BURKE: What happened? Was it the market?

HAYES: It's hard to say. Please recognize what I have said—that to me the library is an important institution. It is important for itself, it is important in society because of its imperatives: the preservation of the records of the past, open access to information, equity, and the principles embodied in the Telecommunications Act of Equity and Access. There are many people that see librarians as fuddy-duddies; as dead or dying, or as threats because of the inertia they have. In academic environments, librarians are seen as threats because of the money involved. Remember, in most universities the library is second only to the faculty in the budget.

The facts are that academic libraries and indeed public libraries are very well managed, superbly managed. They are very service and user-oriented. Traditionally, computing facilities have been managed very poorly. They are very focused on technology. They couldn't care less about the users or the service; only the technology is important. The result is that libraries will

survive. Computing facilities will become what they are—namely, very distributed things. But still there are those that see the library as a dying institution. I don't. I see it as a vital and important institution.

BURKE: Thank you very much. This has been a fascinating interview.

HAYES: Thank you for the opportunity.

[END OF TAPE, SIDE 3]

[END OF INTERVIEW]

NOTES

1. *Liberty Magazine*. Vol. 22, 17 November 1945.

2. Joseph Becker and Robert M. Hayes. *Information Storage and Retrieval: Tools, Elements, and Theories*. (New York: Wiley, 1963).

3. Joseph Becker and Robert M. Hayes. *Handbook of Data Processing for Libraries*. (New York: Becker and Hayes, 1970).

4. Robert M. Hayes. *A System for Inter-library Communication (SILC)*. {Washington: Association of Research Libraries, 1974); Robert M. Hayes. *A Final Report on a Study of a System for Inter-library Communication (SILC)*. (Los Angeles: Becker and Hayes, 1974).

5. *Public Sector-Private Sector Task Force Report*. (National Commission on Libraries and Information Science, 1982).

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