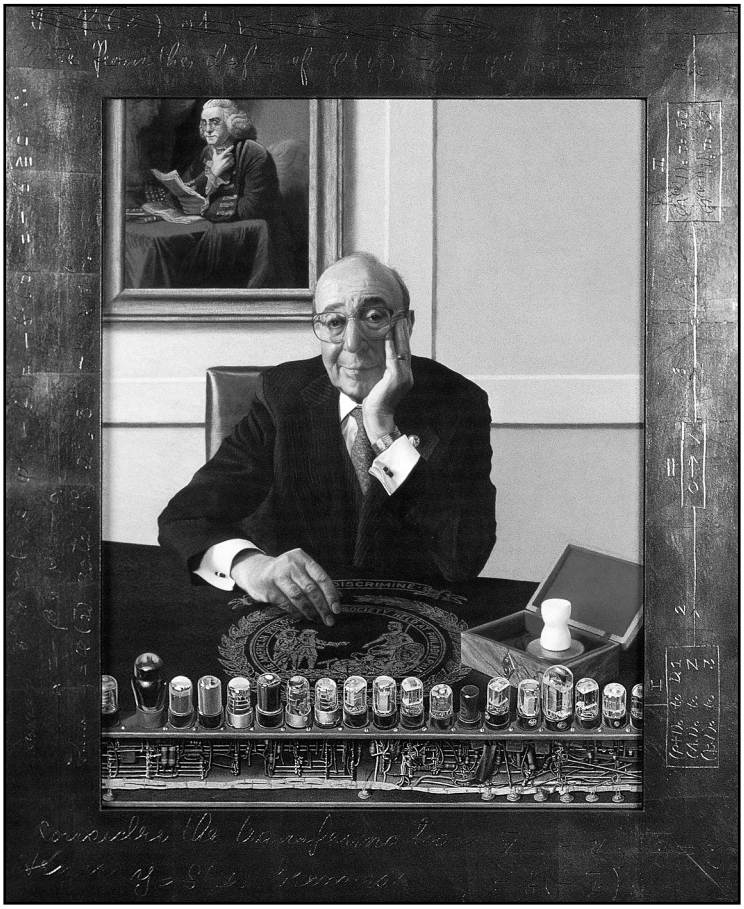
HERMAN HEINE GOLDSTINE



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I FIRST got to know Herman at the Lamb Estate. It was 1959 and the rapidly expanding IBM Corporation was building its research division. While permanent buildings were under construction, the entities that were to become IBM Research were scattered among temporary locations up and down the Hudson Valley.

Herman Goldstine headed the group located at the Lamb Estate up on a hill near the village of Croton-on-Hudson, near the Hudson River, and about fifty miles north of New York City. The Lamb Estate was mostly a complex of small buildings. At the Lamb Estate we were all mathematicians or programmers or logicians or statisticians. We did nothing requiring labs because we worked in old home-sized stone or wood houses. The whole setting was very old-fashioned and picturesque and not at all suggestive of the type of problems that we were in fact attacking there in the first flush of the computer age.

At the Lamb Estate we thought of ourselves as princes of the earth because of our computing support. Every day a station wagon left the Lamb Estate and went up to Poughkeepsie. It carried our programs and returned the next day with results. More than a thousand people up and down the Hudson Valley shared that Poughkeepsie computer, which had less power than the humblest of today's PCs. But by the standard of the day we were princes.

Herman, who had brought me from teaching at Princeton into IBM, was responsible for the site and all its activities, so we had many meetings of a purely business sort: what was I doing, what was my group doing, et cetera, et cetera. But gradually, as was natural in the informal and relaxed atmosphere of the Lamb Estate, our conversations drifted off into a great variety of other things, and despite our differences in age and position we became friends.

It was easy for me as a Princeton mathematics Ph.D. (1954) who had spent time in the navy to relate to Herman's background both in academia and in a technical military environment. When Herman talked about his own history it was peopled with names that were familiar to me. Herman obtained his Ph.D. at the University of Chicago in 1936 and continued there as a research assistant. For much of that time he worked with Gilbert A. Bliss on the calculus of variations. Significantly, in light of what lay ahead, Bliss had been one of a group, organized by the Princeton mathematician Oswald Veblen, that had worked on ordnance problems for the army during World War I. Bliss had made significant contributions to the theory of ballistics. When Herman was called into the army in July of 1942, Bliss wrote to Veblen. Veblen had returned to the army as the chief scientist of the Army Ballistics Research Laboratory in Aberdeen, Maryland. Bliss suggested to Veblen that he should get Herman assigned to the Ballistics Research Laboratory.

This initiative succeeded—barely—as Herman recounted years later in an interview.[1]

Herman was in the army at Stockton, California, when he received not one but two sets of orders at the same time. One set ordered him to leave for a destination in the Far East and the other one ordered him to proceed to the Ballistics Laboratory at Aberdeen. As Herman remembered it, "I called the commanding general, and he (the General) said, 'Which do you want to do?' I said, 'I want to take the Aberdeen post.' And he said, 'Well, the orders from the Adjutant General in Washington obviously take precedence over the orders from a post adjutant in some fort in Stockton, California.' 'Son,' he said, 'if I were you, I would get out of the camp. If you've got an auto, I'd get in the auto, and start driving. Let the paper work catch up later on, because otherwise you'll just have an impossible time.' So I got in the car and drove east."[2]

It was of course a decision with momentous consequences for the early history of the computer. I do not propose to recount that history here in any systematic way. The crucial role that Herman played in supporting and helping to create the ENIAC project at the University of Pennsylvania is well known. That development, which showed for the first time the true potential of the modern electronic computer, is beautifully described in Herman's 1972 book, *The Computer from Pascal to von Neumann*,[3] as is the even more seminal work of Burks, Goldstine, and von Neumann that led up to the Institute for Advanced Study Computer Project, which set the form of the computer as it is today.

I cannot add anything significant to the fundamentals of Herman's and others' descriptions of those events. They occurred ten to fifteen years before I met Herman. However, from my knowledge of Herman and of the mathematical milieu I can provide some sidelights.

Herman was given the task of interacting with the work being done at the University of Pennsylvania in a group affiliated with the Ballistics Laboratory. He quickly saw the possibilities in the new proposals being put forward by John Presper Eckert Jr. and John W. Mauchly for a super-fast electronic computing engine. He began to advocate that the army support their new and daring proposal, which ended up as the ENIAC.

There were many discussions within the Ballistics Laboratory. Herman recalled one critical meeting with Veblen and Colonel Simon, the director of the Ballistics Research Laboratory, who was himself a distinguished contributor to the practical uses of statistics. Herman asked

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[1] See ref. 1.
[2] See ref. 1.
[3] See ref. 2.

Colonel Simon to fund the ENIAC project. There was much discussion back and forth; after all, it was a risky enterprise. Finally Veblen said to the Colonel, "Simon, give Goldstine the money."

There were more meetings after that meeting but their result was foreordained. The trust among the mathematicians and scientists who knew each other was an essential ingredient in a decision that was a turning point for modern computing. The army supported the ENIAC, and Herman was the army liaison to the ENIAC and to Eckert and Mauchly. The ENIAC eventually ran, and showed the world what was possible in electronic computing.

Herman liked to reminisce about many of the mathematicians he had known. Of Bliss and Veblen he had only the kindest things to say. One of the many positive things he had to say about them he repeated at a later date: "Both he [Bliss] and Veblen had this very gentlemanly quality of just treating people the way they were. That was a remarkable quality both of them had. At any rate, I liked and admired both of them very much. I don't know two men that I really liked, respected, and admired so much, and who were so nice to me as those two men."[4]

Herman could also be enterprising and act quickly and without the slightest hesitation. This struck me forcibly in one of our conversations in his office, a conversation that turned on something going on in another part of IBM, something I needed to know more about. When I mentioned this, without saying another word he seized his phone, located the person in question, and immediately found out what was in fact happening. He did not hesitate. He did not say, "I'll find out later"; he simply acted. It was strikingly different from what I was used to in academia.

The same quality was apparent in the celebrated incident of his accidental meeting with von Neumann on the railway platform at Aberdeen. Von Neumann was a member of a very distinguished advisory committee to the Ballistics Research Laboratory, which included I. I. Rabi and several others of similar distinction. Before the war Herman had heard von Neumann give a lecture, but he did not know him, and probably von Neumann had no idea at all who Herman was. But Herman saw von Neumann on the railway platform at Aberdeen and did not hesitate; he went right up to him. He introduced himself and started to talk about the ENIAC project. As Herman wrote later, when he mentioned 333 multiplications a second the whole tone of the interaction changed; Herman had captured von Neumann's interest in the ENIAC. His quick, unhesitating action had momentous consequences for the future of modern computing. It brought von Neumann into contact with the

[4] See ref. 1.

ENIAC, with major effects on the design of a successor machine, the EDVAC, the first computer design in which the stored program concept appeared. In addition it gained him a lifelong friend and collaborator.

This chance encounter led to a long and epoch-making collaboration between the two men. After the war they worked together to create the pioneering Institute for Advanced Study computer. I can remember, at that time and even much later, considerable debate about the real importance of computers to science and to the world. In those pre-transistor days it was not easy to foresee their present ubiquity. As the Institute was deliberately and exclusively dedicated to theory, there was considerable resistance to the idea of building a real hardware machine. But again Veblen, who was among other things a trustee of the Institute, played a vital role. As Herman wrote, "It is doubtful to me whether von Neumann would have persevered in trying to convince the Institute to take on the project if it had not been for Veblen's courage, foresight, and unlimited patience."[5]

But in the end the machine was built. Its design was described in the famous June 1946 report, "A Preliminary Design of an Electronic Computing Instrument," written by Herman, Arthur Burks, and von Neumann. The machine architecture described in that remarkable report is often referred to as the von Neumann architecture. It became the basis of almost all machines subsequently built, including today's microprocessors. The actual machine was built at the Institute, was replicated in other places, and became the direct ancestor of the vast array of modern computers that affect every aspect of our lives today.

The fruitful collaboration between Herman and von Neumann lasted until von Neumann's death in 1957.

Herman often reminisced about von Neumann. His stories sometimes touched on von Neumann's remarkable ability to compute in his head. One story he told me was of von Neumann's solving this mathematical puzzle: Two trains on the same track are heading toward each other on a collision course. Their speeds and positions are known. A fly, whose flight speed is also given, flies back and forth between the trains until the two trains collide. How far will the fly travel before it is squashed between the colliding trains?

Now it is quite straightforward to work out how far the fly will go on its first trip between the engines, and then apply the same rule to get its second trip, et cetera, through its very short flights back and forth at the end. Then you can add all these up (sum an infinite series) to get the total flying distance. However, the insightful thing is simply to compute

[5] See ref. 2a, pt. 3, chap. 1, "Post EDVAC Days."

the time to the collision, which follows immediately from the train speeds, then give that much time to the fly who is always flying and see how much distance it would have covered. If the speeds, distances, and so forth, are chosen to be easy numbers, the answer obtained in this way can be done in your head.

When the problem was posed to von Neumann, he immediately gave the correct answer. On being congratulated on having seen through the problem, he was surprised: In fact, he had not seen through it; rather, he had summed the infinite series in his head.

More important to Herman by far than his admiration for von Neumann's mental powers were his warm relations with and genuine affection for the man he always referred to as "Johnny." The relaxed relationship between von Neumann and the Goldstines is reflected in the following story: "Many evenings he [von Neumann] would entertain. Usually a few of us, maybe my wife and me. We would just sit around, and he might not even sit in the same room. He had a little study that opened off of the living room, and he would just sit in there sometimes. He would listen, and if something interested him, he would interrupt. Otherwise he would work away."[6] Von Neumann's early death from cancer was a blow to Herman.

Herman left the Institute and joined IBM in 1958. At that time IBM established Research as a separate entity. First at the Lamb Estate and later at the T. J. Watson Research Center at Yorktown Heights, he headed the mathematical work and built a very strong mathematical sciences group of which I became a part. Later in his IBM career he served in other capacities, for example, as an IBM Fellow, the company's highest technical honor.

An important role Herman had was to strengthen IBM's relationship with universities. In those days computer manufacturers vied with each other to offer especially attractive arrangements to universities, because at that time scientific computing was a large part of the market for computers. Herman was extremely successful at this. However, as IBM became bigger and more successful, times changed. IBM was sued by the government for antitrust violation, a suit that was later dropped by the government after many years of trial. But at the time Herman told me that once the antitrust case started it was "like doing your income tax for April 15th, everything that I had done well and successfully now contributed to a bad outcome and everything I had failed at was good."

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[6] See ref. 1.

Herman testified in the antitrust case and charmed the usually hostile Judge Edelstein. The judge asked Herman if it was true that one divided by zero is infinity. Herman managed to give a diplomatic answer.

Herman often referred to his wife Adele as the world's first programmer. Adele played a significant independent role in the ENIAC and the IAS computer programs.[7] Unhappily, Adele developed cancer and died in 1964. She and Herman had at that time two small children, Madlen and Jonathan. It was a very difficult time for Herman. In 1966 Herman married Ellen Watson, who remained a wonderful support to him and the family for the rest of his life. After the Goldstines moved to Princeton in 1973 and Herman returned to the Institute for Advanced Study, it was often Ellen's efforts that made it possible for me to stay in touch with Herman.

As Judge Adams describes in far greater depth, Herman became the executive officer of our society in 1984. He moved to Rittenhouse Square in Philadelphia and then, on his retirement, to a retirement community in Bryn Mawr. With Ellen's help we managed to stay in touch although in the later years, due to his difficulty in speaking, communication became increasingly difficult. Still, from those later years I have some wonderful memories.

Herman was always very kind to me. He invited me and Spike Beitzel, another old IBM friend,[8] to the ceremony in 1983 at which Herman was awarded the National Medal of Science by the president. It was a great and happy event, with everyone in high spirits. We were all delighted that Herman's wonderful achievements were being properly recognized. As we walked back through the White House, Herman was trying to fasten the beautiful little real gold lapel pin that a recipient gets to his coat jacket. It kept falling off. He turned to me for help, and I confidently pushed the pin through his lapel and then pushed as hard as I could on the backing piece. Then I stood back. Immediately the backing piece fell off and rolled away under some heavy furniture. I do not remember clearly if we ever got it back; perhaps it is still there somewhere in the White House. But I do remember clearly Herman's stricken look as it disappeared. But he, with the kindness he always displayed to me, uttered not a single word of reproach.

A few years later I too received the National Medal of Science, and immediately and cautiously examined the beautiful little pin. I found it was made with a screw backing that could not be pushed on. This meant that both Herman's and my efforts had been doomed from the very start. Fortunately our friendship had survived that difficult moment.

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[7] See ref. 3.

[8] Also a member of our society.

I have another vivid memory of Herman at another ceremonial event in Washington. Herman was the person I wanted to have introduce me. But it was 1998, and Herman, who was already in his mid-eighties and suffering from Parkinson's disease, didn't think he could do it. In the end, with Ellen also persuading him, he agreed to try. On the day of the event the large auditorium was packed. Herman was sitting on one side of the stage; the podium was at the other side. When it was his turn, he rose and started, slowly and with visible effort, to cross to the other side of the stage. The audience knew it was seeing one of the great computer pioneers and was totally on his side. He reached the microphone and started to speak; it was hard to make out the words but you could feel the audience straining to understand. When he returned slowly to his seat, they all cheered. They cheered the man, they cheered his visible courage, his effort, and his great achievements. It was a wonderful moment.

RALPH E. GOMORY
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MY FIRST ASSOCIATION with Dr. Herman Goldstine occurred in 1984. At that time, Jonathan Rhoads was the president of the Society, and our distinguished friend Whit Bell decided to retire as the executive officer. Because I occupied a number of critical positions in the Society, Dr. Rhoads consulted with me regarding a successor. I doubt that Dr. Rhoads had any questions about the replacement, but as a great believer in the democratic process he sought to engage me in a serious discussion regarding the selection.

In any event, the unanimous choice was Herman, who at the time was at the Institute for Advanced Study in Princeton. Soon, Dr. Rhoads stepped down as president of the Society, and was succeeded first by Crawford Greenewalt and then by Eliot Stellar. When Eliot became very ill in 1992, Jonathan—as chair of the Committee on Nomination of Officers—visited me at my home, and asked me to take the helm.

Thus began a six-year engagement, starting in 1993 and ending in 1999.

I quickly realized that the success of the Society depended in large measure on leadership. Fortunately Herman and I not only saw the possibilities for the Society in exactly the same way, but also worked closely as a team.

Almost every morning when I came to my office I would telephone Herman and we would review the possibilities for the day.

We devoted considerable attention to the endowment, which during this period went from less than $60,000,000 to more than $120,000,000, a result that received a substantial assist from a strong stock market. The endowment is important for many reasons, but since it provides most of the funds for the Society's programs, it is critically important.

We both saw the need to enhance our membership. Great effort was made to elect women, younger people, and minorities. We also saw the need to augment the traditional five classes, by establishing TNGS (Temporary Nominating Groups) to cover the new disciplines that were developing, especially in technology.

Special effort was made to keep our Annual General and Autumn General Meetings filled with provocative subjects and interesting and highly qualified speakers. We had a very special meeting to mark the Society's two hundred fiftieth anniversary, as well as a Millennium Program in 1999.

One interesting episode illustrates our relationship as well as the importance of staying in touch with APS members, a quality Herman expressly nurtured. We both recognized—at almost the same time—how helpful David Packard and Bill Hewlett had been to the Society. David had just died, but Bill was still coming to work, although with considerable pain. So we decided to fly to Palo Alto, to express our

thanks and appreciation, and give him a token of our esteem. Bill, in his walker, met us in the lobby of Hewlett-Packard, and almost immediately urged us to accept an envelope, which, we were confident, contained a large check.

We remonstrated with him, and told him we made the trip to show our appreciation, not to solicit funds. We then spoke about a great many current matters. Then, as he was tiring, Bill decided to walk us back to the lobby, but extracted a promise that we would go to the Hewlett Foundation, because the director, himself an APS member, wanted to see us. We did as he suggested, and when we arrived, the director told us that the Hewlett Foundation was sending a large grant to the Society.

In addition to keeping in touch with our members, Herman also knew of my keen interest in keeping in touch with comparable learned societies in Europe. Special meetings were arranged with the Royal Society of Great Britain, the Royal Society of Sweden, and the oldest learned society of all, the Accademia Nazionale dei Lincei in Italy. Herman also assisted me in fulfilling an engagement to address the Royal Society of Scotland, in Edinburgh.

We also agreed to use the Council nominating system to elect new members who had important, non-academic achievements in the larger world. These included, for example, Justice Sandra Day O'Connor, Ambassador Walter Annenberg, Secretary of State George Shultz, General Colin Powell, and Senator Nancy Kassebaum.

Near the end of my presidency, Herman advised me that he thought the time had come for him to step down as executive officer. Although he still had a sharp and discerning mind, he was handicapped by a serious illness. I most reluctantly agreed and began searching for a suitable successor. Dr. Alexander Bearn was, at the time, a member of Council. As a consequence, I had gotten to know him quite well, and was aware of his extraordinary background and his deep regard and affection for the Society.

Unfortunately, at the time, Alick Bearn had a one-year commitment at Cambridge University. When I discussed this problem with Herman, he agreed that he would "hang on" until Alick could return to the United States. And so it was that Alick succeeded Herman in this important role.

To demonstrate our enormous respect for Herman, at the last Annual General Meeting that occurred while he was still executive officer, we awarded Herman the Benjamin Franklin Medal, the highest honor in its pantheon that the Society could bestow.

I end my comments by repeating what the citation on the Benjamin Franklin Medal provides:

> In recognition of a central figure in the development of the first large-scale general purpose electronic digital computer, a gifted mathematician who co-founded the field of numerical analysis and created a mathematics group at IBM that became a world center for the mathematics of computation, who for thirteen years exercised vision and leadership of the nation's oldest and most prestigious learned society, the American Philosophical Society awards Herman H. Goldstine the Benjamin Franklin Medal for Distinguished Achievement in the Sciences.

Dr. Goldstine will always have my greatest respect, my greatest esteem, and my greatest affection.

Elected 1979; Councillor 1980–83; Executive Officer 1984–97; Committees: Advisory on Election of Members 1984–97; Auditorium Ad Hoc 1989–91; Benjamin Franklin Award for Distinguished Public Service 1989–97; Executive 1983–97; Finance 1989–90, 1998–2001; Jayne Lectures 1984–97; Jefferson Medal 1994–97; Lewis Award 1984–97; Library 1981–84, 1989–90; Library Advisory 1995–2001; Long-Range Planning 1989–93; Meetings 1981–97; Publications 1984–97; Public Information 1989–90; Research 1989–90, 1998–2000; Scientific American Award 1989–91; Slater Research Fund 1989–90; Two Hundred Fiftieth Anniversary 1987–88, 1989–90

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