

But when you cannot measure it, express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge but you have scarcely in your thoughts advanced the stage of science."

The other principle that I went on, was that one ought to be liberal about new ideas but be conservative on their execution. In later years, we had a big sign in one of our labs and it said, "Principle or execution." What it meant was, when something didn't work was it due to the principle or to its execution.

I sometimes see articles that say John Mauchly was the idea man and Pres Eckert the implementer. This is a vast over simplification. In the beginning, John had built some counters and I had worked on the differential analyzer. I had learned to use a desk calculator, but I didn't know as much about them as John. Mauchly knew how desk calculators worked inside. I had never integrated an equation by difference calculus. John taught me alot about the problems to be solved on the ENIAC. I had designed a lot more circuits than John. When we started the ENIAC, John introduced me to his concepts for a subroutine in the machine. It was one of the big principles of the ENIAC. Using a straight line programming as in the Harvard Mark I, I figured the ENIAC would have had over a million tubes instead of 18,000. I was told later that Babbage may also have had the idea of subroutines. Our idea was to have nesting of subroutines. If Babbage had the idea outlined, then Aiken probably would have used subroutines on the Mark 1. We introduced Aiken to the idea of subroutines. What you can say is that John worked more on software and I worked more on hardware.

I think that I have enough evidence to show that I developed the idea of internal storage or the stored program. I proposed the idea to Mauchly. Arthur Burks, in an article in the *Annals of Computer History*, over and over again tries to compare the ENIAC to the Differential Analyzer. I think this is strange because I don't see any comparison. If there is a connection it is this: before Mauchly wroteup the ENIAC idea for Brainerd, we said the worst feature of the Differential Analyzer was the inaccuracy of the integrators. We had worked to achieve a one-hundredth of a percent accuracy from the previous tenth of a percent, but we decided we were at the top of an S curve. The machine might achieve a thousandth of a percent

accuracy, but only with hard work and that was the end of the curve. Further room for improvement would have to be electronic. We thought that we might take the shafts that came into the integrator, put little pinwheels with stripes on them, look at them with photocells and get pulses out that told how the shafts were spinning around. These would be fed into some counters, multiply these counters, accumulate them in another counter, and then use another pinwheel on the output shaft and feed it back through a servomechanism to make it track the thing. This was a mechanical integrator whose guts were sort of a digital system. We decided that was crazy, if we were going to have all these pulses then we should shoot them directly and get rid of all the gears. Then we thought this counting pulses is crazy, to count a million you need a million, but in the binary code it only takes twenty pulses. And even in a decimal system that can be based from a punch card machine, it will only take 60 pulses. So we decided we would code numbers and shoot them around that way in our machine. And that's about the extent to which the differential analyzer influenced the ENIAC. Later Dr. Floyd Steel developed the Digital Differential Analyzer that had some popularity for some time.

The best way to dismiss Atanasoff is to say the machine really never worked and he didn't have a system. That's the big thing about an invention: it's that you have a whole system that works. De la Rue tried to build a lamp in 1820, Starr in 1845, Swan in 1880, and Edison built a whole system that related to the generator that was only developed five years before. Every one of Edison's ideas had been used before. Edison was a system's engineer and made it all work. The ENIAC was built as a system that has led directly to today's computers. I look back at the scenario and ask you to consider the following question: How would you like to see your life's work end up on a tenth of a square inch of silicon?

ENIAC's Birthday

On February 13, 1986, The Computer Museum celebrated ENIAC's 40th birthday with a champagne-and-cake gala complete with 1940's orchestra to remind revelers of the era which gave birth to the machine.

ENIAC's Big Birthday Bash was conceived and sponsored by Ann Roe-Hafer, Marketing Director for Bitstream, Inc. of Cambridge. Starting in 1985, Bitstream dubbed February 13th the beginning of the Digital Year with a special calendar. The 1986 edition of the calendar was given to each attendee.

Many aspects of the event paid tribute to ENIAC's significant impact on the evolution of the computer. The invitation to the Birthday Bash was designed and produced using computer generated graphics featuring the special effects of digital fonts. ENIAC received the most fantastic birthday card ever produced by a computer for a computer, thanks to the Fantastic Animation Machine. They created a computer generated animated video birthday greeting that was displayed throughout the evening, and has now been added to the Museum's permanent collection. The 20-second long piece required about 100 hours of compute time and would normally cost about \$3000 per second of finished video—a labor of love to honor ENIAC and a show of support for The Computer Museum.



Presper Eckert and Kay Mauchly.

Maurice Wilkes, Gwen Bell, Mike Parker, Presper Eckert and Kay Mauchley.

The birthday cake for 500 guests was fashioned after a Bitstream font spelling out E-N-I-A-C. A tastier type there will never be. Among the decorations was a ten by one foot digital sign in the Museum elevator carrying a continuous birthday message.

To insure many happy returns of the day, eight "ENIAC Enthusiasts", AT&T, International Typeface Corporation, NCR Corporation, Michael Parker, John Poppen, XRE Corporation, Herman Zapf, and Zenith Data Systems, each contributed \$10 for every year of ENIAC's age to support the event and subsequent Museum projects.

The tribute to ENIAC was really a tribute to those who had created her. What turned this celebration into a momentous occasion was the talk by her co-inventor, Dr. J. Presper Eckert. Dr. Eckert's appearance drew a full house with close to 500 guests seated and standing in the auditorium, and watching on closed circuit T.V. in the galleries.

Bitstream president, Michael Parker was Master of Ceremonies for the evening. He first presented Bernard Gordon, President of Analogic, to introduce Dr. Eckert. Bernard Gordon, who had worked for Eckert Mauchly Computer Company, introduced Dr. Eckert as, "the greatest engineer and role model I've ever known". In his opening remarks, Dr. Eckert expressed his regret that co-inventor John W. Mauchly was not there to share his stories or be a part of the celebration. However, he noted that Kay Mauchly Antonelli, Mauchly's widow, and a programmer on the ENIAC, was in attendance.

After Dr. Eckert's talk, a film composed of the only existing original footage of the ENIAC from 1946 was viewed. It was met by the audience with both awe and amusement, and was a perfect transition from the inspiring talk by Dr. Eckert to the official toast and cake cutting.

Michael Parker, back on the podium, offered the first toast to the "41st digital year". The next toast "to the ENIAC" was given by Professor Maurice Wilkes, who studied the ENIAC before building the EDSAC. Kay Mauchly Antonelli toasted "the young ladies in the film", her fellow programmers. The closing toast by Dr.



Ann Roe-Hafer at the ENIAC function table, wearing the Eckert-Mauchly medallion.

Eckert was in memory of John W. Mauchly.

The Sperry Corporation, which absorbed the Eckert Mauchly Computer Company, is producing a video tape of the lecture and the 1946 film clips for the Museum's collection.

The ENIAC birthday celebration drew the attention of the media nationwide: it was featured on the CBS Morning News, National Public Radio's *All Things Considered*, WNEV-TV's *Sci-Tech Spot* and Cable News Network, and it was the subject of articles in *TIME* Magazine, the *New York Times*, the *Boston Globe*, the *Boston Herald*, and the *Baltimore Sun*. Also picked up by both the Associated Press and United Press International wire services, the story ran in over 50 newspapers across the country—from the *Honolulu Advertiser* in Hawaii to the *Tribune* in Scranton, Pennsylvania, from *Investor's Daily* in Los Angeles, California to the *Daily Southern Economist* in Chicago, Illinois!

Ushered into the world with special press conferences, the computer continues to hold public fascination with its growth from childhood to maturity.