Events and Sightings

Chigusa Kita, Editor
Kansai University

MIT 150th Anniversary and MIT Museum Project Whirlwind Presentation

The Massachusetts Institute of Technology (MIT) celebrated its 150th anniversary in 2011 (http://mit150.mit.edu). The celebration scheduled between 7 January and 5 June 2011 included hundreds of special events, symposia, publications, and a major exhibition at the MIT Museum.

The MIT 150 Exhibition (http://museum.mit.edu/150) opening at the MIT Museum was the inaugural (7 January) event of the institute's celebration. Running through 31 December 2011, the exhibition consisted of 150 objects representative of MIT's history and ambitions for the future. The exhibition curator, Deborah Douglas, noted that the list of 150 objects was determined by "crowd sourcing" from the MIT community rather than the typical curator-driven approach. Naturally, a number of the objects fell under the exhibition's Analog/Digital MIT theme.

Throughout the year, the MIT Museum also had many presentations on a variety of topics, including the 15 October public event that I attended, entitled "Project Whirlwind, Sage, and Pioneering MIT Computer Projects." A couple dozen participants from the Whirlwind development era in the late 1940s and 1950s were present for the presentation, making the event also sort of a Project Whirlwind reunion.

The primary focus of the event was a panel session with Project Whirlwind leaders Jay Forrester and Robert Everett (see Figure 1), moderated by museum director John Durant.

Durant's first question for Forrester was, "What was Project Whirlwind?" Forrester explained that Whirlwind had a varied history. At first it was to be an analog computer for predicting the controllability of future airplanes—unlike the Link Trainer, which was for training pilots of an existing airplane. After a year or so, they concluded the future-airplane task was not possible with an analog computer. At that point Perry Crawford, who was with the US Navy's Special Devices Division, which was in charge of project oversight, suggested they switch to digital computing. Bob Everett remembered that one day Forrester came by and said, " 'We are now working on a digital computer,' and I said, 'What's that?' "

Forrester talked about the risks inherent in the project. Whirlwind was transferred to the Office of Naval Research, which generally spent only enough money on a project to support one mathematician and an assistant. The Whirlwind project needed 100 times as much money, so funding involved an "annual inquisition." Some people in the Electrical Engineering Department thought computers needed to do decimal arithmetic, and the Whirlwind team had to argue for the efficiencies of binary arithmetic. The average life of a vacuum tube was 500 hours, and their machine would have tens of thousands of vacuum tubes, which if you do the arithmetic, meant major reliability problems.

Some useful prior efforts existed, however. Coming out of World War II, the MIT Radiation Laboratory had knowledge of pulse circuits and vacuum tubes. The Whirlwind team knew of the early computer work at Harvard and of work with EDVAC at the University of Pennsylvania where John von Neumann pushed the idea that a computer could run on a program stored in its own memory—"a very big breakthrough," said Forrester. (The EDVAC was a serial system, but Whirlwind needed a parallel computer system to handle the speed required for the real-time work they had in mind.)

Mercury delays lines were one memory possibility, but it took a millisecond for a bit of data to cycle from one end of the delay line to the other. A Williams tube using a 2D grid on a cathode-ray tube was another possibility, but they were unreliable. Forrester said that he wanted a 3D storage system and first thought about using glow discharge tubes, but he gave that up as impractical. Forrester went through another idea or two before settling on ferrite cores (little doughnuts of ceramic magnetic material) arranged in an a 2D array with interconnecting wires so any individual core was instantly accessible. (Multiple such core planes provided access to the bits of a word of computer memory.) Forrester explained that a guy in New Jersey could occasionally produce a ferrite core that had the square-wave on/off property needed for digital computing. He would run his hand through brown power and say, "That feels square to me." Forrester's team at MIT spent lots of money on research before they understood how such cores could be produced reliably.

As the Whirlwind team and its government sponsors discovered numerous possible applications for a real-time, stored-program, digital computer, the original flight simulator task went away. Everett added that their original intention was to build a 32-bit machine, but instead they built half a machine—a 16-bit machine.

Their budget became too big for the Navy, and there was a danger that the project would die. However, Perry Crawford saw possibilities for the machine for the air

 Published by the IEEE Computer Society 1058-6180/12/$31.00

battle emerging circa 1948. The Soviets had produced a nuclear bomb and related bombers. The existing US air defense system was ineffective. Crawford, Forrester, MIT's Jerome Wiesner (later MIT's president and President Eisenhower's science advisor), and George Valley (who was instrumental in the conception of the US Air Defense System) had various interpersonal connections among them that led to Valley becoming aware of the Whirlwind group's work. At the time, the Air Force was not very aware of the possibilities of digital computing for air defense: "We began to talk about a computer to run an air defense system when nobody in the military knew what a digital computer was," Forrester said. However, Valley could see a possible computer-based solution involving Whirlwind, so the Air Force adopted the project with substantial funding. The Cape Cod system was built as a demonstration and was followed by the SAGE system.

An operational system required solving the vacuum-tube reliability problem. They found and removed the cause of 500-hour tube life, extending tube life to 500,000 hours. They added a "marginal checking system" that detected when things were drifting out of spec, and they required that each SAGE center have two parallel systems. This led to 99.8 percent up times.

At this point, museum director Durant began to take questions from the audience. The first question was, "Did you realize at the time that this was an amazing thing that was setting the stage for the future of computing?" Everett replied that they knew that lots of things could be done if they solved the technical problems of building such a fast, reliable computer. They didn't anticipate the spread of computers we see today, but they had a lot of ideas about what such a computer could do.

Forrester added that in 1948, before any such computer had functioned, they prepared a report on the future of computers in the military that culminated in a chart covering a 15-year period (1948–1963) across the top and 10 areas of military application down the side, with every square filled in with what could be done (including time for politics and administration) with the associated costs. This forecast was done before any reliable, high-speed, general-purpose, digital computer had yet operated. Forrester said that the air defense 15-year forecast was completed by the MIT Lincoln Laboratory a couple of years ahead of the 1948 forecast. The total estimated cost for the efforts on the chart was $2 billion.

Figure 1. Jay Forrester and Robert Everett at the MIT Museum Project Whirlwind event. (Courtesy of Nalin Springer.)

The next question was, "Did you imagine miniaturization such as we have today in our cells phones and wrist watches?" Everett said, "Yes, we didn't know how to do it, but it was clear that computers had the remarkable characteristic that they got better as they got smaller."

Forrester was asked about software and the overall system thinking, as opposed to the hardware work he and Everett had mostly been describing. Forrester explained that they had to develop a large team of programmers that hadn't existed before. (Eventually, RAND took over the programming). Along the way, he observed that "young women who studied music at Wellesley" were good candidates for programmers—maybe something having to do with "logic and organization of symbols." Everett noted that these women were smart and had no preconceptions about computing. Forrester emphasized that it is "important to have a team that don't know you can't do it." Forrester also explained that people were coming back from the war under the GI bill and applying for the graduate studies in electrical engineering at MIT. He would review their applications looking for people to recruit to the Whirlwind project.

From the audience, John Frankovich (an early software innovator on Whirlwind) said that as the computer became operational, the separately run Scientific and Engineering Computation Group support by the Navy allowed students and others from around the campus to develop lots of software,

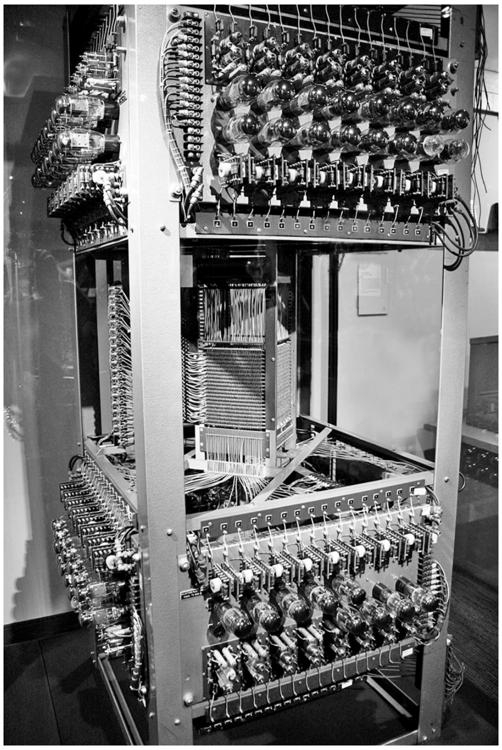

Figure 2. Whirlwind core memory unit on display at the MIT Museum. (Courtesy of Nalin Springer.)

including the first algebraic compiler. Forrester noted that a number of new fields got started based on Whirlwind such as oil field exploration analysis. Frankovich added that pioneering work was done on Whirlwind in the fields of numerical milling machine control, studies of radio station radiation patterns, TV frequency assignment calculations, photographic lens design, and so forth. Many students used Whirlwind "for lots on non-SAGE stuff" and then went elsewhere to "spread the gospel."

Jack Gilmore, an early Whirlwind software designer, related that Charles Adams, a genius at imagining what software could do, had a team of men and women programmers. After hours they would go into the basement of the Barda Building (where Whirlwind was built), and Adams would give some assignments for projects that needed to be done while the others would critique the work, optimizing the resulting programs.

Another question from the audience was about Whirlwind and priority interrupts to handle real-time events that happened while other parts of a program were running. Everett explained that Whirlwind did not have a hardware priority-interrupt system. Rather, the system design was based on putting tasks to be done in buffers, and the program frequently looked over the various buffers choosing which task to do in appropriate priority order. Frankovich noted that the TX-2 at MIT's Lincoln Laboratory (to where the SAGE work moved from MIT before the project then moved to MITRE) implemented a 33-level hardware priority-interrupt system with state saving. Many visitors from computer vendors around Boston saw that, and it became a standard approach for commercial computer products.

Gilmore told another story of visiting a Canadian laboratory in those early days. When he explained to people about the possibility of single-person interactive use of Whirlwind, he was asked to "leave the room" by the lead person who was incredulous that Gilmore would say that individuals would ever have a whole computer to themselves.

Frankovich also noted that military sponsorship of Whirlwind and activities such as the TX-2 development had major benefits such as development of the first virtual memory, operating system innovations, and early experiments that led to the Internet.

Forrester noted that he left computing in 1956 because he felt computing's pioneering days were over—"more happened in the decade from 1946 to 1956 than in any decade since," he said. Everett concurred, "Like a child who learns more in the first two years of his life than in the rest of it." Everett concluded that "Jay left me with the secondary task of finishing the SAGE system."

The Q&A session ended with members of the audience putting their names in a bag for a drawing to give away a dozen copies of Tom Green's *Bright Boys: 1938–1958, Two Decades That Changed Everything* (AK Peters, 2010), a book that covers the history of the Whirlwind system. Tom Green was in the audience, and his publisher had provided the dozen copies of the book. He also provided a copy for the museum's collection that Director Durant asked all the Whirlwind pioneers present to sign. The book describes in fascinating detail what was only touched on during the session with Forrester and Everett.

Following the Q&A session, Deborah Douglas led a tour past some of the computer aspects of the 150 Exhibitions (http://museum.mit.edu/150/theme/analogdigital-mit) including Vannevar Bush's 1931 differential analyzer, a core memory unit from Whirlwind (see Figure 2), the TX-0 computer console, a Spacewar console, a SAGE system display, and the Multics system's shelves of documentation.

Figure 3. Parts of the differential analyzer of Institute of Industrial Science, University of Tokyo, are preserved in the institute's archives.

While describing the Whirlwind core memory unit, Douglas mentioned that when the museum first acquired this unit, something looked wrong to her in terms of its being an original unit—it didn't have the patch wires and incremental fixes she expected to see on a original unit. After she finished her story on the complicated provenance of this particular object, Everett told her softly that the first Whirlwind units were also completely tidy. To this day, the Whirlwind pioneers are proud of the skill and craft with which they accomplished their breakthrough in computing.

Even though the MIT 150 Exhibition was only on display through the end of 2011, the MIT Museum remains a wonderful place to visit while touring Boston. There are always fascinating exhibits, the price is reasonable, and it can be seen within a couple of hours. In addition to the MIT history and technology, Arthur Ganson's kinetic art is a must-see exhibit.

David Walden *retired from BBN in 1995, after working as a computer programmer, technical manager, and general manager. Contact him at dave@walden-family.com.*

IPSJ 4th Information Processing Technology Heritage Certification Ceremony

The 4th Information Processing Technology Heritage Certification Ceremony of the Information Processing Society of Japan (IPSJ) was held on 6 March 2012 at the Hiroshima Institute of Technology, Japan, during the 74th IPSJ National Convention. This time the IPSJ certificated 12 additional artifacts:

- parts of a differential analyzer of Institute of Industrial Science, University of Tokyo (1952–1955),
- HIPAC MK-1 parametron computer (1957),
- NEAC-1101 parametron computer (1958),
- MELCOM-1101 transistor computer (1963),
- ASPET/71 optical character reader (1971),
- Busicom 141-PF electronic calculator (1971),
- NEAC System 100 office computer (1974),
- MCC board with LSI packages for FACOM M190/Amdahl 470V6 (1976),
- automated teller terminal AT-20P (1977),
- FAST LISP of Kobe University (1978–1979),
- EVLIS Machine of Osaka University (1978–1979), and
- T1100 laptop computer (1985).

(The manufacturing year of each artifact is listed in parentheses following the item.)

The IPSJ also certificated the NTT History Center of Technologies (the exhibition area of the historic computers of NTT) as an additional satellite museum of historical computers. So far IPSJ has certified 55 artifacts and six satellite museums.

During World War II, the Tokyo Imperial University's Aeronautical Research Institute researched mechanical differential analyzers and built a prototype Bush machine. After the war, Masaru Watanabe and his colleagues successfully researched mechanical differential analyzers using the prototype. They developed a basic system with four integrators in 1953 and completed a large differential analyzer with eight integrators and automatic tracking capability in 1955. They realized the high accuracy of 0.03 percent and used it for orbit calculation of small rockets. Existing parts of a torque amplifier, an adder, and an optical head for automatic curve tracking were certified (see Figure 3), which will be exhibited at the University of Tokyo's Institute of Industrial Science.