

A Visit to the Tsukuba Science Exposition

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Abstract

Tsukuba Expo '85 is huge, interesting, and fun. The Japanese pavilions are plush and well-organized, and contain some impressive artificial intelligence demonstrations. The U.S. pavilion is an embarrassment.

Tsukuba Expo '85 opened on March 17, 1985, to enormous publicity. The *New York Times* reported that "the budget for the fair is more than \$2 billion, and individual companies have spent large sums. A huge billboard in the Ginza, Tokyo's stylish shopping district, has for two years been counting down the days until the opening."¹ The exposition (technically a "world's fair") is intended as an international showplace for advanced technology, and for months rumors had been circulating about the technological marvels to be displayed, including artificial intelligence exhibits, in the U.S. and other pavilions.²

I spent one day at Expo '85 (April 20), not nearly long enough to see it all. It is enormous (250 acres) and contains some massive pavilions (see Figure 1). And it is crowded. According to the *Official Guide Book*,³ the government expects 20 million visitors (one sixth of the entire population of Japan). There are 113 different organizations with exhibitions at the fair: 28 Japanese corporations, 48 countries, and 37 international organizations. There

are over 250 concessions (restaurants, fast food, souvenir shops), 10 information centers, 5 post offices, 3 banks, etc. Other "events" include concerts by the New York Symphonic Ensemble Concert and performances by the Soviet Folk Dance Troupe. Expo '85 also includes an amusement park, the world's largest ferris wheel, the world's largest TV screen (see Figure 2), parades, marching bands, and floats with dancing girls. In short, it is a cross between a technical trade show and Coney Island—it's fun.

Fujitsu: Long Lines

First on my list of places to visit was the Fujitsu pavilion, which is said to contain the world's largest robot. However, the line seemed endless (a two-and-a-half hour wait, I was told) so I decided to go on to my number two spot, which was the Matsushita pavilion. Along the way I noticed that there was no line at the U.S. pavilion, which I took to be a bad sign.

Matsushita: A Portrait-Drawing Robot

At Matsushita (which uses the brand names Panasonic and National) the line was long but not unendurable. As you enter, you are greeted by a number of attractive and courteous young hostesses in uniform. They bow to welcome you and bow again to wish you farewell as you leave. (A nice touch, which I encountered in all the Japanese pavilions.) The exhibits themselves are elegantly displayed, and one gets the feeling that no expense has been spared.

My principal interest at Matsushita was the famous robot that draws portraits of live subjects. At the exhibit two such robots work side by side, simultaneously drawing two subjects. The demonstrations are continuous; as soon as one portrait is completed, a new subject is taken from the front of a queue, seated in the subject's chair, and

¹ "Japan's View of the 21st Century," *New York Times*, March 8, 1985. Page D1

² "The United States Information Agency is quite excited about the American contribution to the 1985 Japanese Expo in Tsukuba, Japan. The U.S. pavilion is a state-of-the-art display of artificial intelligence technology." ICS Applied Artificial Intelligence Reporter, "Tsukuba Expo '85 Opens," Vol. 2, No. 6 (March 1985).

³ Tsukuba Expo '85 Official Guide Book, Japan Association for the International Exposition, Tsukuba, 1985.



The Mitsui Pavilion.

Figure 1.

the robot begins work anew. I watched the robot produce quite a few portraits, all flawless. There was never a hitch, delay, or any downtime. (In fact, there was never the slightest hitch in any of the exhibits I saw in the Japanese pavilions.)

The subject sits in a chair facing a television camera. To his or her left is the "robot," that is, a multi-jointed robot arm (see Figure 3). All of this takes place in front of a seated audience, which can also see three overhead display screens.

The television camera first takes a color, high-resolution snapshot of the subject's head and displays it on the first of the overhead screens. A computer analysis then takes place, resulting in what I will call a cartoon version of the picture; it is displayed on Screen 2. The cartoon consists of black areas on a white background (*e.g.*, a thick black line for the chin, two black irregular blobs for the nostrils, etc.). The likeness is good. It is not a caricature or an impressionistic version of the face, but a realistic black and white picture, as one might draw with charcoal on paper, though without shading. During the 40 seconds it takes to complete the cartoon, the robot arm goes through various gyrations, bowing to the subject and to the audience, and keeping everyone entertained.

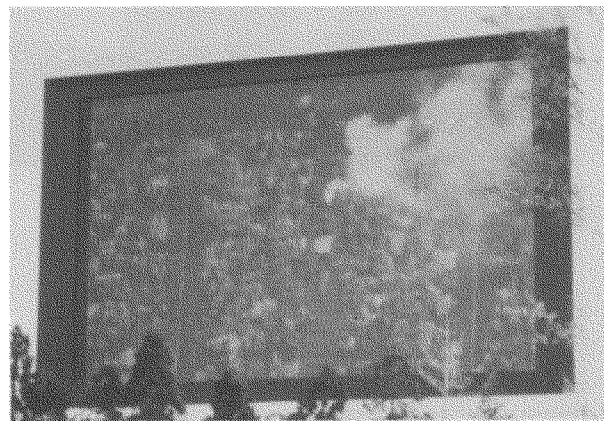
Then the robot picks up a pen from a pen holder, using a special attachment at the end of its arm. (The pen is something like a very large ballpoint.) It proceeds to draw a series of short pen strokes on a large piece of paper clamped to an easel. The resulting picture (displayed on

Screen 3) approximates very closely the cartoon on Screen 2. At the conclusion of the portrait, the robot puts the pen back into the pen holder, lifts up the paper from the easel, and drops it into a slot in front of the subject, who picks it up and takes it home.

The whole demonstration strikes me as brilliant. It is imaginative, technically advanced, and flawlessly executed. To implement such a system requires first-rate professionals who have a close acquaintance with advanced AI techniques, not to mention a lot of time and money. To be sure, other advanced groups (in Japan, the U.S., or elsewhere) could implement a system like this one. But it would take a lot of doing, and it hasn't been done.

Hitachi: Outer Space in 3-D

In truth, I had no great interest in the Hitachi pavilion, since the literature did not indicate any AI exhibits. But I happened to have an advance reservation ticket admitting me at 2 pm, which it now was, so I decided to go and have a look.

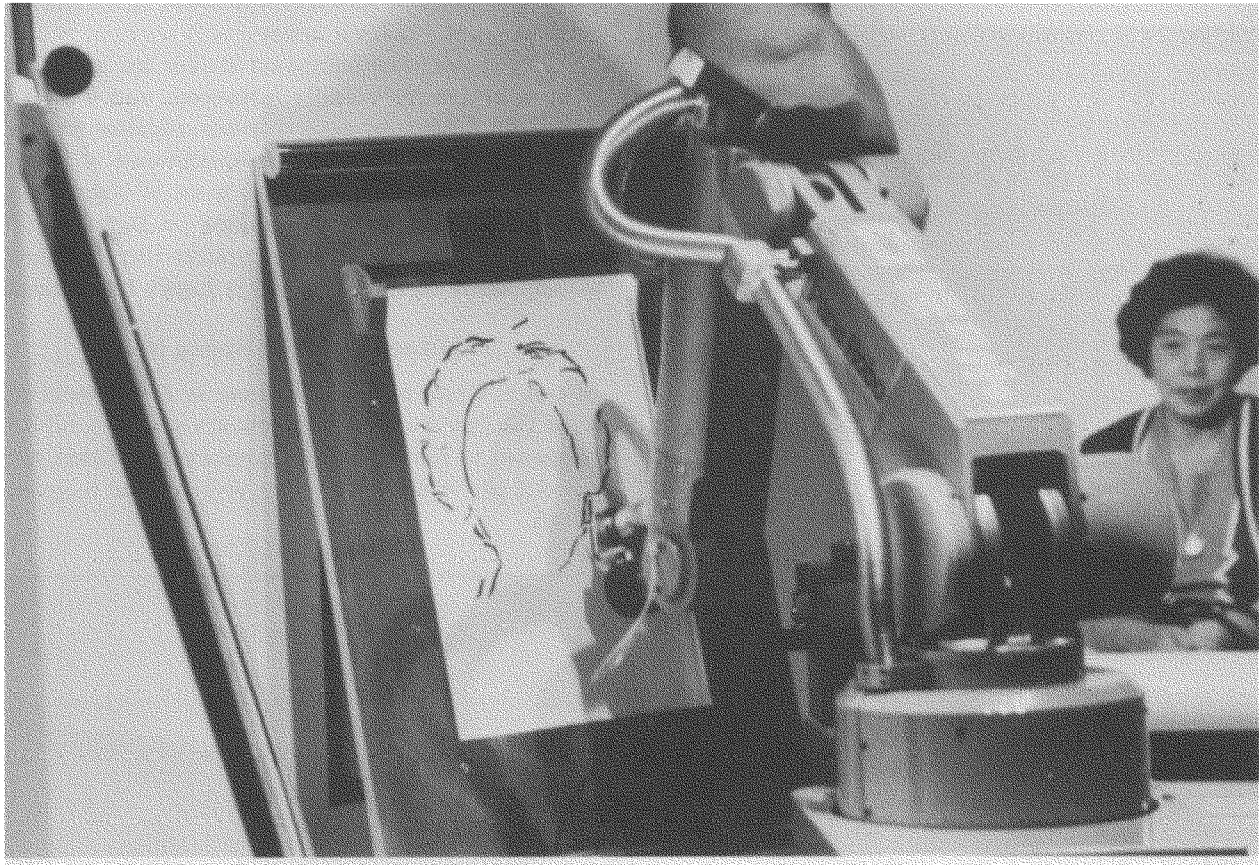


Sony JumboTRON 25×40 meter color television screen.

Figure 2.

The pavilion is elegant (see Figure 4). Every five minutes an audience of 20 or 30 people is admitted to a small, empty auditorium. Following a brief and unremarkable music-and-laser show, the seating section moves noiselessly into what appears to be a second auditorium.

In actuality, we were seated in one quadrant of a larger seating section, the other three quadrants of which were invisible to us. When we moved, all four quadrants rotated



The Portrait-Drawing Robot—(Note the artist's cap perched on top of the robot arm).

Figure 3.

90 degrees, and each quadrant entered a new section of the auditorium. This rotation occurred every five minutes, with new visitors being admitted at the beginning of Show Number 1 and leaving at the end of Show Number 4.

The guidebook calls Show Number 2 a "musical show of the history of scientific development presented through robots and imagery." On stage are several larger-than-lifesize animated stuffed animals ("robots"), of which I remember a bear and two cats. There are also flashing lights, music, movies, etc. The animals converse with one another and in the process lecture the audience on science in Japanese). The animals gesticulate and have (very limited) mobility around the stage. Altogether, Show Number 2 is nothing earth-shaking.

The third show was a movie depicting aspects of the future. It was nicely done, brief, entertaining, and unpretentious.

The last show "is the highlight, taking you on a journey through outer space and showing you Haley's Comet. The show is created through the world's first three dimensional color computergraphic images, synthesized with stereophonic sound."⁴ This is a stereoscopic-effect, three-dimensional movie viewed through eyeglasses with polarizing lenses. The movie consists of a romp through a vision of outer space, with spaceships, comets, space creatures, and other colorful interstellar phenomena. At one point, a small space ship parks within an inch of your nose. You are persuaded that you can reach out and grab it.

The whole show can only be described as wonderful; a dazzling experience, somewhat like the special effects in the movie "Star Wars," but better.

How do we evaluate this show? Stereoscopic movies

⁴Tsukaba Expo '85, *op. cit*

have been around for a long time and even computer graphics for movies are hardly brand-new. Nonetheless, Hitachi deserves a lot of credit for this effort: They have it, it works, and it's great. No one else has anything as good, so far as I know. After the show, the audience is invited to see further exhibits in the Hitachi pavilion, but I declined the invitation.

Japanese Pavilion: Music-Playing Robot

The pavilion of the Japanese government is even larger and plusher than the others. I headed straight for the famous music-playing robot, passing up other exhibits (such as the indoor tomato plant that bears 10,000 tomatoes). The robot looks just like a mechanical man should: it has a head, two arms with hands, two legs with feet, and a head with an eye (see Figure 5). It is seated at an electric organ having three keyboards and a set of foot pedals, and it performs every ten minutes or so.

What happens is that a one-page sheet of music, printed in ordinary musical notation, is placed in a slot in front of its eye (the sheet is attached to a metal frame that is locked precisely in position by an attendant). The robot reads the music, or so we are told, and plays it on the keyboards. (There is no doubt in my mind, by the way, that it really does play it, but I had a flicker of suspicion as to whether it really read the music, since we were told that it also plays from memory. However, on reflection, I decided that it works as advertised. This opinion is based on the care with which the music sheet is located in front of the eye, the great attention paid to the illumination of the sheet, but perhaps most of all on the thought that there would be a torrent of criticism if the Japanese government were found to be cheating its audience.)

First, I saw and heard it perform "London Bridge is Falling Down" and later a musical comedy selection, which it played "from memory." It uses both hands and one foot, the two hands making use of the various keyboards, and the foot playing on a dozen or so foot pedals. The music sounds professional, with correct harmonies and rhythms.

How does it work? There are five independent fingers on each hand, and the hands move in three dimensions (see Figure 6). Each finger appears to be made of a single piece of metal. It seemed that, with the wrist locked, a finger could be in only one of two positions, up (above the key) or down (pressing on the key). If so, this robot can play the organ, but it could not play the piano, where different displacements of the fingers are required. As nearly as I could tell, the articulation of the fingers and wrist is such that the robot could not move its wrist while holding a finger down on a key. Thus, the robot could not play a legato scale, and therefore the repertoire that it can play competently is quite limited.

No information was available about the visual system. One can only make the obvious assumptions: That a television camera scans the music, an analysis program ex-



The Hitachi Pavilion.

Figure 4.

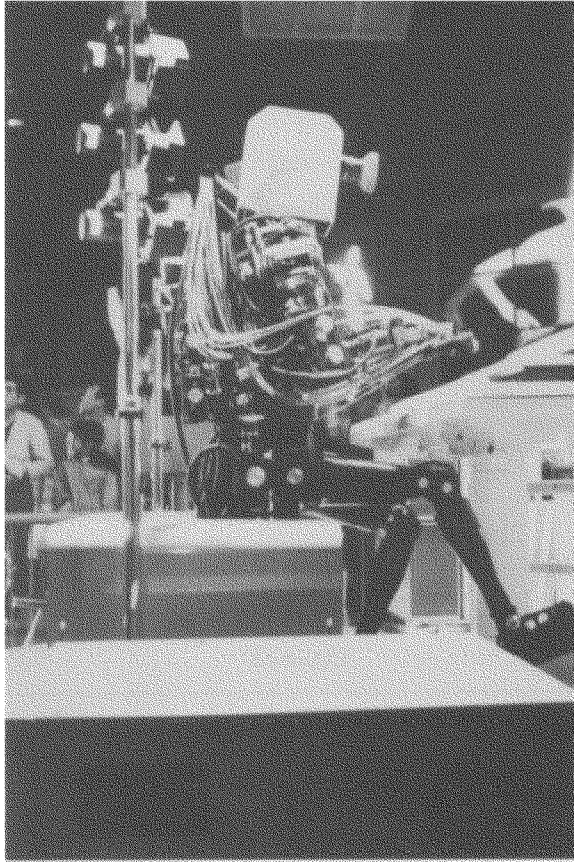
tracts the musical information, a planning program generates instructions to the robot, and the instructions are input to motion control programs. (Obvious assumptions, but very hard to implement!)

This whole demonstration (in spite of the noted minor shortcomings) strikes me as being on a par with Matsushita's portrait-drawing robot: a first-rate achievement—imaginative, beautifully executed, and at the frontier of the art. We were not told who the implementors are, but they should be congratulated.

NEC: Speech Recognition and Translation

My next visit was to the automatic translation exhibit at the NEC pavilion. I arrived in the middle of the demonstration and was immediately dazzled. There were two individuals, a Japanese policeman and an American lady, both speaking into microphones and wearing earphones. The policeman spoke no English, the American spoke no Japanese; the American was lost, and the Japanese was trying to help her. They spoke normal sentences and, when they wanted a sentence translated, pushed a button on a hand-held box. This would cause the translation to be displayed on a screen and to be output orally through the earphones. Extraordinary! Continuous speech recognition! Automatic real-time translation! Continuous speech output!

Unfortunately, my dazzlement evaporated when, at the next demonstration, a few minutes later, the same two individuals appeared on the stage and repeated the same skit, using the same sentences. It became clear that the



The Music-Playing Robot.

Figure 5.

two people were actors trained in this skit, and it became entirely possible that the system could handle only these particular sentences and only these two particular speakers (if indeed it could even handle these). A swindle!

Upon calmer reflection, however, I realized that the fault, if any, was probably mine. In the first place, the introduction to the demonstration was in Japanese and therefore incomprehensible to me. Secondly, the *Guide* clearly refers to this system as a "research model," as does the literature I received later. (The literature is quite modest; its message is: If you want to have a complete voice-actuated language-translation system, here are the components that you would have to put together, and here are the technical problems that you would face.) Thinking back over the demonstration, it was clearly intended as a lighthearted piece of entertainment and not as a serious scientific presentation.

I tried to talk to the person who had introduced the demonstration (as usual, a courteous hostess in uniform), but unfortunately she spoke no English (and she didn't offer to use the automatic translation system). However,

she instantly brought out an English-speaking colleague to help me. I explained that I had been very much interested in the demonstration and wondered how I could learn more about it. "No problem," she said, and took me to a wall display at which, through menu selection, one could call up explanations in a number of languages of any of the demonstrations in the NEC pavilion. I spent a few minutes reading this material, which, while not technically profound, contained interesting information. I was impressed by the fact that the information display worked so well. However, I was really impressed when, a minute later, my young lady returned with seven pages of printout representing hard-copy versions (in English) of the display-pages that were relevant to my interest in language translation. She apologized for having taken so long, but explained that she had gone to a computer and generated this output on the printer. (What she handed me, by the way, was xerographic output and included graphics.)

I understood from the printouts that the demonstration is based on the NEC DP300. "The DP300 is a speaker-dependent system which gives a pre-set answer (voice response) by recognizing what the pre-registered speaker says (voice recognition). The unit can recognize up to 50 words pronounced continuously and up to 450 words when pronounced separately. Recognition takes only 0.3 seconds after the utterance is completed. The automatic interpretation research model at the [NEC Pavilion] has two DP300s..." The DP300s are connected to a host computer, which in turn is connected to various display-control units, as well as to voice synthesis units.

How do we evaluate this work? My impression is that the demonstration shows that NEC is working at the frontier of the technology but has a long way to go (like everyone else) in achieving a voice-activated translation system.

The U.S. Pavilion: "System in Preparation"

The U.S. pavilion turned out to be at the extreme west corner of the expo site in one of three tentlike structures. These structures are the home of exhibits from Costa Rica, Brazil, Uruguay, Portugal, Belize, Nepal, Dominican Republic, Panama, Jamaica, and the U.S. The appearance of the U.S. pavilion is not enhanced by an unprepossessing entrance, flanked on one side by a panel showing an American flag (see Figure 7) and on the other by a picture of —Ronald Reagan. As one enters, and not many people did, one's impression is of gloom and disorganization. A number of young people, dressed in bright red suits, are hunched over computer terminals, not speaking to anyone. Presumably, these are the hosts (debugging their programs?).

One of the first exhibits that caught my eye was a big panel giving the names and dates of American Nobel prize winners. According to the *Guide* "a touch sensitive monitor gives access to the lives and work of the 133 American Nobel prize winners in the field of science." An interesting



The Music-Playing Robot and the Three Keyboards.

Figure 6.

idea: Unfortunately, the part of the display dealing with the more recent prize winners (the part that really interested me) was hidden behind some computer terminals and could not be seen. Even worse, the touch sensitive display was not working. There was a hand-lettered sign saying "system in preparation" (that is, "demonstration not working"). In fact, as I walked around the pavilion, I found quite a few signs saying "system in preparation."

According to the *Guide*, there is an exhibit called the "mind machine." It is "an AI system of the future, with video monitors, satellite dishes, robot arms, microphones, keyboards, etc., [which] demonstrates processes such as memory access, deduction, inference, logic, and learning, in order to solve problems." Now this really sounded interesting, but unfortunately, I didn't find the mind machine. Perhaps it was a "system in preparation." In frustration, I went to talk to one of the young men in red suits and I asked, "A lot of the demonstrations are down, aren't they?"

"Well," he said, "quite a few things are running. We have a number of Symbolics systems that are going."

"Oh," I said, "What do they demonstrate?"

"Well," he said, "it's not really artificial intelligence [I had not mentioned AI]. But the graphics are so good that it may as well be called artificial intelligence."

So I went looking for the Symbolics systems and did find several. One of them had a display of a Go board. That was it: Nothing was moving, no literature, no presentation, just a display of a Go board. Another had a display filled with small text in the style of 11:14:80GC: You have 999,548 words of consing left." And again, "You may have missed your last chance for incremental garbage collection." Nonfascinating.

As I left, the young man I had been talking to said apologetically, "You know, funding was a problem." But was it really? "U.S. Information Agency Director Charles Z. Wick reported that 80 American companies have contributed \$6.7 million toward the American pavilion. . . The federal government has kicked in \$8.5 million of its own for the U.S. display, bringing the total to \$15.2 million."⁵



The US Pavilion.

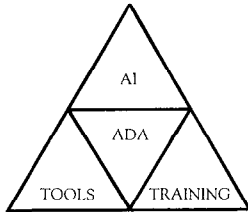
Figure 7.

Overall, my reaction was one of acute embarrassment. Why were the Japanese pavilions clean, plush, and well-organized, and the U.S. pavilion dirty, amateurish, gloomy,

⁵ICS Applied Artificial Intelligence Reporter (March, 1985), op cit

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and unprepared to receive visitors? Why were the Japanese demonstrations exciting and well presented, and the U.S. demonstrations "in preparation," hidden behind other equipment, or just uninteresting? Why did the U.S. exhibitors promise "clear, lively displays, introduce the concept of AI, define the scope of the task of replicating human intelligence, and demonstrate the present state-of-the-art" and then fail to deliver?

Around the time of my visit to Expo, the press carried a lot of talk about U.S./Japanese trade competition. I couldn't help thinking that if the pavilions at Tsukuba are any indication of our relative status in this competition, it is really no longer a question of whether we will win or lose. We've already lost.

The following is an edited excerpt from a letter to Ed Feigenbaum from a Japanese ICOT member, giving another perspective on the U.S Pavilion at the Tsukuba Expo. —Ed.

...The U.S. Pavilion shows technology very straightforwardly, while all the Japanese companies' pavilions show what technology can do with 3-D and big screen movies, etc. It is disappointing that they do not show the underlying technology. I prefer going to Disneyland.

So, the U.S. Pavilion is most interesting... I enjoyed looking at all the VAX and Symbolics machines, and expert systems I have heard of before. I also enjoyed the VTR program your group prepared on AI and knowledge engineering. But how shameful! There is very little explanation about the exhibition (almost none in English). Some of the systems are even without any explanatory signs, and I am afraid the general public won't be impressed very much.

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