The following article first appeared on "The Book and the Computer": http://www.honco.net

The Dynabook Revisited

A Conversation with Alan Kay

When you sit down at your computer to access this site -- moving your mouse to point and click at an icon that opens a window -- you owe a debt of gratitude to Alan Kay. These actions are second nature for us today and it's difficult to imagine that this wasn't always how we used computers. In 1972, Kay took a position at Xerox PARC (Palo Alto Research Center) and subsequently led efforts to develop the graphical user interface and the personal computer. One can certainly make a convincing argument that PARC's breakthroughs (which also included laser printing, client-server networks and Ethernet) provided a foundation for the emerging computer revolution. Kay had once said, "The best way to predict the future is to invent it." And he did just that.

Yet even before his years at Xerox PARC, Kay had envisioned the Dynabook, which he described as "a portable interactive personal computer, as accessible as a book." The Dynabook would be linked to a network and offer users a synthesis of text, visuals, animation and audio. Kay drew an initial pen and ink sketch of this device, which is widely considered the prototype for the notebook computer. Today, most portable computers contain all the technology his vision would require, yet Kay has insisted in his talks and writings that the Dynabook remains a dream. We decided to find out why.

On a mild winter day in Los Angeles, with a bright sky bleaching the landscape, we met Alan Kay at his office. His current project, Viewpoints Research Institute, and his new programming system, Squeak, are focused on children and education -- primary inspirations for all of Kay's work, including the Dynabook. He greeted us warmly, carrying his trusty "analog" notebook. Before formally beginning the interview, our conversation turned to music. Kay, an accomplished jazz guitarist, lovingly described the pipe organ he now uses to play Baroque music at his home. We then spoke for well over two hours and, in a roundabout and most entertaining manner, discovered the answer to our central question about the Dynabook.

The Book & The Computer : Thirty-four years ago you first envisioned what you called the Dynabook. Today, we have notebooks, laptops, and PDAs [personal data assistants]; they are lightweight, with flat screens, brilliant color, outstanding graphic capabilities, multiple media, and wireless connections. In other words, the technology has caught up with the vision. Yet you say the vision has not become reality. What's missing? What will finally bring the Dynabook to fruition?

Alan Kay : Let me start by describing a parallel between the development of printing and that of computing. Before Gutenberg, the handwritten manuscript books in Europe were, by and large, owned by institutions --

the church, the monarchy, and so forth. In the case of computers, when the Univac-I appeared, sometime around 1950, computing was done on machines that also had to be owned by an institution.

In its day, Gutenberg's printing press was the equivalent, we might say, of computer workstations. In today's money, they might have cost 60 or 70 thousand dollars. Only wealthy people could own them, and only wealthy people and institutions could own the books produced on them. And the number of books printed on the Gutenberg press was still small. Also, a Gutenberg Bible was not something you would travel with; it was not designed to be replaced if it was lost or damaged. It wasn't until 50 years after Gutenberg that printers like Aldus Manutius began producing books that were affordable enough to be widely owned. They were still fairly expensive -- several hundred dollars in today's money. But they were replaceable, and they were something you could carry with you from place to place.

Still, it wasn't for another hundred some-odd years, until the 17th century, that the real potential of the printing press was realized in any full sense. So it took about 150 years for writers and publishers to really get what the technology could do and to put it into practice. And the result was that, in the 18th century, Western society underwent the transformation that produced the modern world, the world we live in today.

My point, of course, is that there may be considerable lag time between the development of a new technology and the realization of the technology's potential. This was true of the printed book, and I think it is true of the Dynabook as well.

B&C : The revolution set in motion by the Gutenberg press took a long time to mature. But digital technology is advancing so much more rapidly than print technology. Can we expect a similarly long period of cultural maturation?

AK : When I worked at Xerox PARC, our thinking was that, by the time the general public would be using computers for all the wonderful things they could actually do, we'd already be long dead. New media take their initial content from the old media, and it takes a long time to discover what is new about what is new. So our attitude at PARC was, "Well, let's take a shot at inventing as many things as we can right now." And we were interested in all aspects of the technology -- hardware and software, especially software. We came up with the first displays for text. We had an Internet before there was an Internet, a network connecting different departments at Xerox. We created a lot of stuff, but we didn't know how long it would take for society to catch up to the technology. I still don't know. It is, though, hard to imagine that it would take 150 years, as it did with the printing press.

The Music of Ideas

B&C : What was the thinking behind the Dynabook?

AK : There were several sets of ideas that came together in thinking about the Dynabook. But there was one event that catalyzed my thinking. In 1968, I visited Seymour Papert, at the MIT Artificial Intelligence Laboratory. Seymour was working with kids, teaching them to use the LOGO program that they had designed there. By learning to use the program and doing some simple programming, these kids were able to learn meaningful mathematics and to understand the foundations of some very powerful mathematical ideas. The computers made this possible.

I had been working on a desktop personal computer in the late '60s. But on the plane ride back from Cambridge, I realized that the desktop computer was really just a phase, and that what we needed to be doing was working on a computer for children. For me, the potential of computers as an aid to learning was, in

itself, a validation of them.

Another thing I was thinking about at around that time was the question, "What is the new kind of argument that's important?" I knew, of course, that we were going to be able to use computers to make lots of unimportant arguments. But what was the new kind of important argument we could make? I remembered reading about how the printing press led to a huge change in how ideas were argued. The reliability and accuracy of printing allowed people to present their ideas with fewer claims and more logic, with less allegory but tighter reasoning. So I wondered how computers could change the way ideas are presented and tested.

The thing that jumped into my head was that simulation would be the basis for this new argument. Of course, I wasn't the first to see the potential for simulation. But in that context, it was a realization for me. If you're going to talk about something really complex, a simulation is a more effective way of making your claim than, say, just a mathematical equation. If, for example, you're talking about an epidemic, you can make claims in an essay, and you can put mathematical equations in there. Still, it is really difficult for your reader to understand what you're actually talking about and to work out the ramifications. But it is very different if you can supply a model of your claim in the form of a working simulation, something that can be examined, and also can be changed.

More and more, I was thinking of the computer not just as hardware and software but as a medium through which you could communicate important things. Before I got involved with computers I had made a living teaching guitar. I was thinking about the aesthetic relationship people have with their musical instruments and the phrase popped into my mind: "an instrument whose music is ideas."

Just as the book was an extension of the oral medium, so is the computer an extension of the print medium. There are many things that books can do, but computers have an extra dimension that seemed to me incredibly important, and this is key to the Dynabook idea. To really use a computer, you've got to be the author as well as the reader. Or in terms of music, a computer is something through which you can compose and play. So the relationship with the computer is different than your relationship to a book. Or at least it has that possibility.

B&C : So how did you then approach the problems of design?

AK : Well, when I sat down to think about it, I didn't worry about how long it would take. I just thought about things like, it better not be larger than this; it better not be heavier than that. I figured it should weigh about two pounds -- any more and it would be too hard for a kid to carry. As to the dimensions, it had to be really thin, so you could carry other stuff at the same time.

I was more interested in the software. It occurred to me that there might just be enough time to solve some of the software problems by the time Moore's Law caught up with us and allowed us to do the physical package. [Editor's note: In 1964, the semiconductor engineer Gordon Moore observed that the amount of information storable on a given amount of silicon roughly doubled every year. Moore's Law held until the late 1970s, at which point the doubling period slowed to 18 months.] I estimated that, if everything went perfectly, it was going to take about 10 years. There was already a little flat screen display; Rand already had a good hand character recognizer. So many of the pieces were already there in some form.

But the toughest problem has still not been fully solved. This is the problem of creating software that facilitates dynamic interactions between the computer and its user. Obviously, a lot of great technology has been developed since I began talking about the Dynabook. But what is really most significant about the idea of the Dynabook lies in the constructions that people, especially kids, can do with it, and which they can't do in any other way. In other words, it is a matter of the relationship between the computer and the user.

B&C : How have you been addressing that? Have you made much progress?

AK : I think that we have made steady progress. I mean, we have something much more like the Dynabook now than we ever had. I still get together with my old group of colleagues periodically. About six years ago, we created an authoring environment called Squeak, which allows for more of the kind of dynamic relationships I'm talking about.

Next fall will be the 34th anniversary of the Dynabook idea. For about 30 years now, we've been experimenting, trying to understand what children can do and what we need to do to help them do it. It's a very complicated business. It's not always clear what things they should be doing at a given age. When things are going wrong, it's not clear whether the problem was one of age or whether the user interface wasn't good enough or whether a particular version of the computer system is just too slow to hold the kids' interest. When things are going right, it's not clear whether the cause is something we did or something the kids did. So it takes a lot of experimenting with a lot of kids. But we've made a fair amount of progress. We've got some very cool stuff now that seems to work extremely well with a very large percentage of children.

B&C :Do you have some sort of experimental project?

AK : We always do. There are several schools here in Los Angeles and a few elsewhere where the kids are using Squeak. The last three years of experimentation have been by far the best we've ever done, in terms of both what the kids are able to do and also in the percentage of kids in a typical classroom who are really interested in it.

A New Literacy

B&C : I had a follow-up question, based on something that you said about spending 30 years working with children. What is your perception of how kids used computers in 1972 compared with how kids today use them?

AK : It was much better back then, by far. Nobody knew what a personal computer was back then, so there were absolutely no prejudices about, say, whether this was a boy thing or a girl thing, which is a huge problem today. Nobody had ever done stupid things on a computer before, so you got a chance to see what people would do if you showed them only smart things. Now you've got millions and millions of people who think that doing even the most trivial things on a computer is a sign of computer literacy. This includes parents, teachers and the kids themselves. But most of what is done is about as worthwhile as playing an air guitar.

B&C : That's the opposite of what you would think would happen.

AK :Yeah. The last 20 years have been basically air guitar. The same thing happened back when television came along. In 1945, people thought that television would bring serious works of theater to the general public. Obviously, it hasn't worked out that way. There's not a lot of Shakespeare on TV.

B&C : Reading a book requires a type of literacy. What type of literacy will the Dynabook require? What will be the relationship between the two types of literacy?

AK : Every idea, no matter how revolutionary it may appear, is built on previous ideas. Still, at some point the accumulation of new ideas might suddenly require a new context in order to deal with them. I think this applies to the Dynabook. What interests me, in regard to your question, is adding something more to literacy. And this is a grand tradition.

What is literature about? Literature is a conversation in writing about important ideas. That's why Euclid's Elements and Newton's Principia Mathematica are as much a part of the Western world's tradition of great books as Plato's Dialogues. But somehow we've come to think of science and mathematics as being apart from literature. In spite of the fact that our society is built largely on the technologies that come out of understanding science and math, we've ceased to regard literacy about these things as important. And that's a big mistake.

Literacy is not just about being able to read street signs or medicine labels. It means being able to deal in the world of ideas. In a democratic society you need people to be in conversational contact with the important ideas of the past and of the present, which means being able to read about them and write about them and talk about them. It's obvious that the American educational system has fallen far short of reaching that goal.

B&C : But let's go back to the question of the type of literacy required for the Dynabook.

AK :Right. When I began thinking about the Dynabook, I thought of it from the standpoint of literature. What is the new literature going to be? Well, the new literature is going to be a bunch of things, and it must include the old literature. But not every idea can be expressed in spoken language. I think it was Stravinsky who said, "Talking about music is like dancing about architecture." Music is already a means of expression in itself. There's only so much you can say before it's all bullshit, because what is special about music is precisely the stuff that you can't put into words. The same is true of the visual arts or the kinetic arts, like ballet. All these forms of expression are part of our landscape of ideas, and so in that sense they are literature. So when I started with the Dynabook, I couldn't imagine designing something that couldn't be used for, say, orchestrating music.

That's the glory of it. In a book you can print a score, and that's good. But on a computer, you not only can print the score, but you can start moving things around and experimenting with whole sets of musical languages. I've used the term "metamedia" to describe the computer, and what I mean is that it is a holder of all the media you can think of, as well as ones you haven't thought of yet. The computer allows you to capture important ideas, whatever the form of their expression, and convey them in a way that will help other people understand them, and maybe even add to them.

An Enriched Environment

B&C : So is the Dynabook just another potential learning tool?

AK : It's just like a musical instrument. You don't need it. The most important thing about any musical instrument is that you don't need the damn thing in the first place. Because people all have got an instrument inside them. If you have a great musician and a bunch of children, you've got music, because that person can teach them how to sing. On the other hand, you can have the best instruments in the world, but if the music teacher is no good, nothing's going to happen. You can look for the music inside the piano, but that's not where it is.

Same thing with the Dynabook. You don't need technology to learn science and math. You just absolutely don't need it. What you need to have are the right conditions. In music, if you've got the right conditions and you've got music happening, then the instruments amplify what you've got like mad. The best thing a teacher can do is to set up the best conditions for each kid to learn. Once you have that, then the computer can help immeasurably. Conversely, just putting computers in the schools without creating a rich learning environment is useless -- worse than useless, because it's a red herring. There's a sense something good is happening, when nothing real is happening at all.

Marshall McLuhan made the point that one of the crucial things about printed books was that you didn't have to read them in a social setting, such as a classroom. People can pursue knowledge independently and from the most unorthodox, subversive, or just plain weird points of view. But that is rarely how things are taught in school. Most educators want kids to learn things in the form of belief rather than being able to construct a kind of skeptical scaffolding, which is what science is all about. The ability to explore and test multiple points of view is one of the great strengths of our culture, but you'd never know it by looking at a classroom.

Science today is taught in America as a secular religion. But science is not the same as knowing the things learned by science. Science itself is a stance in relationship to knowledge. In order to do science, you have to give up the notion of truth. Because we don't know the world directly; we know the world through our mind's representational systems, which are like maps. Science is a map that is always incomplete, and so it can always be criticized and improved. And that's why it's so effective at, say, treating diabetes, or whatever. Because the map is incomplete, it can always be improved, and so it is the best way to deal with what is.

One of the problems with the way computers are used in education is that they are most often just an extension of this idea that learning means just learning accepted facts. But what really interests me is using computers to transmit ideas, points of view, ways of thinking. You don't need a computer for this, but just as with a musical instrument, once you get onto this way of using them, then the computer is a great amplifier for learning.

B&C : Last question. How would you like kids 30 years from now to be using a Dynabook? What do you hope will happen?

AK : When kids are three or four, most of their learning happens kinesthetically and visually. So as a parent watching them play and learn, you'd like them to be doing a lot of stuff in the physical world. You might even be a little bit disturbed to see them with their faces always tucked in a book that early. But I think you would want to have books around in the environment, and you'd want to be reading to the kid so the kid would be getting interested. So you could expect that using something like a Dynabook would have some of the same tempo. Also, books that first appeared in print will appear pretty much the same on the Dynabook. So I don't think there's a big change there.

For me, the key is education. And in my mind the patron saint of how to teach kids is Maria Montessori. A hundred years ago, Montessori understood that children always are trying to learn about their environment, and so the best way to help them was to give them carefully organized, rich environments, where the toys and the play have 20th-century side effects. In my opinion, this is one of the great ideas in the history of education. Even today, most of the best cognitive science about education harks back to Montessori's original insights.

Seymour Papert used to talk about the kid who has difficulty in mathematics. Typically, the teacher will say, "Well, this kid is not math-minded. Let's try the kid on something else." But if the kid were having difficulty in French, we couldn't say that that kid is not French-minded, because we know that had the kid been born in France he or she would have no trouble learning French. So Papert's idea was that there's something environmentally wrong about the way math is taught to kids. If the environment were right, they would learn. Well, the computer is a tool with which you can actually make rich environments, in which learning can have the character of play.

I think that for kids, play is the most important means of learning, and so you want to harness it for as many years as you possibly can. Play is nature's built-in mechanism for the child's deepest learning. And if the environment isn't rich enough, you lose the element of play. But if you can make the environment rich and can keep the play going, then you win in a big way. Because maybe the biggest question about education is,

"What is this kid going to do when teachers and parents are not around?" If children love the learning process, they want to spend all their time at it. If they don't love it, it doesn't matter much what you do in a classroom.

See, every question you ask me, I come back to my interest in education. Because without that, well, I don't care about the other things that might be done with the Dynabook.

B&C : And that takes us full circle. If we go back to the first question, which is what's missing, why isn't the Dynabook a reality -- what's missing is that the population to use them isn't there yet. We haven't taught people how to use them.

AK : Exactly. Because the music is not inside the piano.