Chapter 5
The Vision of Interactive Computing And the Future

by Michael Hauben

What is the reality behind all the talk about the so called "Information Superhighway"? This is an important question which U.S. government policy makers seem to be ignoring. However, understanding the history of the current global computer networks is a crucial step towards building the network of the future. There is a vision that guided the origin and development of the Internet, Usenet and other associated physical and logical networks. What is that vision?

While the global computer networks are basically young – the ARPANET started in 1969 – their 25 plus years of growth has been substantial. The ARPANET was the experimental network connecting the mainframe computers of universities and other contractors funded and encouraged by the Advanced Research Projects Agency of the U.S. Department of Defense. The ARPANET started out as a research test bed for computer networking, communication protocols, computer and data resource sharing, etc. However, what it developed into was something surprising. The widest use of the ARPANET was for computer facilitated human-human communication using electronic mail (e-mail) and discussion lists. (Popular lists included Human-Nets, Wine-Tasters and Sci-Fi Lovers lists.) The human communications achievements of ARPANET research continue to be today's most popular usage of the Net by a growing number and variety of people through e-mail, Usenet discussion groups, mailing lists, internet relay chat, and so on. The ARPANET was the product of previous U.S. government funded research in interactive computing and time-sharing of computers.

Until the 1960s, computers operated almost exclusively in batch mode. Programmers punched or had their programs punched onto cards. Then the stack of punched cards was provided to the local computer center. The computer operator assembled stacks of cards into batches to be feed to the computer for continuous processing. Often a programmer had to wait over a day in order to see the results from his or her input. In addition, if there were any mistakes in the creation of the punched cards, the stack or part of it had to be punched again and resubmitted, which would take another day. Bugs in the code could only be discovered after an attempt to compile the code and therefore "debugging" was a slow process. This batch processing mode was a very inefficient way of utilizing the power of the computer. People began thinking of ways to alter the interface between people and computers. The idea of time-sharing developed among some in computer research communities. Time-sharing makes it possible for people to utilize a computer (then predominately the IBM mainframe) simultaneously. Time-sharing operates by giving the impression that the each user is the only one using the computer. This is executed by having the computer divvy out slices of CPU time to all the users in a rapid, sequential manner.

Crucial to the development of today's global computer networks was the vision of researchers interested in time-sharing. These researchers began to think about social issues related to time-sharing. They observed the communities that formed from the people who used time-sharing systems and considered the social significance of these communities. Two of the pioneers involved in research in time-sharing at MIT, Fernando Corbato and Robert Fano, wrote, “The time-sharing computer system can unite a group of investigators in a cooperative search for the solution to a common problem, or it can serve as a community pool of knowledge and skill on which anyone can draw according to his needs. Projecting the concept on a large scale, one can conceive of such a facility as an extraordinarily powerful library serving an entire community in short, an intellectual public utility.”[1]

Research in time-sharing started in the early 1960s around the country at different research centers. Some examples were CTSS (Compatible Time-sharing System) at MIT, DTSS (Dartmouth Time-sharing System) at Dartmouth, a system at BBN, Project GENIE at the University of California at Berkeley, and so on. J. C. R. Licklider, the founding director of ARPA’s Information Processing Techniques Office (IPTO) thought of time-sharing as interactive computing. Interactive computing meant the user could communicate and respond to the computer’s responses in a way that batch processing did not allow.

Licklider was one of the first users of the new time-sharing systems, and took the time to play around with them. Examining the uses of this new way of communicating with the computer enabled Licklider to think about the future possibilities. This was helpful because Licklider went on to establish the priorities and direction for ARPA’s IPTO research monies. Many of the interviewees in a series of interviews conducted by the Charles Babbage Institute (CBI) said that ARPA's money was given in those days under Licklider’s guidance to seed research which would be helpful to society in general and only secondarily helpful to the military.

Both Robert Taylor and Larry Roberts, future successors of Licklider as director of IPTO, pinpoint Licklider as the originator of the vision which set ARPA’s priorities and goals and basically drove ARPA to help develop the concept and practice of networking computers.

In one of the CBI interviews, Roberts said: “what I concluded was that we had to do something about communications, and that really, the idea of the galactic network that Lick talked about, probably more than anybody, was something that we had to start seriously thinking about. So in a way networking grew out of Lick’s talking about that, although Lick himself could not make anything happen because it was too early when he talked about it. But he did convince me it was important.”[2]

Taylor, also in a CBI conducted interview, pointed out the importance of Licklider’s vision to future network development, “I don’t think anyone who’s been in that DARPA position since [Licklider] has had the vision that Licklider had. His being at that place at that time is a testament to the tenuousness of it all. It was really a fortunate circumstance. I think most of the significant advances in computer technology, especially in the systems part of computer science were simply extrapolations of Licklider’s vision. They were not really new visions of their own. So he’s really the father of it all.”[3]

Taylor also described how research in time-sharing led to surprising results. He succeeded Licklider as Director of the IPTO at ARPA. A phrase that J. C. R. Licklider frequently used to express his vision was “an Intergalactic Network.” Taylor explains that Licklider used this phrase to describe the potential community that he realized would emerge from the interconnection of the local communities of Net users that develop from time-sharing. At first, Taylor notes ARPA supported research had as its goal achieving compatibility and resource sharing across different computer systems. However, he explains, “They were just talking about a network where they could have a compatibility across these systems, and at least do some load sharing, and some program sharing, data sharing that sort of thing. Whereas, the thing that struck me about the time-sharing experience was that before there was a time-sharing system, let’s say at MIT, then there were a lot of individual people who didn’t know each other who were interested in computing in one way or another, and who were doing whatever they could, however they could. As soon as the time-sharing system became usable, these people began to know one another, share a lot of information, and ask of one another, ‘How do I use this? Where do I find that?’ It was really phenomenal to see this computer become a medium that stimulated the formation of a human community. And so, here ARPA had a number of sites by this time, each of which had its own sense of community and was digitally isolated from the other one. I saw a phrase in the Licklider memo. The phrase was in a totally different context something that he referred to as an ‘intergalactic network.’ I asked him about this…in fact I said, ‘Did you have a networking of the ARPANET sort in mind when you used that phrase?’ He said, ‘No, I was thinking about a single time-sharing system that was intergalactic’”[4]

As Taylor explains, the users of the time-sharing systems would form, usually unexpectedly, a new community. People were connected to others who were also interested in these new computing systems.

The vision driving ARPA inspired bright researchers working on computer related topics. Roberts explains that Licklider’s work (and that of the IPTO’s directors after him) educated people who were to become the future leaders in the computer industry. Roberts describes the impact that Licklider and his vision made on ARPA and future IPTO directors: “Well, I think that the one influence is the production of people in the computer field that are trained, and knowledgeable, and capable, and that form the basis for the progress the United States has made in the computer field. That production of people started with Lick, when he started the IPTO program and started the big university programs. It was really due to Lick, in large part, because I think it was that early set of activities that I continued with that produced the most people with the big university contracts. That produced a base for them to expand their whole department, and produced excitement in the university.”[5]

Roberts describes how ARPA supported university research had a significant impact on the computer industry as well. “So it was clear that that was a big impact on the universities and therefore, in the industry. You can almost track all those people and see what effect that has had. The people from those projects are in large part the leaders throughout the industry”[6]

Licklider’s vision was of an “Intergalactic Network,” a time-sharing utility that would serve the entire galaxy. This early vision of time-sharing spawned the idea of interconnecting different time-sharing systems by networking them together. This network would allow those on geographically separated time-sharing systems to share data, programs, research, and later other ideas and anything that could be typed out. In the article, "The Computer as a Communications Device", Licklider and Taylor predicted the creation of a global computer network. They wrote: "We have seen the beginnings of communication through a computer – communication among people at consoles located in the same room or on the same university campus or even at distantly separated laboratories of the same research and development organization. This kind of communication – through a single multiaccess computer with the aid of telephone lines – is beginning to foster cooperation and promote coherence more effectively than do present arrangements for sharing computer programs by exchanging magnetic tape by messenger or mail."[7]

They point out how the interconnection of computers leads to a much broader class of connections than might have been expected. A new form of community is generated. "The collection of people, hardware, and software the multiaccess computer together with its local community of users will become a node in a geographically distributed computer network. Let us assume for a moment that such a network has been formed. Through the network of message processors, therefore, all the large computers can communicate with one another. And through them, all the members of the super community can communicate with other people, with programs, with data, or with a selected combinations of those resources."[8]

Licklider and Taylor consider more than just hardware and software when they write about the new social dynamics that the connections of dispersed computers and people will create. They explain: "[These communities] will be communities not of common location, but of common interest. In each field, the overall community of interest will be large enough to support a comprehensive system of field-oriented programs and data."[9]

In exploring this community of common affinity, they describe the main advantages that come from connecting to and being part of these new computer facilitated communities. Life will be enriched for those people who can communicate on-line with others who have similar goals and interests, as they won't be limited by geography. Communication will be more productive and thus more enjoyable. And the kind of programs that those on-line will have access to will be customized to one's interests and abilities, and thus more satisfying. And they describe the advantages to society that the increased opportunities and resources made possible by the Net can provide for everyone.[10]

Since the advantages that computer networks make possible for society will only happen if these advantages are available to all who want to make use of them, Licklider and Taylor realize there is a crucial challenge put on the agenda of our times by the development of the Net. They conclude their article with a prophetic question: "Will 'to be on line' be a privilege or a right?"[11] They argue that it must be a right. Otherwise, instead of providing all the many benefits it makes possible, it will only increase the inequities of intellectual opportunity that currently exist.

The challenge they raise is one of access. The authors point out that the positive effects of computer networking will only come about if the networks are made easy to use and available to all. They argue that access should be made available because of the global benefits that would ensue. They conclude by describing how humankind can benefit immeasurably from the educational opportunities the Net makes possible, "if the network idea should prove to do for education what a few have envisioned in hope…surely the boon to humankind would be beyond measure."[12]

Licklider and Taylor raise the important point that access should be made available to all who want to use the computer networks. Therefore it is important to ask if the National Information Infrastructure is being designed with the principle of equality of access. The vision of the interconnection and interaction of diverse communities guided the creation of the original ARPANET. In the design of the expansion of the Net, it is important to keep the original vision in mind to consider if the vision was correct, or if it was just important in the initial development of networking technologies and techniques. However, very little emphasis has been placed on either the study of Licklider's vision or the role and advantages of the Net up to this point. In addition, the public has not been allowed to play a role in the planning process for the new initiatives which the U.S. government is currently undertaking. This is a plea to you to demand more of a part in the development of the future of the Net.

Notes for Chapter 5

1. "Time-sharing on Computers", in Information, A Scientific American Book, San Francisco, 1966, p. 76.

2. Lawrence G. Roberts, Interview by Arthur L. Norberg, 4 April 1989, San Mateo, California, Charles Babbage Institute, The Center for the History of Information Processing, University of Minnesota, Minneapolis, Minnnesota, p. 29.

3. Robert W. Taylor, Interview by William Aspray, 28 February 1989, Palo Alto, California, Charles Babbage Institute, The Center for the History of Information Processing, University of Minnesota. Minneapolis, Minnnesota, p. 8.

4. Ibid., p. 24.

5. Lawrence G. Roberts Interview, p. 29.

6. Ibid., p. 30.

7. "The Computer as a Communication Device," in In Memoriam: J. C. R. Licklider: 1915-1990, p. 28.

8. Ibid., p. 32.

9. Ibid., p. 38.

10. Ibid., p. 40.

11. Ibid., p. 40.

12. Ibid., p. 40.
