

A HIBAR Research Story: How [Hyperlinks](#) Were Designed to Become Ubiquitous

An interview with Professor Ben Shneiderman of the University of Maryland, conducted by Lorne Whitehead of the University of British Columbia. Prof. Shneiderman was a Peter Wall Institute for Advanced Studies International Visiting Research Scholar at the University of British Columbia during 2018.

Thanks, Ben, for agreeing to this brief interview. Would you like to briefly describe how hyperlinks started and became ubiquitous, from the perspective of your own involvement?

Sure! Like most important developments, the origins go way back. In 1945 U.S. Presidential Science Advisor Vannevar Bush imagined a fancy desk with rolls of microfilm records that were linked together so readers could easily jump from one article to another. However, his design assumed typing numerical codes to navigate across documents while recording a trail of the documents. Bush was thinking of legal documents that cited other cases, but the idea was very general and exciting to many readers of his *LIFE Magazine* article. His ideas were an early vision of what Ted Nelson, an American pioneer of information technology, labeled “hypertext.”

Discussions continued, but hypertext was still just an idea in the early 1980’s as I did research on the human-computer interaction and user interface design, as a professor in the Department of Computer Science at the University of Maryland. This was before the World Wide Web, but we already saw a need for some kind of hyperlinking. We recognized that there would be huge benefits if people who were reading screens could easily navigate across documents by jumping, (not scrolling), using a simple, intuitive and fast interface. Remember, this was before the mouse and the graphic user interface were widely used! We were attracted to this challenge because ordinary users *wanted* computers to be easy to use – to feel comfortable and responsive - and we were aiming to making these new machines work well for human beings. Computer users wanted to concentrate on the information, not the navigation, so our goal was to satisfy that need through innovative, cognitively appropriate and scientifically verified designs.

Our work was grounded in the principles of direct manipulation, which elevated computer use from the realm of paper-based teletypes to graphical user interfaces. Direct manipulation builds on foundational theories in psychology, and is informed in part by the applications that users loved, such as computer games, simulations, and graphical interaction. The common design principle was to give users a visual representation of the world of action, shift from keyboards to clicking with a mouse or other pointing device, and give users rapid feedback. Direct manipulation has proven to be a key foundation for much of contemporary computer use from touchscreen mobile devices to clicking on e-commerce websites.

We could not have done this alone – the project was intimately connected with computer system manufacturers, content creators, major early customers (in our case the Smithsonian Institution), and other computer science colleagues around the world. Over time, our research, based on human factors studies, led us to recommend the light blue font color, still used in most hypertext today, as the subtle indicator of a hyperlink. Of course, in those days computers generally weren’t networked, so the links were limited to a local computer system. However, as Tim Berners-Lee launched the World Wide Web in 1989, hypertext links became enabled to navigate to any computer on the internet. With that threshold crossed, hypertext began a long steady growth period

that still continues. Today, people of all skills and ages navigate easily and intuitively using hypertext, and many feel comfortable adding hypertext links to their own documents.

As you've said, this was a big complex success story. Would you like to expand a little on your own involvement, and perhaps some personal insights? For example, from today's perspective, how would you describe the "problem" or "need" that existed in society - which quite likely was not readily apparent to most at the time, but seems very clear from today's perspective?

Let's try to remember what things were like before computer-based hypertext. There was a huge difficulty back then – one that was so ubiquitous that most of us probably didn't think of it, so let me remind you: when people were trying to learn about a subject, they would go to an encyclopedia, visit a library to check a card catalog, or read through thick books with references to research papers. The real problem was one of time – it might take 10 minutes, or even 10 days to find the right resources. This is an area where I've especially enjoyed contributing - through my knowledge of computer technology and human factors research, I have been able to envision solutions that at the time were not immediately practical, but I estimated they could be *made* practical. I do think *practical* is a critical word – practical means useful for people, and this requires careful research with human subjects. Research goes well when I have deep interactions with professionals working outside the university systems and who teach me what I need to know to make things that work in the “real world”. True, diverse leadership adds complexity, but I like working with other people, and to me it just feels natural to keep on trying things while learning, networking, and creating.

I'd love to hear a bit more about the role that non-university experts played in this story. Could you briefly expand about how the leadership of the work included experts from outside the university system? How did this co-leadership arise, and what were some of the challenges in maintaining it?

That's a really good question and it is difficult to be brief. First, I'd like to mention my former student Dan Ostroff who implemented the highlighted selectable link that we called *embedded menus*. Then graduate student Larry Koved worked with me on the key paper published in the widely read monthly *Communications of the ACM (CACM)* in 1986. As the ideas became more real, an important partner was my long-time friend and colleague Charlie Kreitzberg who founded Cognetics Corp. in 1983. He believed in our designs and worked to commercialize them in an online encyclopedia, which we called HyperTIES. This system was used by Cognetics to produce the first electronic user manual for the Hewlett-Packard Laserjet 4. HyperTIES was also used to make the world's first electronic scientific journal for the July 1988 issue of the CACM, which is what Tim Berners-Lee cited in his Spring 1989 manifesto for the World Wide Web. Tim was clever enough to change the name to *hotspots* and eventually *hot links*.

Dan, Larry, and Charlie were just three of the students and professionals we worked with to implement, test, and refine our initial design and software tools. Many people contributed to the evolution of hypertext. The vital lesson is that joining forces with academic colleagues and experts working outside the university system enhanced our capability and vision.

Another important lesson was to build something for others to use and to watch them as they used our designs. We worked with the Smithsonian Institution, the International Center of Photography, and the emerging U.S. Holocaust Memorial Museum to develop public kiosks with information

related to exhibits. These projects pushed us to learn the lessons of how to write in a hypertext environment, in which users could jump around to learn about people, places, and events, as they now do regularly in contemporary services like Wikipedia. They also led us to observe and test different designs, gaining feedback to improve our next design, while taking advantage of the rapidly improving technologies of higher resolution screens, faster computers, better networks, and improved touchscreens or pointing devices.

As you think back over the project, were there times when key decisions were made that you now realize were critically important for success?

One thing comes to mind: I didn't want to control or own things; I wanted our work to be openly available. I recognize that there is sometimes a place for greater control, but with the hypertext story, I think open collaboration was really the right way to go, enabling many people to contribute to the innovations and offer competing approaches, thus leading to many benefits. Early software tools for exploring data and navigating across documents were tedious to use, but hypertext links caught on because they were easy, quick, and safe. Every time a person clicks on a hyperlink, they save time in finding information they want and maybe enjoy encountering ideas that they didn't expect. Part of the satisfaction of clicking on links is to discover something new and important, surprising, or enjoyable. Hypertext puts users in control, giving them the freedom to explore and expand their thinking, but safe because they can always go back to where they came from.

Looking forward, as you approach new opportunities, are there more general lessons that can be applied to future work, or related ideas that you would like to share?

An important lesson is that when exploring new ideas, many of them are likely to fail, but don't give up – keep on trying. Persistence and hard work are common patterns in developing new ideas. Even simple ideas like the hyperlink had many alternative designs that didn't prove to be useful. Now hyperlinks seem like an obvious idea, so newcomers can't imagine any other way of working -- the satisfaction for me is that they now seem so natural. The thrill of discovery and "Aha!" moments of invention keep researchers going, and it is all sweeter when the results are shared with colleagues and adopted by billions of users.

Ben Shneiderman is a Professor Emeritus in Computer Science and a member of U.S. National Academy of Engineering, whose work has earned him six honorary doctorates. More information on hypertext research at <http://www.cs.umd.edu/hcil/hyperties/>

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