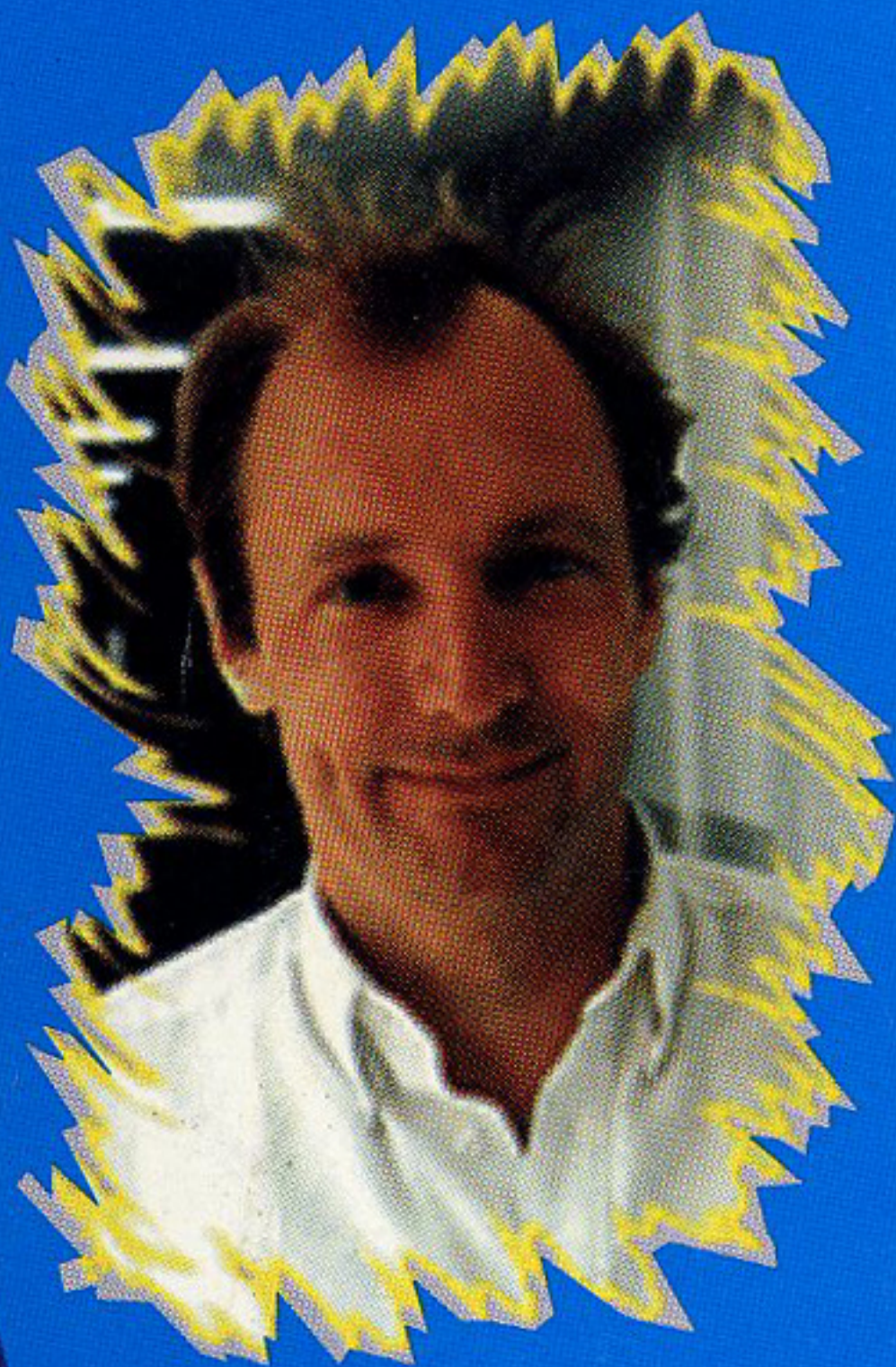
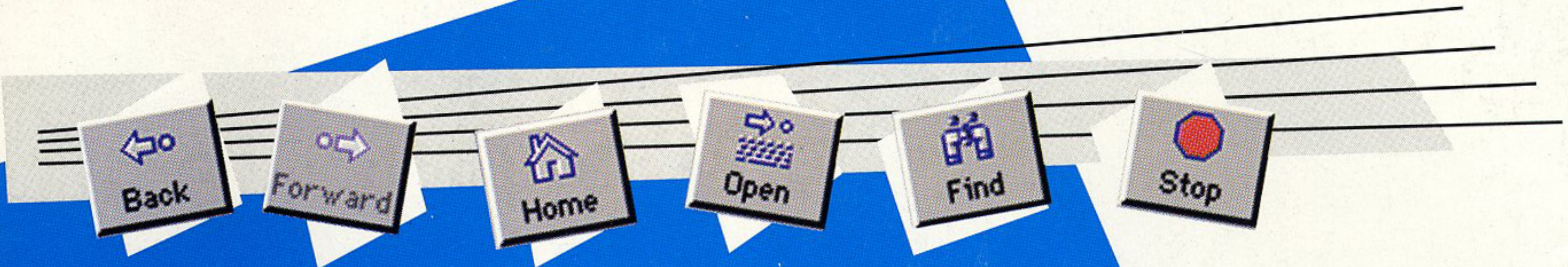


Technology Review

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Tim Berners-Lee

THE ARCHITECT OF
THE WORLD WIDE WEB
TALKS ABOUT:

- WHERE IT CAME FROM
- WHERE IT'S AT
- WHERE IT'S GOING



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THURSDAY APRIL 18, 1996

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Good Afternoon

Welcome to the White House

What's New: The Japanese govt. President to Japan

What's New: The Japanese govt. President to Japan

FISHCAM

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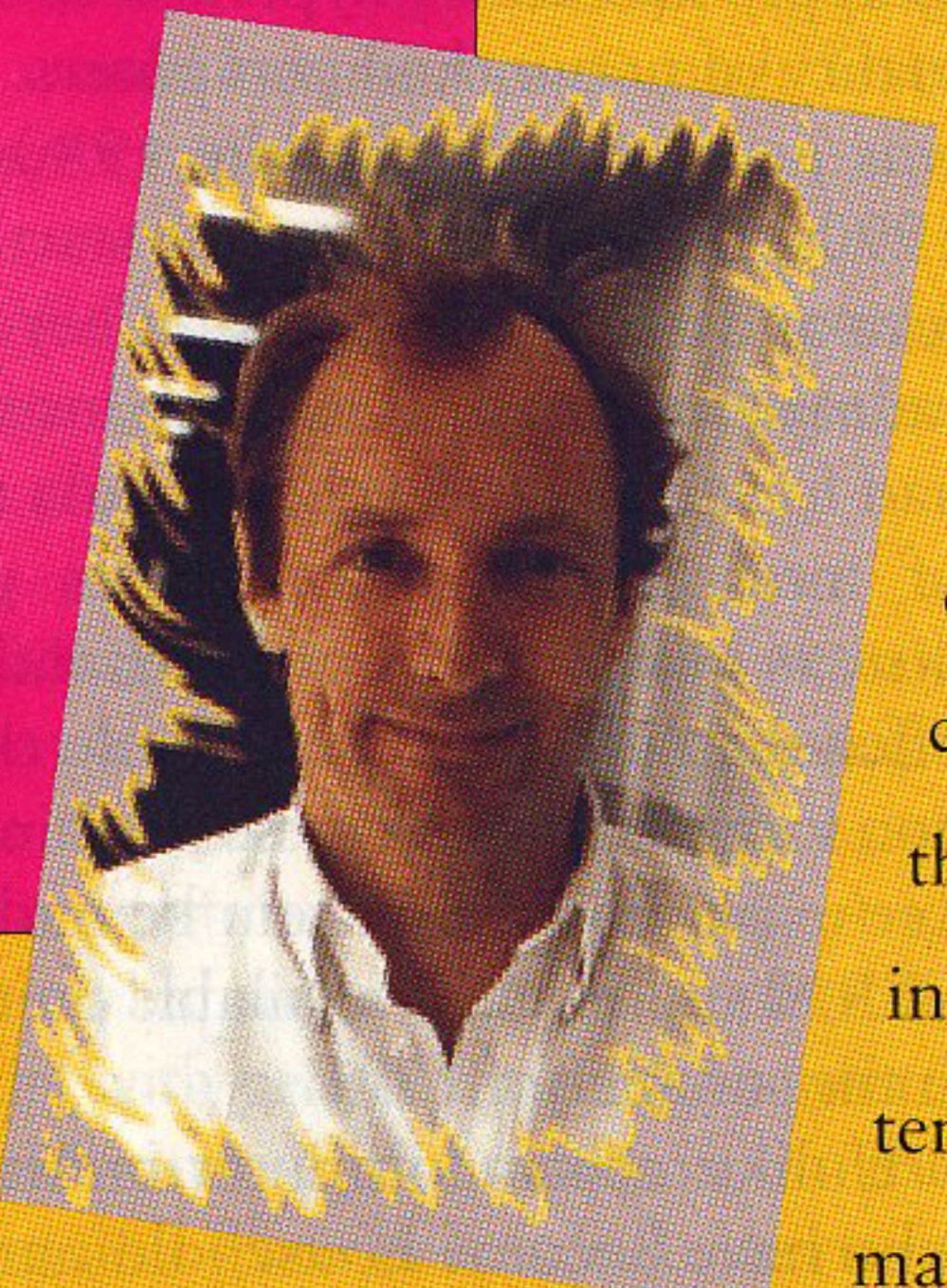
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pullquote

The Web Maestro

AN INTERVIEW WITH TIM BERNERS-LEE



The man who wove the first few strands in what has grown into the World Wide Web—and who oversees the organization that coordinates the Web's further development—peers into the future he's helping to create.

THE World Wide Web is giving Tim Berners-Lee a problem. He is eager to demonstrate a new feature he is working on, which will make it much easier for users of the World Wide Web to forge connections between documents, or "pages." But Berners-Lee's mouse clicks seem to fall on deaf silicon; supposed links appear not to exist, and when connections do get made the text and images flow onto the screen at less than eye-popping speed. Since everyone who has used the Web has experienced this dozens of times, it is perversely gratifying to see Berners-Lee suffer the same frustration. Wouldn't we all love to see the inventor of the VCR get hung up on programming it to record a TV show? "Usually, this is blindingly fast," he insists, and with persistence he prevails. But the man who invented the World Wide Web is, at least for the moment, trapped in his own glorious creation.

The Web's key feature is information connected through hypertext "links"—clicking on a word or a picture summons into the user's computer text, pictures, sounds, software, or any of a thousand and one gimmicks. So powerful is the appeal of the graphics and hyperlinks that newcomers to the online world might be forgiven for thinking that the Web is the Internet, rather than just an especially powerful and convenient way to navigate through the worldwide collection of networked computers.

Berners-Lee did not set out to invent a contemporary cultural phenomenon; rather, he says, "it was something I needed in my work." He wanted simply to solve a problem that was hindering his efforts as a consulting software engineer at CERN, the European particle-physics laboratory in Geneva. Mainly to become more efficient, he developed a system that provided easy-to-follow links between documents stored on a number of different computer systems at this international laboratory and created by different groups.

Hypertext had been proposed as early as 1945 by Vannevar Bush, and rudimentary hypertext software had been developed to interlink material among different files on individual PCs. Berners-Lee's innovation was to apply the idea of hypertext to the growing reality of networked computers. His timing was just right. In the late 1980s and early 1990s, the Internet was just starting to blossom and achieve recognition beyond a small cadre of military and research institutions that had formed its early clientele. As the number of interconnected computers grew from dozens into the tens of thousands, the Web offered an ideal way to tap into the information scattered among these machines. Berners-Lee expanded the system he had devised at CERN and made it available on the Internet in the summer of 1991.

Unlike other computer-industry figures who have become household names, he has stayed in the shadows. Rather than spin off a company to cash in on his ideas, the British-born Berners-Lee became in 1994 the first director of the World Wide Web Consortium,

a nonprofit organization with more than 100 member organizations that coordinates the development of Web software and standards. When looking for a place to locate the consortium, Berners-Lee chose MIT's Laboratory for Computer Science. "MIT has a reputation for doing the right thing on technical standards," Berners-Lee explains. Typically, he says, MIT will hold the copyright on a standard but keep it for the public good; "this isn't a place that will turn around and slap on license charges when you're five years down the road."

Berners-Lee is not, it turns out, a typical user of the World Wide Web. His use of the Web is almost exclusively related to his work on devising standards for it. Asked if he surfs the Net for pleasure, he replies that he doesn't have time for that kind of thing; Henry Ford is too busy in the garage to go out for a Sunday drive. In any case, Berners-Lee tends to dismiss complaints that the Web is too hard to search and that the gems are hopelessly submerged in gigabytes of drivel. "There's no fundamental right for people to be able to discover anything instantly," he maintains.

The glitch on the Web soon surrenders to Berners-Lee's careful, persistent, and knowledgeable ministrations, and the illusion of the machine taking revenge on its inventor recedes. Close call. With electronic tools now acquiescent, a confident Berners-Lee spoke with *Technology Review* senior editor Herb Brody about how he devised the Web, why its critics are off base, and how he envisions it will change and improve in the years ahead.

TR: Do you ever step back and marvel at how rapidly your idea has taken root? The World Wide Web has to have set some kind of record in the speed with which it progressed from unknown and esoteric to fashionable and then to almost commonplace.

BERNERS-LEE: Yes, the Web's growth has been exponential. For the first three years, the load on the servers was always 10 times what it was the year before. But after a few years of that kind of growth, you get used to it.

TR: Hypertext had been proposed many times before, and implemented on a small scale. Why do you think the concept caught fire with the World Wide Web?

BERNERS-LEE: Earlier hypertext systems had generally been limited to pointing to documents within the same local file system. Those systems often used a central link database to keep track of all the links. The advantage of this kind of approach was that it ensured that a link would never point to someplace that didn't exist.

TR: And the disadvantage?

BERNERS-LEE: There was no way to scale up such a system to allow outsiders to easily contribute information to it.

TR: So the original concept of the Web involved a trade-off favoring universality over reliability.

BERNERS-LEE: Yes, I sacrificed that consistency requirement to allow the Web to work globally. What was really new with the Web was the idea that you could code all the information needed to find any document on the network into a short string of characters. These strings, originally called universal document identifiers, are now known as universal resource locators, or URLs. The notion that all these tagged documents from computers all over the world could share a common naming and addressing "space" was what made hypertext links so much more powerful.

TR: What was your goal in designing the World Wide Web?

BERNERS-LEE: It was something I needed in my work. CERN is composed of a variety of bright and creative people from institutes in many countries. When they work together on a project, the result can be a tangle of complexity. Coming into this organization as a software consultant, I found a tremendous need to be able to find out what was going on, particularly the interdependencies—what work was related to what. If I needed to modify some program module, for instance, what else was that change going to affect? I wrote a program called Enquire, which had a little bit of what we think of now as hypertext: at the bottom of each document would be a list of references that you could follow to immediately jump to another piece of information. I found this really useful because it was so flexible—I used it to keep track of everything I did.

TR: But this wasn't the Web as we now know it, right? Weren't you interlinking things like computer programs and their documentation?

BERNERS-LEE: Yes, mostly, but it wasn't limited to that. You could put recipes in, if you wanted, and link them back to your ingredients—so that you could follow the link from onion pies to onions, or whatever you liked.

TR: Did Enquire solve your problem?

BERNERS-LEE: Not entirely. I had details of my own work nicely organized in this web-like fashion, but what I really needed was to make links to other people's documents. We needed a program that was so easy to use that everybody would end up putting their data into it. That way when you wanted to collaborate with other people you could easily share data, you could point to things that they had written before, rather than having to copy them. It was also crucial to allow different people to be able to start their own webs in different places and later link them with only incremental effort.

TR: How was this an advantage over what was available to you at the time?

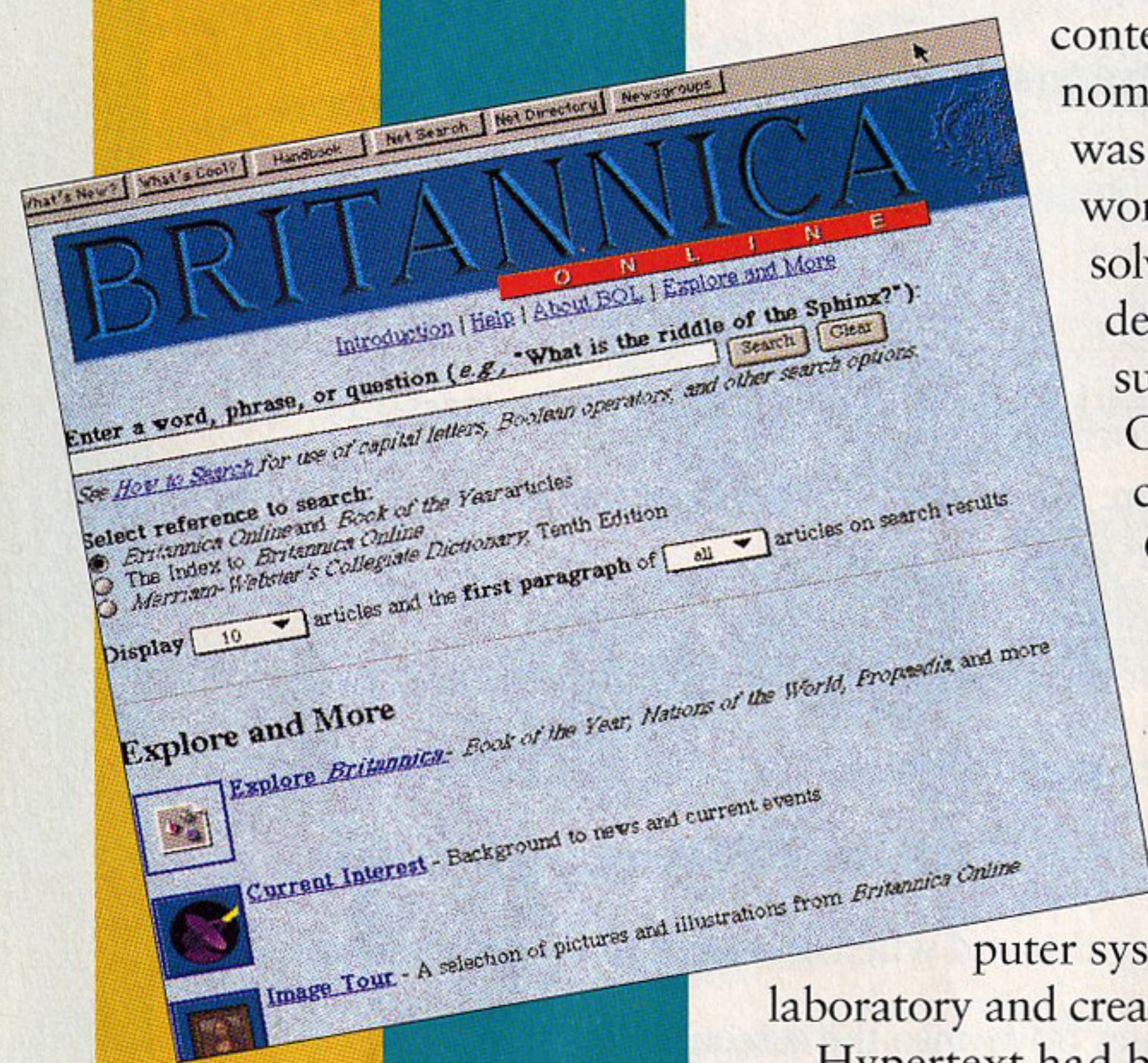
BERNERS-LEE: In a typical documentation system, if you wanted to make a reference from one document to another, you had to merge the two computer databases that held the information. That entailed moving all the stuff onto the same computer and arguing about who would keep it maintained. That wasn't going to work.

TR: So the Web was born not as a "world wide" system but as an internal computer network—a closed universe.

BERNERS-LEE: The network was used mainly by people working for CERN, but "closed" may not be the best word. The people at CERN did come from all over the world. And I was working before, during, and after on other projects with people from the Stanford Linear Accelerator and FermiLab in the United States and from Britain's Rutherford Lab, to name just a few.

TR: Still, it seems like a pretty big leap from a network for nuclear physicists to the cul-

For the first three years, the load on the first Web servers was always ten times what it was the year before. After a few years of that kind of exponential growth, you get used to it.



"The better sources on the Web, such as Britannica, have involved considerable human effort, and so there will be a subscription to pay or a volunteer to thank. Or did you want quality for nothing?"

Anyone whose Web page carries a message saying "Sorry, you need software from Company X to enter this site" appears to be yearning for the bad old days, when you had little chance of reading a document written on another computer or network.

tural phenomenon that the Web has become. How did it get from there to here?

BERNERS-LEE: The first few years involved a lot of persuasion—we had to convince people to use the Web and to put information up on it. But what really made it go was the set of specifications we had developed early on.

TR: You're referring to the alphabet soup of Web standards?

BERNERS-LEE: Yes—there was hypertext markup language (HTML) for creating the documents with hypertext links, and hypertext transfer protocol (HTTP) for specifying how the network would respond when a user clicked on a link. And above it all was the system of URLs, which ensured that every item put up on the Web had a unique "address." For the Web to function and to grow, everyone had to stick to these specifications, and to agree on any changes to them.

TR: How has the Web departed from your early vision of it?

BERNERS-LEE: The original idea was that anybody would very easily be able to write documents that could be connected through hypertext links. What has surprised me is the way people have been prepared to put up with manually encoding text. HTML was never supposed to be something that you would see—it was intended to be something produced by an editor program. An analogy is with word processors. Computer users don't have to write in all kinds of codes to format their document with fonts, margins, and so on. So it staggers me that people have actually put up with having to write HTML by hand. Similarly, I had not expected people to have to work out the hypertext links by looking up and typing in those long, complex codes for addressing. URL syntax was never intended for human consumption. It was intended for a machine.

TR: But ordinary users of the Web don't need to know HTML—that's only for the people who create content.

BERNERS-LEE: Yes, but the Web needs information providers as well as readers. And the fact that creating Web pages has been difficult has directly influenced the type of information

made available on it; content is produced only by those with enough incentive to learn to write HTML.

TR: How had you envisioned it working?

BERNERS-LEE: In the prototype, you could create a link without having to write any code. You'd just browse around, find something interesting, go back to the thing you were writing, and then just make a click on a hot key, and it would make a link for you automatically. This ability is now starting to become available—in a couple of years, all the documents on the Web will probably be created without the direct use of HTML and URL syntax that is now so much a part of the Web.

No Instant Gratification

TR: The Web has a reputation in some quarters as more sizzle than steak—you hear people complain that there's no way of judging the authenticity or reliability of the information they find there. What would you do about this?

BERNERS-LEE: People will have to learn who they can trust on the Web. One way to do this is to put what I call an "Oh, yeah?" button on the browser. Say you're going into uncharted territory on the Web and you find some piece of information that is critical to the decision you're going to make, but you're not confident that the source of the information is who it is claimed to be. You should be able to click on "Oh, yeah?" and the browser program would tell the server computer to get some authentication—by comparing encrypted digital signatures, for example—that the document was in fact generated by its claimed author. The server could then present you with an argument as to why you might believe this document or why you might not.

TR: This would be particularly useful, I'd think, in verifying orders or payments for electronic commerce.

BERNERS-LEE: Yes—it would help if, for example, you find a beautiful offer on the Web for some product and you want to find out if it's for real. But this kind of verification is important for more than just buying and selling things. Every political candidate, for instance, seems to have two or three "spoof"

Web sites—they look almost, but not quite, like the real thing. When you visit the real White House Web page, for example, you can click on an icon of a cat and hear a meow. Then one day you click on a White House link from somebody's page and you click on the cat and you hear some awful noise instead—you've been spoofed. You're not really at the White House—you're at something like white-house.com instead of the real thing, which is whitehouse.gov. So you ought to be able to press "Oh, yeah?" and the browser sends out a request to cryptographically check the authenticity of the site.

TR: Another common gripe is that the Web is drowning in banal and useless material. After awhile, some people get fed up and stop bothering with it.

BERNERS-LEE: To people who complain that they have been reading junk, I suggest they think about how they got there. A link implies things about quality. A link from a quality source will generally be only to other quality documents. A link to a low-quality document reduces the effective quality of the source document. The lesson for people who create Web documents is that the links are just as important as the other content because that is how you give quality to the people who read your article. That's how paper publications establish their credibility—they get their information from credible sources. A journal on the Web, for instance, needs to have an editor who is paid to make sure that the pointers lead to good stuff. You don't go down the street, after all, picking up every piece of paper blowing in the breeze. If you find that a search engine gives you garbage, don't use it. If you don't like your local paper, don't buy it. If you find that an article refers to stupid articles, don't read it, and don't quote it yourself. Pretty soon you'll have some bookmarks on places you trust, and your reading quality will increase. You may find that the better sources have involved considerable human effort, and so there will be either advertising to read, a subscription to pay, or a volunteer to thank. Or did you want quality for nothing?

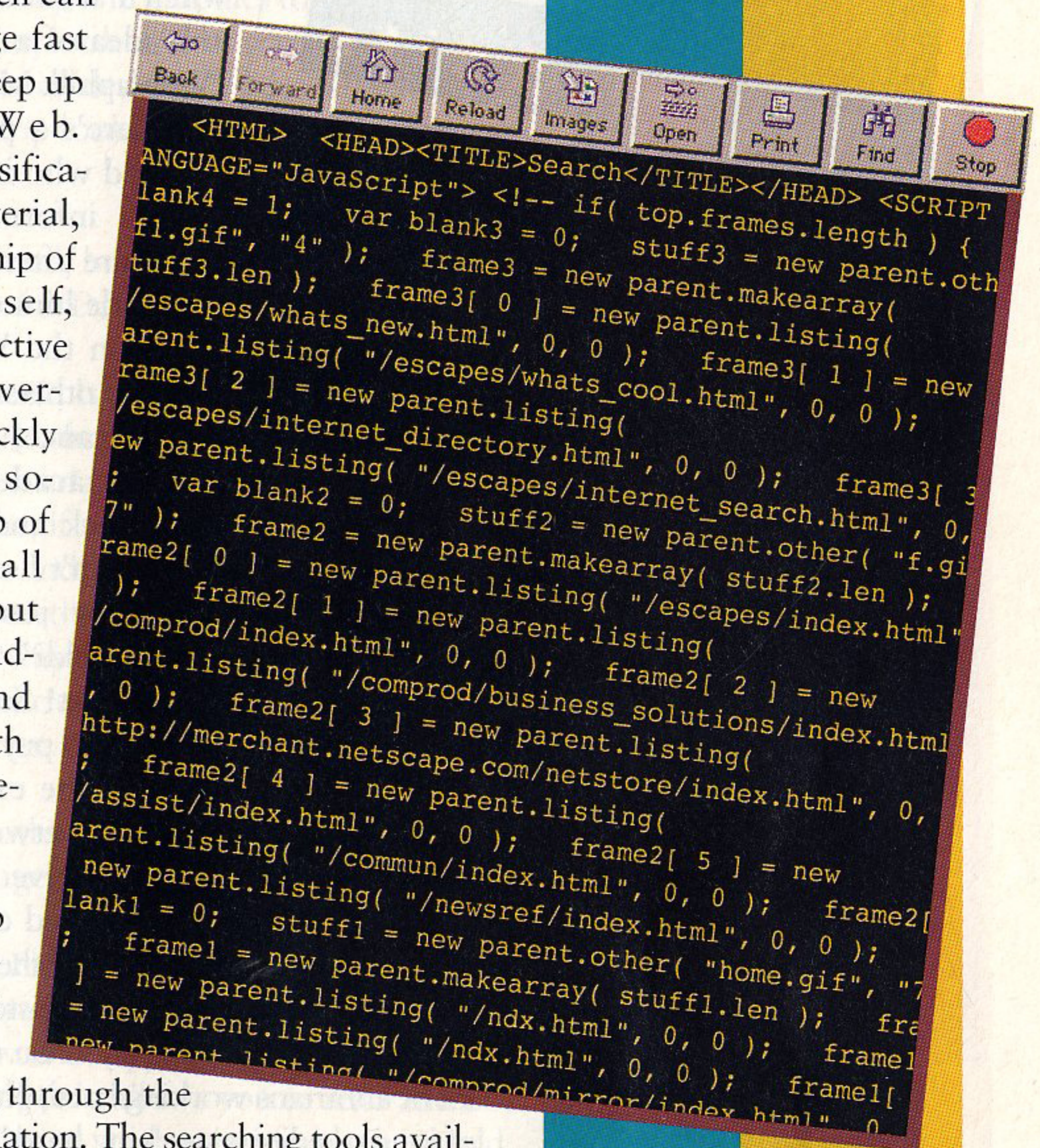
TR: While there are a number of tools to help users find information on the Web, they aren't terribly precise. Wouldn't it be better

if the creators of Web pages labeled them with keywords that could be searched for?

BERNERS-LEE: Yes, that would make searches more productive, but there are two big snags. The keywords, or the topic names, form a rather centralized rigid point in the system, which can never change fast enough to keep up with the Web. And the classification of material, like authorship of material itself, can be subjective and controversial, and quickly become obsolete. The job of classifying all human output is a never-ending one, and merges with the job of creating it.

TR: But Web users nevertheless crave better ways of searching through the sea of information. The searching tools available now give you a list of Web pages very quickly, but many of these "hits" seem to have little if any relevance to what the person is looking for.

BERNERS-LEE: People have no fundamental right to discover everything instantly. Information providers want to be found easily and will use standard ways of registering themselves and their products, and there will be tools to scan the Web so that users may quickly find them. But other providers will prefer to express themselves any way they want and thus might be more difficult to track down. They might not be cataloged, and they won't mind. So just as you have a right to scribble anything on paper and not show it to anybody, you'll also have the right to post things on the Web and not make them easily found. The Web, like paper, should be a universal medium, in which it is possible for all kinds of information to exist.



"It staggers me that people have actually put up with HTML [hypertext markup language]. It was never supposed to be something that you would see, but something produced by an editor program."

TR: People are developing high expectations, though: they want to know why, if we have all this information online, it is so hard to find what we want.

BERNERS-LEE: This question goes back to the early days, when I was really pushing this idea of a World Wide Web uphill. My response is: If there's a person in the world who is apt to have the information that you're after, go and persuade him or her to put it on the Web for you and others to find it. For instance, you can't as an academic just sit back and say, "Why can't I see a list of all the journals in my field?" Go write that list! Somebody has to put in the effort; the existence of a network doesn't give you a well-

sorted catalog of all the information on all the machines on that network for free. The existence of paper doesn't give you a library. You need a whole lot of librarians working hard, plus a whole lot of journal editors working hard, plus a whole lot of academics working hard at writing and supplying references. Together all these people produce a library full of good journals.

Looking Ahead

TR: Although begun as an academic project, the Web stands to make a few companies a lot of money. Do you see any dangers posed by this commercialization?

BERNERS-LEE: Commercialization of the Web is giving it a lot of momentum, helping it expand, and bringing it a lot of new ideas. It is true that some people feel that there is a threat that a particular company will try to take over the control of the standard protocols that govern the Web's operations.

TR: How might that happen?

BERNERS-LEE: A company could start by

releasing Web browser software and make it available free or at very low cost, to capture the vast majority of the market. Later, that company decides to introduce a feature in this product that can be taken advantage of only if the designer of the Web page deviates from accepted Web standards in some fashion. A Web user would then suddenly begin encountering pages that read, "Sorry, you need software from Company X to enter this site." Anyone who slaps a "this page is best viewed with Browser X" label on a Web page appears to be yearning for the bad old days, before the Web, when you had very little chance of reading a document written on another computer, another word processor, or another network. And once a browser vendor has established such a monopoly, it has an incentive to continue to make arbitrary changes to the de facto standard, forcing potential competitors to play an endless game of catch-up. All the other bright ideas at all the other software companies are stifled because they have to be compatible with a "standard" that changes at one company's whim.

TR: What forces might tend to prevent this?

BERNERS-LEE: If the competing companies band together and move in a different direction, then the monopoly company could lose out badly for having introduced an incompatibility. The World Wide Web Consortium helps people to agree on standards. We also sometimes write and disseminate the programming code to give people an idea of how to put these standards in place. We recently did this, for example, with style sheets, which are a nice clean way to give Web pages consistent and distinct layouts, fonts, and so on without having to insert all the formatting codes each time. Another good example is Java—a programming language used, for example, to create small applications programs, or "applets," which can be put into a Web page. When Java first came out, three companies—Sun, Microsoft, and Spyglass—introduced three different applets for inserting an animation or video file into a Web page. Since none of the companies wants to be called the incompatible one, each has to make sure it supports the other two. This is an awful lot of effort, which would be better spent improving the products. The consortium got every-

body around a table, and we now have a draft of a standard that is a compatible, consistent way of doing this operation.

TR: In what ways do you think the Web is being underutilized?

BERNERS-LEE: A lot more people can browse the Web than can put up their own Web pages. The Web is therefore not being used so much the way I originally conceived it—as a communications tool that would enable small groups to work more efficiently in teams.

TR: How do you envision that kind of use?

BERNERS-LEE: Say that you conduct a meeting as a hypertext document. You start by dragging in a video version of yourself, with real-time sound. You remind those invited to come by sending them a hypertext e-mail with a pointer to the meeting. To join, they just follow the link. They can not only read this meeting/document, but they also write to it. Some join by audio and some drag their own video into the document. People introduce points by writing them into the minutes, making links to background material. At one point in the meeting three people realize they need to discuss something separately, and with a single keystroke one forks off a new meeting document that they will catch up with later. There is no rocket science here, but an integration of group editing, hypertext editing, and real-time audio-video technologies. These technologies all exist in crude forms, but must mature and be standardized before global hypertext teams can feel comfortable using them.

TR: So the Web could be used for a kind of videoconferencing?

BERNERS-LEE: Yes—participants would have video cameras connected to their computers, and they would all see on their screens a picture of the meeting. This kind of videoconferencing is possible right now, but not everyone has a fast enough Internet connection—that is, enough bandwidth—to transmit all the data needed for full-motion video. One option is to represent people who don't have enough bandwidth with flat, cutout shapes, which could change when the person is talking or indicates a desire to talk. Other people will be present as a real-time video image. All of these will be put into the virtual space so that they all

seem to be part of a room.

TR: Wouldn't this require a leap forward in graphics? Images on the Web now are pretty two-dimensional.

BERNERS-LEE: Yes, but I expect three-dimensional rendering and graphics to become common. I mean, look at that screen over there. You call that a "desktop"? Maybe that's how a real desktop looks from a camera flying at 10,000 feet.

TR: It's stylized, but it seems to work. What's the benefit of 3-D, other than razzle-dazzle?

BERNERS-LEE: It provides a better model of the real world. In the physical world, people's documents overlap each other and stack up in piles. Imagine if you could build "shelves" on your screen and you could fly through them and find something that you put somewhere. Maybe this way of presenting information will click with how people actually store and retrieve things.

TR: What other refinements in the Web are you most eager for?

BERNERS-LEE: I hope that the notion of having a separate piece of software called a "browser" will disappear. A browser is something that (a) only allows you to read and not write, and (b) is a single window on the world. Instead, your entire screen should be a window on the information world, with a small part of it representing what's on your local "desktop." Browser and operating-system interfaces will become so interlinked that they will, for all practical purposes, become one. Whether the operating system swallows the browser or the browser swallows the operating system, there will be one interface. As with the television and the home computer, the question of which will "win" is really a question about which companies will come out on top; the resultant object in any case will be both.

TR: What will using the Web be like in a few years, assuming these developments occur?

BERNERS-LEE: You won't see a browser, you will see a document. You'll follow some links and find other documents and these documents will leave a trail of documents across your desk. And then you might find that one

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P

people who complain about too much junk on the Web should remember that you don't go down the street picking up every piece of paper blowing in the breeze. A link from a quality source will generally be only to other quality documents.

of them takes you to a store, and in the store you find a shopping cart that you can move around and put into it things that you want to buy. And then at the end of the day you can buy what's in the cart. The code that makes this cart do what it does won't be anything you've bought, but when you first click on the cart icon that software will be automatically transferred through the Net to your computer.

TR: So software would be acquired on a need-to-use basis?

BERNERS-LEE: Yes, as you wander around the Web, your computer will become encrusted with pieces of software necessary to allow you to interact with and represent to you the things that you're reading about. If you happen to be an astronomer and you've been looking at spectra, then spectrum-analyzer software will allow you to manipulate them. If you're a biology student and you download some images of DNA molecules, then the code to send this DNA will come with a little bit of software that allows you to spin it around and break it up. And so your computer's software ability will not depend on where you've been shopping but just where you've been reading—where you've been browsing on the Web. The very idea of software will become a bit more submerged. It will be seen less as a discrete entity that you go out and buy and more as a support to the objects that are part of the information space. The software will move on and off your machine without your having to worry about it.

TR: What you're talking about sounds like a world in which far more people write software than do now.

BERNERS-LEE: Yes, but they won't think of it as creating a program. They will just be creating documents, but the software needed to view and manipulate these documents will be part of it. Tables of data will have spreadsheet software built into

them, for example, but the person writing the table certainly won't have to write a spreadsheet program. Java is a step in this direction. But an incredible amount of work needs to be done to achieve the user interface that I have rather glibly described. We also have to establish a level of trust that makes it possible for information to move from the Net onto your computer and to do work, possibly including writing files onto your hard drive. You want to make sure that it's not possible for a malicious person to be able to send you something that will look at your personal files and override them, or broadcast their contents.

TR: Are there any other items on your World Wide Web wish list?

BERNERS-LEE: I want better international access, especially in developing countries. And I'd like to see a more organized market of Web server space, so that everybody with an Internet connection could put information out cheaply. I expect that computers able to use the Web will become fairly ubiquitous, about as pervasive as televisions are now. In fact, the last computer I bought can play video—when you have a computer and good Web access, who even needs a television? I don't think everybody will want to post information on what amounts to a global bulletin board, but I certainly hope that every business has a Web page. I would also like to see deregulation of telecommunications globally so that Internet access to the home becomes cheaper. The United States is better than Europe in this regard, but even here Net access is not as cheap as it could be.

TR: Why do you think the Web has resonated so strongly with today's culture?

BERNERS-LEE: The openness of the Web is a powerful attraction. Everyone can not only read what's on the Web but contribute to it, and everybody is in a sense equal. There's a sense of boundless opportunity.

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MITnews

FROM THE ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT

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ROTC Stays. . .for Now

AFTER MONTHS OF GATHERING AND ANALYZING FACTS FROM INTERNAL AND EXTERNAL SOURCES AND VIEWS FROM ALL SECTORS OF THE INSTITUTE COMMUNITY—A “HERCULEAN EFFORT” THAT WAS UNIVERSALLY PRAISED—THE ROTC TASK FORCE OFFERED, AND THE FACULTY APPROVED, A SET OF RECOMMENDATIONS THAT INCLUDE A “CONSTRUCTIVE ENGAGEMENT” WITH THE DEPARTMENT OF DEFENSE TO DEVELOP A MODIFIED RESERVE-OFFICER TRAINING PROGRAM THAT IS “MORE INCLUSIVE AND IN KEEPING WITH THE VALUES AND MISSION OF MIT.”

As currently required by law, all branches of the U.S. military including ROTC are governed by a “don't ask, don't tell, don't pursue” policy in regard to sexual orientation. It means that the services are not permitted to inquire about sexual orientation or launch investigations to ferret out suspected homosexuals. But homosexual conduct and even statements of same-sex preference can be grounds for discharge, or, in the case of cadets and midshipmen, for withdrawal of ROTC scholarships.

The removal of a requirement for an up-front statement of sexual preference and the prohibition on investigations

represent an improvement over the policy that prevailed prior to 1993. But today's approach “does not address the core issue of the ban against gays in the military,” the Task Force wrote in its final report, and is in clear violation of MIT's general anti-discrimination policy. The military ban has triggered many rounds of debate on campus, the most recent culminating with the vote at the April faculty meeting.

This latest study began last fall, when President Charles Vest delivered his charge to the ad hoc ROTC Task Force, under the leadership of Professor Stephen Graves: to gather information,

engage the MIT community in informed discussion, frame the issues for the faculty, and recommend a course of action. All complete—to the max. The Task Force distributed 3,000 copies of an interim report in January, produced a 25-page final report in March, and made a number of adjustments to its original recommendations to respond to community concerns. It created a Web home page that had received 1,400 visits by the time it was drafting its final report. It held two campus-wide forums and more than 25 meetings with individuals and groups. In all settings and circumstances, it listened.

Alumni/ae Association Executive Vice-President William Hecht, '61, is quick to note that of some 117 letters commenting on the value of ROTC that were sent to President Charles Vest or directly to the Task Force, 80 came from alumni and alumnae. As a result of publication deadlines, the *Technology Review* article on the interim report of the Task Force was not in the hands of alumni/ae until March, observed Hecht—himself a past participant in Air Force ROTC—but once informed of the discussion on campus, graduates lost no time in expressing their views.

Among the points that the Task Force emphasized in its final report was the principle of the “citizen soldier,” which posits that a democracy is more secure if its military leadership is representative of the whole population—people who bring a range of personal and educational experiences—rather than coming only from a professional elite trained at a few military academies. Through their ROTC programs, MIT and more than 500 other schools produce the citizen soldiers who fill some 60 percent of the nation's officer slots. Through the exten-