

Like The Air We Breathe

M.I.T.'s *Project Oxygen* is developing technology to revolutionize computing environments and user interactions in hopes of realizing a global vision: "helping people do more by doing less."

by: Josh Peters

Years from now, some people envision a future where computers are abundant and essential, integrated into every aspect of our lives. Most "techies" have dreamed of being completely submerged in a world of computers at some time or another, often turning to virtual reality models to simulate the experience. Surprisingly, it looks like the dream of actually living and working in a computer-world may finally come true with the help of several researchers at the Massachusetts Institute of Technology's Laboratory for Computer Science (LCS). Consider the following scenario from the research project's web page:

Helène calls Ralph in New York from their company's home office in Paris. Ralph's E21, connected to his phone, recognizes Helène's number, answers in French, reports that Ralph is away on vacation, and asks if her call is urgent. The E21's multilingual speech and automation systems, which Ralph has scripted to handle urgent calls from key people, recognize the word "décisif" in Helène's reply and transfer the call to Michael's hotel. Ralph speaks with Helène; they bring George, who is at home in London, into the conversation, and the three of them decide to meet next week in Paris. They ask their automated calendars to compare their schedules and check the availability of flights from New York and London to Paris. Next Tuesday at 11am looks good. All three say "OK," and their automation systems take over the job of making the necessary reservations. After Helène signs off to make another call, George asks Ralph to hold and asks for "...that message with the technical drawings," which appears instantly on his and Ralph's H21 displays. Ralph says that Helène should see this message before their meeting. George points his H21 at his home fax and says "send it to Helène." They say good-bye. (Total elapsed time 3.5 minutes.)

The scenario is an example of *Project Oxygen's* goal. *Project Oxygen* is a research endeavor of LCS, working cooperatively with MIT's Artificial Intelligence Lab, to help people "do more by doing less." This simple vision of LCS director Michael L. Dertouzos has been the driving force of *Oxygen* since its inception.

Previous generations of technology, Dertouzos says, have designed technology catering to machines and specifications rather than people. *Oxygen* hopes to destroy this rigid designing mind-set in favor of an attitude of “bringing new technologies into our lives, not vice versa.” In other words, we will not have to change our lifestyles to use technologies—rather, technologies will evolve around the lives we currently live. Entering some virtual reality cyberspace to work and play is not as effective as integrating that cyberspace into our current world—letting computers perform our tasks for us in our current environment is “doing more by doing less.”

While changing the mind-set used to approach design problems is fundamental to *Oxygen*’s implementation, another important specification is the focus of applications. In this light, new technologies in the *Oxygen* system will be designed to greatly increase human productivity and ease of use. Human productivity improvement is simply the amount of workload shifted from a person to a computer for a specific task. This improvement might range from performing simple computations to quickly organizing a large group and synchronously locating and distributing information at their video-teleconference.

Ease of use, on other hand, is not simply a flashy graphical interface in every device. Today’s user-friendly devices target aesthetic appeal and a few simplistic features. Tomorrow’s devices—thus *Oxygen*’s specification—must make ease of use pervade the whole system. Even advanced features of software and hardware devices must be readily accessible to an inexperienced user. *Oxygen* hopes to close the gap between advanced users and inexperienced users through natural language interpretation—determining what the user is trying to do and accomplishing it for them. In the case of Helène, Ralph, and George, for example, the system may interpret asking for “that message with the technical drawings” as a query to search recent documents that George has shared with Ralph for embedded figures, rate the results based on technicality and recency, and display the top match to both users.

Finally, enabling “doing more by doing less” necessitates making the whole world affected by *Oxygen*. Today, a small fraction of the world’s population has personal access to the largest informational and commercial resource ever seen—the Internet. We must bridge the existing communication gaps, because the improvements cannot benefit only a few markets or a few nations. The resulting productivity increases would only further increase the gap between

rich countries and poor countries. Such disparity in standard of living (wealth and services) could easily carry the consequences of bloodshed between rich and poor countries. Thus, the benefits of new technologies must reach all people, not simply the elite or the wealthy. *Project Oxygen* hopes to achieve this global distribution through making the technology cheap, indispensable, and very wide-spread—bringing computation wherever electricity flows perhaps.

Now, with a clear picture of how to “do more by doing less,” we can visit the engineering model of implementing *Oxygen*’s vision as a revolution in technologies. First of all, the engineering goals of *Oxygen* are that it be purely pervasive, embedded, nomadic, and eternal. Each component of the system must be pervasive--everywhere around us with all components drawing from the same information base. The technology must also be embedded, that is, completely integrated into our world, both sensing and responding to changes. It must be nomadic in the sense that it follows users wherever they need it, and, perhaps most importantly, *Oxygen* must be eternal. It must never shut down or reboot. Of course, individual components must be able to change and upgrade, but the system as a whole must continuously run with no downtime.

Project Oxygen’s model for fitting these goals while still achieving Dertouzos’ vision is conceptually rather simple. *Oxygen* will be a fully integrated application of eight different technologies: Handy 21 (H21), Enviro 21 (E21), Net 21 (N21), user interaction, information access, collaboration, automation and customization.

The H21 is the real meat of the *Oxygen* project, allowing you to bring the system with you wherever you go. Similar to a cellular phone or Personal Digital Assistant, the H21 incorporates a display, a camera, a speaker, a microphone, an infrared detector, a computer, and a wireless data transfer system. The individual components function as you would suspect, providing a powerful video telephony device with a small addition. The infrared detector reads infrared identification tags you place on physical objects allowing the H21 to know “where” you are and what device you are referring to when you ask in an abstract way (for example, the “nearest printer” or “that clock”).

H21's communicate and distribute processes among nearby E21's. The E21 is a stationary device of larger size and considerably more power than the H21. It creates an fixed environment

with which you or your H21 can interact. Consider the analogy of plugging a portable device into a wall outlet for more resources (in this case power) as a description of H21's communicating with E21's. E21 devices can be found in the walls of your home or office and the trunk of your car, and can conveniently automate tasks involving appliances.

The final device technology is a novel network, the N21. The N21 creates a secure collaborative region for the interaction of different users communicating from H21's and E21's in much the same way a group of personal computers might connect to a server to form a “chat room” or other communications channel today. This technology is much more complicated than it may seem, though, because it has to adapt to a variety of changes. The N21 must operate with high security and latency on top of a very busy and noisy global network, find you wherever you are, connect to a variety of appliances and information networks, and deal with all of these asynchronous nodes joining and leaving the network rapidly. Very different network protocols must be created for such a regional network to operate quickly and efficiently on an existing global network, but establishing these protocols is another of the goals of *Project Oxygen*.

Additional technologies in the project which may not be implemented specifically in hardware or device technology, but might instead feature software on an existing computational platform are user interaction technologies. Such technologies include recognizing and interpreting natural language speech and perhaps even speech tones and facial expressions as instructions. Asking a question or giving a command in natural language must be translated into an instruction sequence that *Oxygen* devices can carry out. While natural user interaction may seem like a peripheral issue, without which *Oxygen* could still be implemented, such perceptual technology is actually part of *Oxygen*'s core. Interaction is where human productivity improvement and ease of use—two of the project vision's main components—are achieved.

The next technology involves finding and accessing information. *Oxygen* will be designed to respond to a query by first searching your own information store, then the shared stores of friends and co-workers whom you might ask this question. Finally, it will search the global information network (currently the Internet) and show how those results pertain to your own information store.

Collaboration technology will be useful in remembering what happened during collaborations. Hyperlinked transcripts of meetings or notes kept by a human secretary will be available in an accessible information store for reference when trying to remember what work was accomplished, what was assigned, and what exact decisions were made.

Oxygen will additionally make automation of tasks easy by composing scripts in E21's—fixed computers in your home or car. If you want to brew coffee every two hours, starting with a fresh cup when you arrive at work, simply ask your H21 to schedule the task and your E21 will handle it. Similarly, if you want regular reports on stocks or other information, your E21 will perform scheduled queries and provide you with the information. These examples are more cases in which human productivity can be vastly increased: automating tasks to be performed while your system is idle and having the results waiting for you as soon as you need them.

Finally, the technology of customization must be integrated with *Oxygen*. No packaged software products will be included on every H21 and E21. Rather, the devices will download packages from the global network for applications you wish to use, either by your request, an error signal in the existing package, or an upgrade notification from the package manufacturer.

These eight technologies—handheld computers, environment computers, novel networks, user interaction, information access, collaboration, automation, and customization—each form a different aspect of the *Project Oxygen* research. Still, these technologies must be completely and seamlessly integrated with each other to see *Oxygen* perform as a system meeting the goals and specifications of Dertouzos' vision. With appropriate advances in these technologies—which researchers at LCS are currently developing—*Project Oxygen* will let people immersed in a computing environment as pervasive as the air we breathe “do more by doing less.” ♦

For more information about *Project Oxygen*, visit <http://www.oxygen.lcs.mit.edu/>

To: Charles Wardell <charles.wardell@tmm.com>

Subject: Submitting Article on *Project Oxygen*

Mr. Wardell,

I understand that you are the Home Technology Newsfront Editor for *Popular Science* magazine. I am interested in submitting an article that I have written about *Project Oxygen*, a research project of the Massachusetts Institute of Technology's Laboratory for Computer Science. *Project Oxygen* is an endeavor to create an infrastructure of handheld devices, computers, network protocols, embedded sensors, and software to immerse a user into a completely pervasive computing environment. With a vision of "helping people to do more by doing less," *Project Oxygen* hopes to engender the next revolution of technology including a larger and more connected global network than the Internet and an ultimate level of user-accessibility through interpreting natural language commands and following users wherever they go. As you are well aware, *Popular Science* readers are simply enthralled with very young technologies showing promise to change their day-to-day lives, and *Project Oxygen* is exactly such a technology.

I have attached a copy of the article's first draft. I first introduce the concept of *Project Oxygen* with a scenario. Next, I explain the requirements *Project Oxygen*'s vision entails. Finally, I relate the engineering model of *Project Oxygen*, explaining the purpose and applications of each device and technology. Please let me know if you think this is a worthwhile topic in Home Technology news for *Popular Science* magazine to cover, as well as any comments you have on the article draft. Any suggestions concerning illustrations, reference links for an online version of the document, or other supplementing material would also be greatly appreciated.

Sincerely,

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