Managing Transitions in Information Spaces: Roles for Cyberinfrastrucuture

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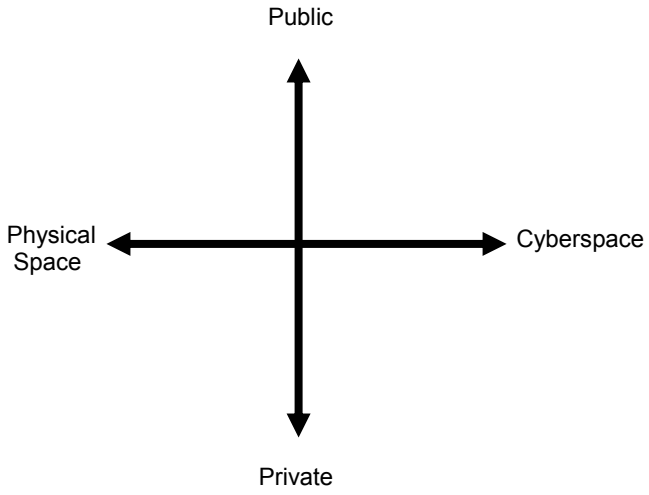
Cyberinfrastructure as defined in the Adkins report will continue to emerge rapidly in the decade ahead with some breakthroughs coming from planned activities and some arising organically through experience. Increasingly sophisticated technologically enabled conceptual and affective spaces, often labeled cyberspace, are becoming crucial to life in knowledge-intensive cultures. Because many of the CI developments that are emerging will be irrevocable a decade hence, it is important that we plan and test judiciously to shape cyberinfrastructure (CI) to human needs. To maximize our theory, design, and development investments, it is important to identify and prioritize the greatest challenges. This outline focuses on one class of challenges that are crucial to our long-term success**: creating resources and tools that help people interact with information in cyberspace and make transitions to and from cyberspace.**

Surely it is probable that every larger portions of our information interactions will be digital. Although this has been a trend for scientists in work settings for some time, the trend is toward digital information for all aspects of life, including personal and recreational. Because the tools and services (e.g., various computational devices with keyboards and screens; search engines and web browsers) are so similar at work, home, and play, CI must provide good cues to help us maintain distinctions between our goals and activities that involve digital information. It is very likely that for most people, transitions to and from various aspects of cyberspace will take place hundreds of times daily and I argue that if we do not invent good resources and tools to support these transitions, they will lead to errors, frustration, and lost productivity.

Services and tools for working in cyberspace are best represented by ongoing work in digital libraries and we can expect continued creative payoffs if we are diligent in building upon our early successes. CI will especially benefit from continued efforts to build interoperable digital libraries and metadata registries, to leverage grid computing to improve performance, to create search and discovery techniques that address semantics and cross cultures, and to invent visualizations for abstracting and understanding information. Scientists and other professionals use and create a variety of DLs that themselves become part of infrastructure, but we must find ways to help them transit across these resources as well as work within them.

To contextualize the challenges, consider the following figure that crosses a physical world-cyber world continuum with a public-private continuum. In the physical world, we control analog objects (e.g., an automobile to travel, a racquet and ball to play tennis, a cell phone to communicate, our bodies to sustain life). In cyberspace, we control bits (actually higher level abstractions of bits) to accomplish a variety of goals (e.g., documents to learn and to communicate, code to execute well-defined tasks, video games to entertain ourselves). Increasingly, the objects in these spaces share digital components (e.g., as the numbers of computational units in our lives increase and communicate with each other; as we take sensors into our cars, homes, and bodies).



We also live in private (e.g., our homes, autos, and minds) and public (e.g., offices, malls, buses, and online forums) spaces. We have private accounts, public blogs, and various levels of open and secure wireless and wired networks in our offices and homes. We have public DLs and private DLs and although we might expect our actions in each to inherit the same public/private properties, the fluidity of cyberspace does not require this. CI must literally support these propagations or provide cues when a search or computation in a private space becomes part of a public space, as in collaborative filtering or data mining applications that depend on private commercial actions in making recommendations to others with similar profiles.

As IT becomes more pervasive, the boundaries between physical and cyber spaces and between public and private spaces grow less distinct and more permeable. We need user interfaces to make explicit our passages between these spaces.

User interface is taken here to mean a set of resources and tools that help people to interact with information in these various spaces. The user interfaces we use today to work in cyberspace are fairly bland—the same screen, keyboard, and browser are used regardless of whether we are writing, communicating, banking, or using a digital library. Customized and specialized interfaces arrive with every new personal device (digital camera, GPS, PDA, home entertainment system, programmable thermostat, etc.) as well as scientific device (e.g., MRI, mass spectrometer, sensor array, radio telescope, especially when shared in a collaboratory setting). In spite of excellent developments in cross-platform languages, we seem destined to have as many ways to interact with digital information as we do with the physical world. The cyberinfrastruture must support this diversity. To illustrate this, consider a small set of interface needs that are required in a permeable space defined by private-public and physical-cyber dimensions.

We need interfaces that help us coordinate and manage our many devices and services made possible by CI. Whether we are moving from scientific data sets in a DL to streams of new data from instruments or from Amazon.com to our files in our LAN to the different email and messaging clients on our phones, computers, and intelligent buildings, our preference settings, collaborative filtering profiles, histories and bookmarks should move with us. We might

imagine common interfaces that we adopt and that move with us to various applications. One direction to move in this direction is to foster the creation of interface servers (Marchionini & Brunk, 2003) that allow people to use a favorite interface across a variety of servers and services. Our vision is of a new set of professional services that meet the diverse needs, preferences, and capabilities of the world's population. These highly customizable and diverse services and tools will also help us move toward true universal access and possible bridges for the digital divide.

We need interfaces that help us manage our public and private information flows. Tools that help us manage exoinformation (the information that leaves us consciously or unconsciously as we live, see Brunk, 2002) will become increasingly important in both cyber and physical space. Today, our actions online are often collected and mined to serve our needs as well as to serve the goals of vendors or security agencies—this will surely expand in a post 911 world. Our smiles, gaits, and other mannerisms tell much about us to those who share out public physical spaces, but we welcome this because it is a mutually reciprocal relationship. Increasingly, the data gathering devices in the environment (video cameras, chemical and biological sensor networks) will make exoinformation in our physical spaces more accessible to others in non-reciprocal ways. One set of resources and tools needed in the cyberinfrastructre focuses on helping us manage our privacy space and make conscious decisions about carrying information across our private and public spaces.

We need interfaces that help us manage our personalized memory augmentations—the logical extension of distributed digital libraries that are instantly accessible to us everywhere and anywhere. How we manage our distributed memories and our other digital cognitive augmenters is crucially important to health and productivity. When we are in high-performance cycles where our mental and CI resources are in sync, these conditions should be sustained uninterrupted by the constant stream of attention grabbers (phone calls, emails, spasm, opportunistic alerts, etc.). Equally important, we need includes interfaces that protect us from overload and give us spaces to rest and reflect—cyber rest stops. Clearly, psychological and sociological research along these lines are needed.

All of these examples of interfaces (broadly conceived to include a variety of resources and tools) must help us differentiate information and actions that we decide are public or private and that help us bring information from cyberspace to physical space and vice versa in ways that help us rather than harm us (it is easy to recover from a crash in a flight simulator but not so in a physical crash brought on by the same set of command decisions executed with a common set of controls).

In addition to the tools and resources themselves, we must create new ways to evaluate our progress. Although usability testing has become an accepted practice for software development, we have an impoverished set of metrics (time to completion, accuracy, satisfaction) and limited data collection tools. CI requires new metrics and tools to assess and understand human information interaction behavior and the effectiveness of our tolls (e.g., new physiological data streams, more sophisticated self reporting such as perceived time completion and critical event reporting). It is also prudent to develop test simulators that quickly find common errors in new designs.

There are of course many other important areas of R&D that the DL community must address to insure that we build and maintain a human-centered and effective CI for the advancement of science and the human condition. Here I have focused only on the need for tools and services (manifested mainly as UIs) in the CI that help us to work in and move gracefully among our increasingly blurred physical and cyber and public and private spaces.