Chapter 8: Vectors of change

*Aggregation . . concerns the emergence of complex large-scale behaviours ji-om the aggregate inter-actions **of less** complex agents. -John H. Holland'*

The many incremental changes in the comput- ing environment have been reinforced with the growing interest in re-engi- neering. Other significant seemingly unrelated, even secondary, developments have also taken place. Almost unnoticed, for example, is the rapid separation of informa- tion from proprietary delivery systems. Commercial data- base companies such as Infor- mation Access are making their data available outside of the traditional Knight- Ridder Information Service and Lexis-Nexis systems.

Making sense of the environ- ment requires penetrating thick clouds of innovation. We can discern some broad trends (like those in the adjacent figure), but we struggle with the particularities that have created our network environment. Like the weather, network publishing is unpredictable, volatile and chaotic.

Progress is evident everywhere. Web browsers have provided users with a relatively standard interface that makes the specific location of the information less signifi- cant. Inter-operable payment and security systems are beginning to enter the market. These Internet products are immature, but they represent movement away from the traditional online model. Such seamless systems provide a new commer- cial infrastructure. In short, the World Wide Web has made distributed information and user-friendly software the mode1 for electronic publishing.
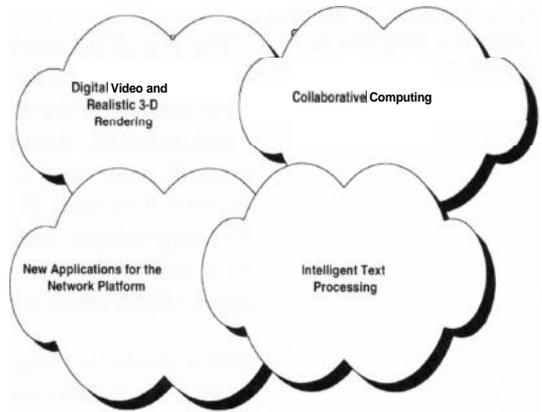
Figure 1: Four cenfres of innovation have emerged from the Internet. Viewed from a traditional information vantage point, the innovations obscure one another

[1] Statement from *Hidden Order: Howl Adaptation Buildsl Complexity,* Addison-Wesley: Reading, Massachusetts, 1995, p. 11.

FTP	C Tools
Mail	Telnet

TCP/IP Network

Figure 2: These are the core UNIX functions that have triggered much of the Internet's innovation along predictable lines.

Information has become digital, more widely available and more of a commodity than at any previous time. Proprietary networks personalised their service and put a distinctive look before the customer. Today online services have embraced the open architecture of TCP/IP. Personalisation no longer means the look and feel of the online service. It is charged with the connotation that the user can determine the path through the data, what information is displayed, and how the data are output. Personalisation is more difficult technically but promises to be a key factor in determining what electronic products and services are most satisfying to the customer. Customers want to recombine information in ways their needs and tastes dictate. The presentation of that information and its delivery medium must accommodate the specific requirements for that particular project.

The eye of the hurricane is the 'Internet'. Rightly or wrongly, the concept of the Internet has become the symbol of the change that is taking place. The Internet has carried online access beyond the limited niches of commercial online, research and academic computing, and bulletin board services. Computer users represent a small percentage of the world's population. Within that segment, online has expanded its base. If projections hold, several years of robust expansion lie ahead. Not surprisingly, comparatively little thought has been given to the consequences of a network-based environment. Understanding is beginning to come as the applications touch more lives.

The cumulative impact has been to unleash what Dr Holland calls "complex large-scale behaviours". It is comparatively easy to explain the use, benefits and drawbacks of electronic mail. It is rather more difficult to explain that the extension of electronic mail is three-dimensional collaborative communications. The problem centres around the ripples set off by more users of electronic mail, increasingly capable technology, and an extensible network infrastructure. Change becomes the norm, and it comes from many directions, often from angles that we cannot anticipate.

In an effort to place the scope of the change in perspective, this chapter examines four basic paths of innovation closely related to electronic information creation, access, retrieval and delivery. We have chosen to call these 'vectors', whilst readily admitting that these four certainly are not the only ones in play. But the path they are following is somewhat easier to extract from the digital roar.

The seeds of innovation

In the early days of the Internet, a limited number of users at academic and research institutions had access to a core of basic functions. Figure 2 depicts the core from which network publishing evolved. The seed was the UNIX operating system developed at AT&T's Bell Laboratories and released into the public domain. Unlike the mainframe architectures then prevalent in major organisations and research centres, the UNIX systems were not proprietary. They were built upon a design concept that invited and encouraged users to develop enhancements, extensions and new features. These developments were, in turn, shared by also placing them in the public domain. The growth of tools and capabilities was organic; that is, evolving from the sharing of information. The development path of the Internet was distinct

from that of the commercial online services and from organisations' proprietary networks.

From its inception, the technology used for the Internet provided an environment in which people could interact. At first, the interaction was limited to messaging and basic file manipulation. When computers or clients were connected with servers using the native networking tools, any computer linked to the network could be used as if it were sitting on one's desk.

For more than 20 years, the Internet and the TCP/IP protocol gained adherents in the academic and research community. Most organisations selected proprietary, name-brand network architectures. These had more robust security, provided the purchasing organisation with service and operational support, and provided a safe haven for managers of computer centres.

The Internet's surge in the 1992-94 interval drew attention to the four vectors that users launched from its UNIX core, depicted in Figure 3. Although the trajectories seem to go in different directions, they are closely related, anchored to or embedded in the network 'environment', datasphere, cyberspace or digital ether. The vectors are:

- *The network vector.* This is the infamous 'information highway' and it embraces areas such as bandwidth, support for TCP/IP on proprietary network architectures such as Novell NetWare, advances in routing, and the deployment of advanced digital and optical technologies.
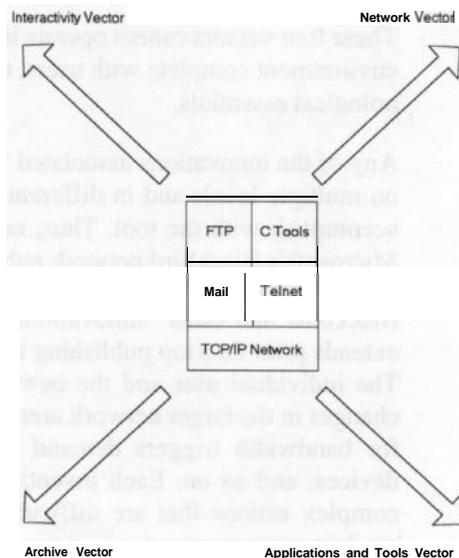
Figure 3: Viewed from a historical perspective, the centres of innovation have their roots in the basic functions of the UNIX-based Internet, circa 1970. The core functions have gathered momentum and followed an understandable development path of archive, applications, networking and interactive functionality.

- *The applications and tools vector.* UNIX has supported direct user manipulation using such programming languages as C, tcl (tools control language) and perl. The platform -boosted by object-oriented programming and the increased sophistication of new languages that permit executable applications to be downloaded and run on client computers -has extended the capability of TCP/IP networks. The emergence of programming languages from General Magic and Sun Microsystems has made possible the use of the Internet as an applications platform.

- *The archive vector.* The amount of information on and in the Internet is not known. Estimates of the growth rate are meaningless because it is not possible to visualise a global information resource doubling every 53 days, a figure cited by the president of Sun Microsystems in a presentation in mid-1995. The amount of information requires different types of presentation, different modes of access, indeed, a re-invention of the concept of text search and retrieval. For instance, the Architext service refreshes its data on more than 300,000 Web pages every seven days.'

- *The interactivity vector.* The basic enabling function of a network is information sharing. With the capability to exchange objects of any data type, to engage in real-time audio and video dialogues, and to trigger cues in intelligent Internet sites, interactivity takes on a new meaning. The Internet and its allied networks are moving toward a game paradigm in terms of interaction, animation, imaging and environment, work, education and social life will be changed.

These four vectors cannot operate in isolation. To 'survive', they require the digital environment complete with users, telecommunications, computers and other technological essentials.

Any of the innovations associated with a particular vector operate simultaneously on multiple levels and in different ways depending upon what the user wants to accomplish with the tool. Thus, on the most primitive level, a new tool such as Microsoft's Blackbird network publishing suite of software provides a single new function to a user: the ability to create a Web page. On a more sophisticated level, Blackbird and other 'innovations' help define an entire product category that extends print desktop publishing into interactive, multimedia network publishing. The individual user and the new software category combine to cause complex changes in the larger network arena in other technological arenas. The user's need for bandwidth triggers demand for faster communications and larger storage devices, and so on. Each invention creates new information flows and triggers complex actions that are difficult to discern from the examination of a single product announcement.

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[1]   The number of new web pages each day is about 5000.

The Datasphere's complex environment

The network publishing environment exists in multiple dimensions. Each time a new innovation appears and begins to aggregate into masses of users or clusters of data, the network publishing environment becomes larger, more dynamic. Figure 4 presents in a two-dimensional figure the layers of complex interaction that the vectors of change create. The type of innovation and information flow that become possible can combine one or more vectors in creative ways.

Whenever the borders of one vector interact with another vector, a need exists to facilitate information exchange or to extend the functionality of the network system to allow a user to accomplish a task. These zones of interaction or opportunity seams provide the clearest evidence of innovation and change in the network publishing environment. They are the proving ground for new technologies, new software and new information constructs.

Examples of this cross-vector fertilisation are:

- The wave of Internet indexing tools that run on agent technology. Open Text, Personal Library Software, InfoSeek, WebCrawler, and more than 50 others use software to create pointers to Internet resources. These indexes are becoming more sophisticated with each new release of the programming tools used to build them. In 1993, there were no useful automated indexing tools for World Wide Web sites. Twenty-four months later, text retrieval technology is becoming a mainstream application. In short, the archives are being tamed.
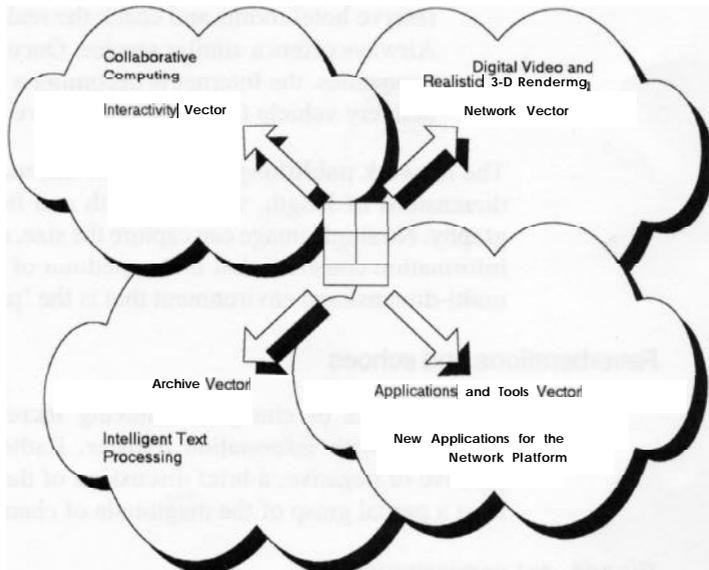

Figure 4: The paths of innovation or vectors of change are creating application-centric software that gives the Internet medium its unique characteristics, syntax and rhetoric. Thus, the evolution of the Internet as an applications platform becomes more evident.

- It was not possible one year ago to place a reliable real-time telephone call using a local Internet connection at 28.8 Kb/s. Telephone calls required the traditional telecommunication set-ups and charges. At this time, full duplex telephony via a PC is possible. Companies such as Quarterdeck and Digiphone are planning consumer products that will bring toll-free long distance voice telephony to the average computer user. Shared documents, video conferences and multiple work spaces are now possible when users have a high-speed network connection. Collaborative computing is becoming a component of interactive communications via the Internet.

- Until recently, a visitor to an Internet server could expect to click-and-point only on occasions through some interesting and unusual information. Daring sites might offer download audio. Now at hundreds of sites it is possible to interact with environments that are applications. Rapid advances in programming tools and techniques that permit downloadable applications – termed 'applets' -to run on client computers regardless of platform, make an Internet visit more than Web page browsing. Spreadsheets, live databases, animations and user-particularised sound can be found at sites from Silicon Graphics in America, to Harlequin in Britain.

- Commerce is moving from the public relations and limited credit card transaction environment to a richer, more lifelike, real-time experience. Most service businesses will be providing some type of for-fee activities for clients. One interesting example is USAir's programme for its most frequent travellers. Via the Internet, these individuals can buy tickets, reserve hotel rooms and check the real-time status of flights. British Airways offers a similar service. Once the preserve of technology companies, the Internet is becoming a for-fee, value-added service delivery vehicle for specific, lucrative market segments.

The network publishing environment has many facets and more than the normal dimensions of length, width, breadth and time. The dataspace has its own geography. No single image can capture the size, reach, shape and flux of the expanding information construct that is the medium of network publishing. It is a complex, multi-dimensional environment that is the 'paper' of this dynamic new medium.

Reverberations and echoes

These vectors of change are having increasingly visible effects on activities associated with information transfer. Rather than characterise these events as positive or negative, a brief discussion of the most visible impacts can provide at least a partial grasp of the magnitude of change taking place.

Blends, not convergence

The co-mingling of the individual innovations of the four vectors illustrated in the figures in this section does not simplify or reduce options or opportunities. The

mingling of technologies is closer to blending colours. No colour is simple, and a large number of shades and hues can be fabricated. Unlike blending colour, the interaction of database and network bandwidth behaves in an organic fashion. Information seems to breed. New 'child' innovations develop and follow their own developmental trajectories. The term *convergence* means moving toward an intersection, approaching a limit, or evolving to a similar structure. The integration of new functionality into an established technology creates a new point in the midst of a spectrum. Novell's management has invested to be certain that NetWare now links to Windows NT and the Internet. The dominant proprietary network is relaxing its grip and giving customers new ways to accomplish tasks. The operating systems interact creating opportunities for new products, services and applications.

New competitors, new customers, new survivors

The rate of change in networked environments is a function of the size of the network and the data flowing within it. The larger the network grows, the larger the number of users. The more users, the more rapidly the pace of the network becomes the pace of life touched by the network. A digital Darwinism emerges. The flora and fauna of the digital greenhouse behave somewhat like an organic world. Technologies and information constructs coalesce, evolve, compete and survive. SGML, long sidelined as a scheme most appropriate for military manuals and computer-literate publishers, has become the underlying technology for network publishing. Individuals who would have resisted tagging text and creating structured documents, happily enter SGML codes and willingly embrace software that facilitates drag-and-drop hypertext composition. Start-ups such as Vermeer Technologies' Web construction tool can enter a niche and compete one-on-one with Microsoft's Blackbird tool suite. The success of start-ups and new competitors comes from their ability to solve a problem that plagues users of the new medium. The network publishing world manifests Darwinian interactions. A publisher may face competition from a former customer. A printer may be put into a new business by offering Internet and paper printing services. The difference is that the vectors of change move forward independently yet within the datasphere. An innovation such as Xerox's DocuTech or Adobe's Portable Document Format can create havoc for some organisations, yet generate rich rewards for others. It is difficult to predict what will happen and who will win because of the amount of activity and the near-impossibility of having adequate understanding of the potential of new technology blends.

New product categories

The idea that all reference products will merge into one super-reference product flies in the face of reality. The television set is evolving into a computer, but the computer is evolving into an ever more advanced data system. As networks and the information flowing on them have proliferated, diversity becomes the norm. The datasphere operates like a rain forest. Many species of information exploit the ecology of this Amazon basin. Similarly, the diversity of users of the Internet has created completely new categories of information products and services. For example, one year ago there were no reviews of World Wide Web sites. There are now a half dozen Web rating services and more coming each day. Not all will

survive, but a new type of reference product has emerged in print, online and CD-ROM formats. The product category of interactive programming tools for virtual reality Web sites was a supercomputer laboratory project twelve months ago. Today, anyone can download three-dimensional modelling software, buy VRML server technology, and access virtual reality databases at dozens of sites around the world. Microsoft, long viewed as the dominant player in the software business, has missed the rich product opportunities presented by the Internet. The firm's brilliant programmers are struggling to catch up with the new 'life forms' that are inventing network publishing products. The pace of innovation will eventually slow for a while, and the seemingly inexhaustible resources of the network publishing world will become quieter. In the interim, the staggering outpouring of new products and services is likely to remain robust for the next 24 to 36 months.

Re-engineering tools

With the new tools and processes readily available, innovative thinkers will use them in many ways. Consider desktop publishing: it had a significant impact on typesetting, spurred the sale of laser printers, and made newsletter publishing a staple of the unemployed professional. Internet publishing seems to be having even broader consequences within and outside the narrow borders of what might be called 'traditional publishing'. Networks allow work processes to be redefined or reinvented. For instance, a group of insurance companies can post its rates on a Web page and incorporate the concepts of automated database building and cross-platform applications created with Java-like programming languages. The tasks associated with providing insurance price quotations are changed and can be further altered as circumstances warrant. Old procedures can be built upon new architectures to speed time to market, reduce costs, or deliver value-added products and services.

Few industries will be immune to network publishing 'organisms'. Organisations can set up private networks on the public networks using software to communicate with customers and employees. Trucking companies can integrate wireless Internet services into their existing communication systems. Telecommunication companies can invent new classes of service that can alter the business prospects of companies working in fields unrelated to telephony. CompuServe Information Service lost access to Cable News Network's business information because AT&T purchased the rights to this information for an estimated $10 million. CIS loses its data flow from this important source, and AT&T gains a foothold in online delivery of business information. CompuServe must re-engineer its approach to financial news or face revenue loss and customer defection. Few information-astute companies will be spared the pressures caused by clever people with the new tools of the network publishing environment. A more significant development is the embedding of the Netscape browser into the Intuit personal finance software. The users of this company's popular chequebook and small business book-keeping tools can access the Intuit Web site and gain entry to financial services from ten large American banks. Internet-enabled software re-engineers the following services:

- *Retail software and Internet access* – The sale of Internet access tools. The Netscape technology is a component of the Intuit application software, not a separate module.

- *Voice or mail customer service functions* – Access to Intuit's cheque and business forms that are designed to complement the report tools of the Intuit products can be ordered via online access using Web forms.

- *Person-to-person small business bank services* – Most basic small business financial services can be initiated and completed via Web access.

- *Bank marketing* – Intuit assumes the responsibility of bringing the participating financial institutions to the customers. The bank's job is to close the sale.

This list is incomplete, but it points to the ripples caused by the vectors of change.

Fast cycle time

As bandwidth becomes more available to those with the money to buy it, the amount of data flowing will grow to fill the available bandwidth. Already gigabyte-devouring applications such as digital video and virtual reality environments are held back by the limited bandwidth the average Internet users or their organisations can afford.

The most immediate effects will be the continued growth in the amount of information in the system, and a decrease in the amount of time one has to process new data and take action. The re-engineering tools give expert users a way to stay informed in near real time and eliminate delays, cycles and processes from marketing, product development and distribution activities. Software can be invented and distributed rapidly. In the datasphere, acting rapidly becomes an imperative. Delay becomes a signal of potential weakness.

The impact of time reduction is little appreciated. It creates a sense of urgency. Traditional processes are often viewed as too slow or too inefficient for the digital world. But unwittingly organisations discard at their peril the proven for the promise of new technology. The jump to network publishing can yield significant rewards if the organisation and its staff know what to do with the technology. Without such knowledge, however, the quest to reduce cycle time leads to a downward spiral of profits and revenues.

Time in the datasphere can only be managed if one has knowledge of the technology, how to use it, when not to use it, and how to abandon it when a newer technology proves itself more fit. Time in the datasphere is a precious commodity because an error can put an organisation out of the game. Being late-to-market suggests a certain weakness in the organisation.

As the pace of business accelerates in the digital environment, markets will become more globalised for many products and services. The quest for a time advantage necessarily leads to distributed, automated facilities. Organisations working in a global market need information tools that are available around the clock. For many

mutual funds and investment firms, disseminating information through traditional means is slow, expensive and vulnerable to disruptions beyond the control of the company. Network publishing allows computer time to replace the rhythm of a process that is not automated.

Hyperspace

The reality of the network environment is that it exists in hyperspace. It has no boundaries other than the reach of the connections. It has only the shape of the individual data structures that compose the contents of the packets, the files and the systems themselves. Hyperspace cannot be visualised nor accurately represented in a drawing because normal perspective and metaphors do not adequately capture the nature of the digital environment.

Hyperspace is real. The data in it are real. The sense of community that one feels when engaging in a conversation via the keyboard, VocalTec-based voice, Internet Relay Chat, or any other interactive information transfer, is real. The problem is that it is a type of reality that can best be understood only by those who have the means to experience the digital environment.

To the person with the tools, expertise and desire, the digital world is an adjunct to the everyday world. It has its own rhetoric, rules, concepts, technologies and characteristics. The revolution that this Briefing documents is irrelevant unless one has knowledge and experience of the new medium. Denial of the shattering impact of the network revolution does not change the reality that information is multi-dimensional and hyper-real. The result is a complex environment that ripples with the impacts of many individual innovations, actions and events. Like a weather system, unknown causes create perfect weather in one place and punishing storms in another. The datasphere behaves in a similar fashion.

Many small events occur in real time. The impact of those events cannot be predicted nor, in most cases, even imagined. Who, for instance, would have forecast that the Internet would be emerging as the next-generation computing platform? Not Microsoft. Who could have forecast that online access tools would move from a college student's workstation to mainstream applications in less than one year? Not the University of Illinois student who wrote Mosaic. Who could have visualised that the architecture of the TCP/IP network would triumph over the technologies of IBM, Novell and Banyan? Not the scientists and engineers at these three companies. Who could have anticipated that distributed computing would make an isolated personal computer the technological equivalent of the horse-and-buggy? Not Apple Corporation whose Macintosh remains somewhat ignorant of network etiquette. Who could have anticipated a world where a computer user could output a four-colour paper document half a world away, and distribute the information to thousands of people from a laptop computer plugged into an airport telephone? Not the local offset printers who are challenged by digital copying technology.

The Internet is not only a laboratory for network technology. The Internet and its child networks are an environment for invention. Incremental improvements in Micro-soft Word or Oracle's 7.x database are impressive to some. The realisation

that networked computers support radical new ways of thinking, creating, sharing and experiencing reflects another level of sophistication in computer technology.

Outlook

The outlook is, in a word, opportunity, unparalleled opportunity – for some. Unlike other technologies of communication, network publishing requires a high-order infrastructure. The absence of a single system can render the network inoperable. Network publishing is a consequence of multiple systems and subsystems that function as a larger system. As the number of connections grows, the infrastructure must expand to keep the digital 'ecosystem' alive.

Network publishing is nothing less than the exchange and subsequent creation of more information as the cyber-environment is used by people and their tools. Toward what end does the network publishing environment move or perhaps evolve? The details are not clear, but the trends are easily discernible.

A collaborative environment

The concepts *groupware* and *collaborative computing* are gaining a new meaning for users of discussion groups, online fora and interactive conferencing. The TCP/IP architecture will be extended to embrace these bandwidth-hungry applications. The limited markets for costly video-conferencing products will expand dramatically. The voice telephone will not be replaced for the majority of routine communications, but for those with the need and the resources, the extension of the Internet environment to include real-time multimedia interaction is a certainty for many applications.

Intelligent software

New services fetch and filter information from the datasphere and bring them to the user's workspace. Advances in software agent technology will expand rapidly the power of Web crawlers and worms that prowl files for new information. The greater computational power at attractive prices will almost guarantee that computationally intensive, linguistically-based text analysis and retrieval tools will become more widely available. These advanced software applications will become more powerful, smaller, faster and increasingly effective. The concept of a personal newspaper or a simple filter – such as those marketed today by Individual, Sandpoint and others – will evolve into useful, flexible tools for locating, screening, selecting and formatting information. Based upon users' responses, intelligent text tools will learn what preferences the user has. Indexing and abstracting services will remain useful for certain applications, but the rapid progress in intelligent text software will revolutionise the monitoring and acquisition of information.

Publishing tools

A significant area for innovation is in the area of disseminating information to others connected to the Internet or any target network. The formatting tools that are flooding the market will become more sophisticated, allowing users with a story to tell or a message to send to combine voice, text, images, videos and combinations

of data types into 'netcasts'. These compound, complex, digital documents will become the World Wide Web pages of tomorrow. The demand for interactive messaging will permit telecommunication companies to expand their high band-width services because a demand exists from a customer segment that will pay for this type of service. It is now almost unthinkable for certain types of professionals to be without an electronic mail address. For certain people and organisations, Internet and intranet publishing tools will become equally or more important.

Image processing

Rarely do observers of the electronic information revolution acknowledge that the vast majority of communications are not available. But broadcasts of voice and video, images and the data, charts, graphs and video records of medical, scientific and technical work, are all effectively lost. The primary reasons centre on the costs associated with the gigabyte and terabyte size projects. Advances in storage and computational power will provide an infrastructure for rapid development of automated image processing tools. Japanese researchers at Kansai Institute of Information Science are making strides in image recognition. Tools that will recognise, digitise, compress and index image objects will become more widely available. The integration of audio and text data with accompanying images has already begun at the Library of Congress and other institutions. The large-scale deployment of these tools will provide users with appropriate computing tools and knowledge to access these information sets. Full motion video and true colour images that replicate three-dimensional space are acting like magnets for certain technology vectors.

User-defined output

New colour copiers and printers from Xerox Corporation, Hewlett Packard, Lexmark and Canon will bring the richness of four-colour printing to people who cannot afford traditional printing. The technology to put images on paper is already racing forward with direct-to-press technologies from Germany, Belgium and Japan. However, other types of output options will become more widely available, at lower cost, and easier to use. CD-ROM and associated optical storage devices – the low-cost floppy disks of the new millennium's medium – will provide local storage and semi-permanent storage for multi-object information constructs. Soft-ware that permits a user to capture an interactive online environment and use it locally will become widely available. Not only will content be captured, but the associated data elements will be identified and copied to the user's system for later use and re-use. Fees may be assessed for this type of data transfer, but the output of an interactive online document may be a replication of that online interactive document and its environment. The user will be able to specify one or multiple types of outputs from a particular data set, using the network as a pathway to the device required for the particular output.

Tool mastery

At the dawn of the computing age when machines filled the room, the savvy user had to be a skilled in many different activities from wire bender to mathematical

wizard. We have entered a time when the successful exploiter of the network publishing infrastructure must have two essential skills: the ability to think about information as a structure, and knowledge of the tools needed to manipulate information. Without the expertise to visualise data structures, it will become more difficult to build a winning product or service. Intelligence and instinct have always been necessary ingredients for innovation. In the networked environment, they are often coupled with an ability to understand what one can accomplish with a particular hardware or software tool. A delay created by a poor technology choice can cripple an otherwise excellent product. What does make the difference is a happy blend of skills. It is one of the ironies of network publishing that technology and content are equally important. Without both, one cannot enter the game. Network publishing appears easy, but it is and will prove to be a difficult medium to master.

Conclusions

After more than 18 months of immersion in the new world of network publishing, there are several conclusions that seem almost self-evident.

First, the network publishing tool has paradoxical and unpredictable characteristics. As it widens access to information, it requires that users have more resources in the form of money, knowledge and computing tools. The gulf between the information haves and have-nots is visible in America's public schools and between developed nations such as Japan and poor nation-states like Rwanda. The gap cannot be closed easily or quickly. Yet without closure, we are moving toward a sharply divided global community.

Second, technology's impact cannot be predicted. Small innovations and incremental improvements interact almost organically and behave in complex ways. The use of those technologies and the impact of those instrumental applications of what appear to be harmless inventions create a new type of information environment. The environment is not routinely recognised as a distinct construct almost in the way that a fish does not recognise water. Experts in electronic information are only beginning to come to grips with the rhetorical and syntactical rules of the network publishing information types. The social impact is not fully understood. The implications for commerce, education, medicine and politics are not understood. Indeed many think it is business as usual. We do not know what will come next. Many aspects of digital life seem unpredictable. They are. It is the datasphere showing its true colours.

Third, dislocations will occur wherever network technology can be applied to work processes. Thus, the re-engineering phenomenon that seems to be losing steam is but a harbinger of more fundamental changes.

- *Automated text processing tools* developed for the Internet can easily displace established companies such as H.W. Wilson. The Architext software seems more than equal to the task of creating basic index entries without human intervention or assistance. Indexers are at risk.

- *Software* from Sun Microsystems, Novell, Quarterdeck, Jouve and dozens of other companies will automate many of the routine editorial tasks associated with building interactive documents. Production editors and staff are at risk.

- *Intelligent software* developed by the University of Massachusetts, Cornell University, Harlequin and more than 40 other organisations, can handle a wide range of filtering, processing, search and retrieval tasks. Librarians are at risk.

- *Decision support systems* such as those being developed by Software AG and many other companies, can handle many routine middle management decisions. What remains of the middle layer of many bureaucracies is at risk.

A new millennium lies moments ahead. It is fitting that a new medium is being invented to mark a turning point in communications. Network publishing is global. It is an outgrowth of our need to cut time and costs.

Employment, social constructs, human relationships and organisational dynamics are heading for more change. A new paradigm for computing has been invented. The Internet is an applications environment. Technologies do not merely converge, thus simplifying life; technologies *blend.* They breed and create further technologies that follow their own vectors. The interaction of these vectors yields sudden, surprising change.

The future is one of rich promise and unparalleled opportunity. The image that comes to mind is the excitement that Spanish and Italian entrepreneurs experienced when voyages beyond the horizon became possible in the fifteenth century. The feeling of promise is similar to what the early newspaper publishers in London witnessed when their broadsheets were snapped up by information hungry readers in the eighteenth century. We are experiencing the emergence of a new medium. Like all technologies, the new medium has no conscience. Like any technology, we let it loose upon the world without any idea of its benign or malignant effects.

One thing is certain: now it has been invented and set loose, there is no turning back. Thus, we enter the new millennium with anew medium. We must live through an interesting new age of discovery and change.