Digital Media

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"One Internet Year is the equivalent of Seven Calendar Years"[1]

Developments and advances in information and communications technology are boosting a convergence of computing, media, and telecommunications. This is dramatically affecting every aspect of society from technology designers and content creators to users. The design-to-product cycle time continues to decrease as new markets open up, and windows of opportunity exist for those who can move fast and make the right connections. Challenges and opportunities exist in each area of the convergence, but one thing is here to stay: being digital. Nicholas Negroponte and the MIT Media Lab (http://www.media.mit.edu/) pioneered the field in many ways and continue to invent and innovate.

It was only a matter of time before the Internet and the media worlds would merge to capitalize more effectively on converging markets and users. On 10 January 2000, America Online and Time Warner announced a proposed $220 billion merger to create the world's first fully integrated media and communications company for the Internet century—and the world's fourth largest corporation (following Microsoft, General Electric, and Cisco Systems).

Gerald Levin, chief executive, said, "The digital revolution has already begun to create unprecedented and instantaneous access to every form of media and to unleash immense possibilities for economic growth, human understanding, and creative expression. AOL Time Warner will lead this transformation." Steve Case, chief executive of America Online said, "New media has truly come of age. We've always said that America Online's mission is to make the Internet as central to people's lives as the telephone and television, and even more valuable. By joining forces with Time Warner, we will fundamentally change the way people get information, communicate with others, buy products, and are entertained, providing far-reaching benefits for our customers and shareholders."

This issue brings together a number of key areas in digital media: technology advances, linked environments, interaction, standards and interoperability, and traditional media developments that incorporate new digital components. As such it's a snapshot in a fast-moving field! This editorial provides a broad view of a number of key components in the field followed by a summary of the articles in this issue.

Digital media drivers

The following key factors accelerate digital media developments:

- *Moore's law.* This law indicates increased hardware functionality at decreasing cost and increasing bandwidth—both occurring at a factor of 2 over 1 to 1.5 years. By 2005, computing components will be 1/10th of today's price. Data traffic is expected to grow 10 to 20 times and be 90 percent of all traffic, with Internet/IP access becoming the norm. British Telecommunications Laboratories expects to see 24 million handsets in use by 2003. Increasingly, mobile and wearable devices will provide access. Advancing miniaturization will provide 1-mm imaging and camera devices that can explore information at the nano level.
- *Increasing reality.* Connecting real-world data to computing devices capable of handling it effectively is coming closer. This won't involve simply faster rendering or more accurate modeling, but digital media information that represents the real world and synchronizes with it.
- *Ubiquity.* Current trends for technology to be less in your face and more in the background (invisible computing) will lead to increasing ubiquity of devices and interfaces. All forms of information will be digital—audio, movies, interactions, publications—with consequent copyright and intellectual property rights implications. The legal ramifications of the digital world of cyberspace and its exploitation are immense.
- *Convergence.* Multiple access points to the same data will require the repurposing of information to suit different media, whether movie, game, documentary,

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or digital book. The traditional distinctions between different media will become blurred.[2]

Smart media

"Being digital" also encompasses the digits that the user unconsciously supplies when interacting with content. Information about user trends and requirements can be built up automatically. This enables content to be much smarter and increasingly targeted to meet user needs before they're specified. This has implications for the future design and delivery of entertainment and advertising. One company has already taken the Smart Media name; see http://www.smartmedia.com/.[3]

Internet media

The Internet is rapidly becoming the ubiquitous transport service for digital media where end-to-end delays aren't critical to quality of service. The Computer Industry Almanac (http://cyberatlas.internet.com/) reported that by the year 2002, 490 million people around the world will have Internet access, that is, 80 per 1,000 people worldwide and 118 people per 1,000 by year-end 2005. The top 15 countries will account for 82 percent of these worldwide Internet users (including business, educational, and home use).

File formats for streaming media

Current formats for streaming audio and video over the Internet include the RealNetworks RealMedia, Apple Computer QuickTime, Microsoft Windows Advanced Streaming Format, and MetaCreations MetaStream 3D file format for 3D objects. The Synchronized Multimedia Integration Language (SMIL) is a markup language for describing the temporal behavior, screen layout, and associated hyperlinks of a streaming media presentation. SMIL is based on the Extensible Markup Language (XML), which in turn is a technology for supporting structured documents on the World Wide Web. The World Wide Web Consortium (W3C) drove the XML specification.

For more information visit http://www.realnetworks.com, http://www.apple.com/quicktime/, http://www.microsoft.com/windows/windowsmedia/en/features/roadmap.asp, http://www.viewpoint.com/, http://www.w3.org/, and http://www.w3.org/TR/REC-smil/.

Distributed digital media

Networked virtual reality (VR) suffers problems due to latency, jitter, and the lack of truly lightweight, user-friendly display devices. However, current developments in display devices are improving this (see the "Display Devices" sidebar). Multiplayer game technology is paving the way for more seamless and ubiquitous virtual reality. Experiments of the kind discussed in the Flerackers article are likely to migrate into standard end-user interfaces.

Standards

The Moving Picture Experts Group (MPEG) of the International Organization for Standardization (ISO) develops standards for code representation, processing, compression and decompression of moving pictures, sound, and their combination. MPEG-1, introduced in 1992, plays video and audio in linear streams and operates like a digital video player. MPEG-2, introduced in 1995, supports compression and transmission of digital television signals. The current MPEG-4 is a multimedia standard that allows interaction with objects within a scene. MPEG-7, a content representation standard for information searching, is currently being developed with an expected delivery date of 2001. MPEG-21 is a new initiative to define a multimedia framework to support the delivery of electronic content that began in 1999. Their URLs are http://www.mpeg.org/MPEG/ and http://www.cselt.it/mpeg/faq/.

Ubiquitous computing

If the first era of computing was one of one machine/many users (the mainframe), and the second era was one person/one computer (the PC), then the third era might be one person/many computers. In this environment users don't interact with any particular computing device; they interact with the functionality and services offered by the devices near at hand. These devices are embedded in the user's environment and don't demand the user's attention. This approach conserves human attention and puts the computers more in the background. Anytime, anywhere—key elements of the future—are the explicit aims of major players in the field. Visit http://www.ubiq.com/hypertext/weiser/UbiHome.html.

Agents

Agents are one of the most exciting areas of research and development in computer science today. One sce-

Display Devices

A virtual retinal display (VRD) can directly project images onto the eye. Rather than wearing a bulky helmet display or sitting in front of a flat, 2D screen, the user puts on a pair of conventional eyeglasses and views images projected directly onto the eye's retina. Using a photon generator (laser), the VRD creates a circumambient environment—a "portable Imax theater for the eyes." Microvision manufactures and distributes the VRD technology for imaging applications in areas such as medicine, education, scientific visualization, telecommunications, and visual entertainment. Visit http://www.mvis.com/.

The Times (Feb. 2, 2000, p. 40) outlined how surgeons in the operating theater can use the VRD to beam pictures and information (for example, a brain scan) directly onto their retina while they're operating on the patient, to improve accuracy and coordination of the surgical procedure. The current technology generates 600 rows of dots per frame, at 25 frames per second. The next generation will scan 1,000 rows of dots per frame at 60 frames per second. *The Times* article comments: "Games programmers, always eager to make Lara Croft and her electronic enemies even more lifelike, are watching hopefully." This also offers scope for addressing the issue of future Web interfaces via portable devices. How do you read the Web if the portable gadget contains a screen that is only 3 inches wide? With a scanning device in the gadget, and holding it 3 to 4 inches from the eye, the user could have a viewing field equivalent to a 15-inch monitor.

Over the Horizon: Digital Media Predictions

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What kind of predictions can we make for the future of digital media? Here's a glimpse at possibilities just over the horizon.

1. Analog television is clearly well on the way out and will be gone in a few years' time (the US Federal Communications Commission's suggested date is 2006[1]).
2. Analog sound broadcasting should be easy to supplant. However, the value of the spectrum and the margins in the hardware market are much smaller than for television. Also, a longer term general transfer to Internet media delivery could drive a large-scale changeover to digital sound broadcasting.
3. Interactivity is set to increase in digital television. This clearly points toward a convergence with Internet services, where the economies of scale should be able to overcome residual problems of resolution and bandwidth.
4. Convergence of Internet-based systems suggests that larger Universal Mobile Telecommunications System (UMTS) terminals will become indistinguishable from a portable digital media terminal.
5. The possibility of various types of 3D display is likely to generate new markets.
6. Mobile multimedia, such as UMTS, is a development that's virtually guaranteed to occur and have a significant "revolutionary" effect.
7. With the increasing reasoning power of computers and the information resources now available on the Internet, computer-assisted methods for forecasting complex systems should be explored to provide a clearer picture of the optimum path for research and development.
8. Revolutionary developments such as quantum computing or direct neural communication with the brain are further away.

Reference

1. J. Fouke, *Engineering Tomorrow*, IEEE Press, Piscataway, N.J., 2000, p. 125.

nario sees the Internet evolving into an economy populated with billions of economic software agents that buy and sell goods and services, represent buyers, sellers and intermediaries, and maximize profit. They're currently being applied in domains such as e-commerce, computer games, interactive cinema, information retrieval and filtering, user interface design, autonomous vehicles, and process control. See http://www.cia.mty.itesm.mx/~lgarrido/Repositories/IA/agents.html and http://lieber.www.media.mit.edu/people/lieber/Lieberary/Letizia/AIA/AIA.html.

Human-machine merger

Ray Kurzweil has a vision of increasing augmentation of human capability and function over the next 10 to 20 years until the machine is more capable than the human.[4] This could have significant implications for our interface with machines.

Digital content creation

The film and special effects industry has used state-of-the-art techniques for producing sequences for blockbuster films. Such techniques are becoming increasingly sophisticated and seamless in their integration with live action.

Current areas of work in this area include the creation of new content, its repurposing, and its storage, archiving, and retrieval.[5] Another work area involving traditional industries is the conversion of existing archives to digital format to facilitate access and retrieval. Such domains include academic libraries, audio, film, and TV archives. The data source can be photographs, graphic art, animation, special effects, audio, video, and text. Issues involved in this process include data integrity, digital abstracts, creation, financial asset value, future proofing, indexing for library applications, knowledge and data mining, legacy data, retrieval (time and reliability), security, standards, storage, and transactional data (changes during creation or postproduction). Visit http://www.medianews.com/ for more information.

User as creator and producer

Any user can produce digital content and make it available on the Web. Users can add their own input to existing content to produce new kinds of stories. Online communities—one of the fastest growing areas currently—generate real-time scenarios that themselves are new kinds of content.[6]

Linking R&D in media and industry

Many academic and research organizations, and their funding bodies, are seeking to develop and strengthen links between leading-edge research in digital media, networking, and IT to facilitate opportunities for technology transfer and revenue generation. One such example in the UK in the area of networking is Media-Tech, which is funded by the European Regional Development Fund. Media-Tech brokers access to skills, people, technology, and information required for innovative improvement and enhancement of company products via multimedia technology. It provides a support network of expertise in multimedia applications and links together universities, small and medium-size enterprises, and leading organizations in a geographical region. Visit http://www.media-tech.org.uk/ and http://www.hefce.ac.uk/research/indlink/rsmain.htm.

In this issue

Yan reviews imaging in digital media applications. Techniques include enhancement, restoration, compression, animation, and retrieval. He discusses image analysis algorithms and outlines future directions.

Peddie provides an industrial perspective on the current trends and developments in digital media technology, including display technology, communications, and systems. Peddie feels digital entertainment boxes will migrate into three major areas—smart digital TV, games consoles, and virtual appliances.

Sandbank addresses the aspect of digital television in a converging environment. He also discusses the development of networking and interface standards.

Capps et al. explore the opportunities for developing the synergy between the entertainment and defense industries. Given predictions about the rate of technological innovation, the authors present a vision for interactive entertainment. This involves computer-generated characters, augmented reality, whole-body tracking, dynamic environment extensibility, and haptic devices.

Cai et al. discuss a prototype Web-based system for the efficient access and manipulation of digital medical image data to support the environment of modern distributed health care delivery.

Long et al. offer a methodology for accurate semantic video object extraction by either fusing spatial and temporal segmentation or performing fast boundary tracking adaptively according to the variation between successive frames. The user can drive the system, or it can be fully automatic. It represents a powerful, flexible tool for digital video applications.

Flerackers et al. outline a networked virtual environment for implementing the gaming part of an interactive drama series for television. This combines Web-based interaction, VE techniques, and the television medium. It's an interesting experiment that seeks to combine new and old media while still using traditional technology.

Joslin et al. describe a shared virtual environment for supporting the building of entertainment attractions. Techniques for communication, scene management, facial and body animation, and interaction are implemented. VRML97 and MPEG-4 synthetic-natural hybrid Coding (SHNC) are compatible with other virtual reality systems. Visit http://www.cselt.it/mpeg/faq/faq-snhc.htm for more information.

The Applications section in this special issue contains a description by Sweeney of a new flagship digital media gallery in the UK's National Museum of Photography, Film & Television. This gallery explores in challenging and engaging ways the imaging frontier where digital media, computing, and telecommunications converge. It also aims to devise new creative means to picture the world of the imagination and entirely artificial computer-generated worlds. Sweeney presents the rationale behind the design and implementation of the gallery and summarizes its impact.

Ultimate medium?

The rate of technology change will bring further exciting developments and advances. It's difficult to predict how these developments will be mediated optimally to consumers. Customers usually want content value and usefulness before speed and connectivity. Thus a range of user requirements might be met in different ways for different purposes. An example is the so-called search for the ultimate device: low cost, common connections and access to a common digital content distribution network catering to the mass market. But devices are designed for a specific purpose; viewing, interacting, and portability aren't easy to assimilate in the design and implementation of one device.

In the general area of convergence we have the following three subsidiary convergences:

- Content (text, data, audio, video)
- Platforms (PC, TV, Internet appliance, game machine)
- Distribution (wired, wireless)

It's not clear how these will progress over time. Platforms won't converge unless they can support current and future user requirements. Content must be scalable if it's to be delivered to a variety of platforms. We shall observe with great interest how digital media and digital entertainment continue to develop. ■

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