

Telemedia: A Survival Guide to the Fifth Dimension

By John R. Forrest

Lord Mountbatten's passion for machinery and innovative engineering of every kind was well known. The National Electronics Council was his brainchild, founded to make sure Britain did not neglect what he saw as the key to the future — electronics. He was remarkably farsighted, because by the end of this decade, electronics will be the largest industry in the world, representing 10% of world gross national product (GNP). Last year, some 30 semiconductor chips were made for every inhabitant of the earth; this number will be around 100 per inhabitant per year in another ten years — a graphic illustration of how our lives have come to depend on electronics, especially in the industrialized countries.

In all his activities, Lord Mountbatten was a man of fiery enthusiasm and total commitment. Philip Ziegler, in closing his biography on Lord Mountbatten, wrote: "He flared brilliantly across the face of the twentieth century. The meteor is extinguished, but its glow lingers on in the mind's eye." It is an exceptional honor for me to give this 1995 Mountbatten Memorial Lecture and to be part of maintaining that glow.

I will start with some brief remarks on a subject with which Lord Mountbatten, with his naval background, would have readily identified — navigation. For mankind, the importance of being able to measure the three dimensions of position and the fourth, time, has always been of the highest rank.

Early competitive advantage in civil or military environments was gained through the ability to measure these quantities more accurately than other traders or adversaries. This is exempli-

fied in the large effort that went into charting the oceans and in chronometer development in the 18th and 19th centuries, but the advances in electronics in the 20th century have made the accurate knowledge of position and time a straightforward matter. A clock synchronized by radio waves to an atomic standard can now be bought for less than £100, and a GPS receiver giving position accuracy to around 10 meters anywhere on the earth's surface costs little more than £200.

History

Navigating the fifth dimension — which I call the telemedia environment — now emerges as the critical process determining such diverse aspects as safety of life, competitive business advantage, and enjoyment of leisure. Information has always been of significance to mankind but was limited in usefulness when the information that could be gathered was limited to very short distances and was frequently not very current.

Competitive advantage in the last 50 years has been focused increasingly on the use of electronic technology to increase the breadth and currency of the information gathered. We are in a situation where it is now technologically possible to gather numerical data, text, pictures, and sound from anywhere in the world and present it essentially instantaneously to people, not just in their homes, but where they may happen to be.

This is the realization of the vision of the President of AT&T, Theodore Vail, who in 1910 talked of: "One system with a common policy, common purpose and common action, comprehensive, universal, interdependent, intercommunicating like the highway system of the country, extending from every door to every other door, affording electrical communication of every kind, from everyone at every place to everyone at every other place."

Many years later, politicians and strategists have picked up this concept and coined the term "information superhighway," but while this term is the one most used concerning the possibilities that now exist, it is misleading and misses some of the key points in Theodore Vail's vision.

The future telemedia environment will involve not a superhighway as such, but a network of networks, some optical fiber, some cable, some satellite, and some wireless. Just as with transport infrastructures, what is really important is what runs on the infrastructure. The recent technological achievement is the ability to deliver all our present communication media on a global basis at a low enough cost to encourage a strong expansion and uptake of services. I feel that the term "telemedia" represents this most accurately. The revolution lies in the effect that this will have on our patterns of social behavior and commerce. It will be a revolution at least as great as the industrial revolution and will occur in a duration about half of the 50-year time scale of the industrial revolution.

It is not possible at this stage to predict the outcome of this revolution, yet there is no question that it has started. For the first three-quarters of the 20th century, the major means of communication were neatly partitioned: telephones for conversation; print for mass distribution of text; cinema and television for visual entertainment; radio for news and musical entertainment. Each had its separate licensing and regulatory process.

The recent rash of mergers, alliances, and acquisitions in and across the broadcasting, communications, and information technology business sectors show the frantic attempts of the major players to understand and position for advantage in the evolving, but as yet unquantified telemedia environment. These new relationships are reducing the distinctions

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between different media in any given country, but also between the media industries of different countries.

Rather than attempt to be prescriptive about the years ahead, let us try to gain some insight into the likely evolution by looking at the forces which will drive the revolution and the forces that will restrain it. These forces may conveniently be discussed under the headings of technology evolution, telemedia markets, and regulatory issues.

Technology Evolution

Technology evolution has always been a major destabilizing force towards existing infrastructures, as was the case in the industrial revolution. The technology evolution in the present case is not that of steam and machinery, but of digital technology.

Professor Alec Broers, in a lecture to the Royal Academy of Engineering last year, commented that: "Progress with microelectronics will continue to be the dominant force in the information technology revolution for the next twenty years." There is much more certainty behind this prediction than behind most 20-year forecasts!

Particularly relevant in semiconductor chip development is the law named after Gordon Moore of the Intel Corp., which notes that the processing capability, or the amount of semiconductor memory on a silicon chip, doubles approximately every 18 months. Although empirical, this law has held since the early days of integrated circuits, and there is good confidence that it will hold for the next 20 years.

Computers and Software

The Acorn and Sinclair microcomputers of the late 1970s used a processor running at 1 MHz, with 32 kbytes of random-access memory and a few megabytes of sequential access audio tape storage. In a mass-market PC today, we now expect nothing less than a processor running at 60 MHz, with 4 Mbytes of RAM, and 300 Mbytes of rapid-access hard disk storage.

An important driver for the evolution of such semiconductor-chip-based products is the ability to reduce the cost of the product by increasing the integration of processing power or memory on each chip, thereby lowering

the total number of chips needed. In memory, 4-Mbit chips are now a standard component, with 16-Mbit chips coming into use, and 64-Mbit and 256-Mbit chips planned for introduction before the end of the decade. Prototype 1-Gbit chips have just been fabricated and will enter the market in the early years of the next century. Multifunction processors such as the Pentium, which handle around 250 million instructions per second, are being complemented by lower cost digital signal processing (DSP) chips. These can typically handle several thousand million instructions per second in dedicated tasks, such as digital television picture processing and other telemedia applications.

The other main driver for the evolution of mass-market digital products is the software industry, which regularly introduces new software (such as Windows 95) with more comprehensive or user-friendly features, all requiring faster processing speeds and more memory. The increasing convergence between the software for the business environment and that for the home PC is also driving ever more powerful machines into the mass consumer market.

All the factors appear to be present to continue semiconductor chip evolution at its present rate through the next decade. On this basis, the semiconductor chip of the year 2010 will have the same number of processing elements as the human brain. The technology to achieve this continued evolution in microelectronics is already predictable, although not yet implemented.

The challenges to implementation lie increasingly in two areas: the development of software or operating systems for such chips and the enormous costs of the semiconductor factories needed for their manufacture. In order to achieve the necessary financial return on the very high development costs and investment in manufacturing plant, manufacturers will combine in consortia, such as the recently announced £1.5 billion joint venture project led by Motorola and Siemens, and target very large market volumes for the resulting silicon chips. This implies a market in which the chips are used as central components of electronic devices of everyday use.

About the only applications one can presently envisage that require such computing and memory power lie in the real-time processing of television or other moving pictures, most likely in parallel with sound, text, and data — namely, telemedia services. This targeting of mass markets with closely-related semiconductor chips is yet another important factor driving convergence in telemedia.

Compression Technology

Of major impact in telemedia services, a result of the enormous digital processing power now conveniently available, is the compression of pictorial information to a low information content without changing the appearance of the pictures or video. There is much redundancy in pictorial information, which the eye does not need. For example, an area of uniformly blue sky does not need to have each tiny element or picture cell specified and stored or transmitted when each is essentially identical. It is sufficient to describe the boundaries of the area with its intensity and color.

Similarly, in television pictures, which are frames transmitted sequentially every 1/25 sec, relatively little changes from frame to frame, and it is only necessary to store or transmit the information which has actually changed from the previous frame. It is now routinely possible to compress television or still pictures by factors of between 50 and 100, radically changing the economics of storage and delivery of television services in the digital environment.

It is possible now to transmit between 4 and 16 television services digitally in a frequency channel that previously carried just one service in analog format and to deliver moderate-quality video services and videoconferencing over the telephone network. The set-top satellite or cable receiver that in the past has brought a few tens of channels now becomes a device capable of delivering some 500 program services, and the personal computer becomes a video terminal.

Storage and Power

Information storage devices are also evolving very fast, with a steady transition from magnetic to optical technology.

The well known floppy disk has the key advantage of being a read-write device, on which the information can be changed readily, but it is very limited for the large amounts of information associated with pictures or video, typically storing only one or two high-resolution pictures in uncompressed form. The optical CD-ROM, with its 600-Mbyte capacity, is better suited to multimedia applications and costs around 50 pence to produce in quantity.

Already in advanced development is the read-write CD, which will by the end of the decade make the floppy disk obsolete. Probably the most exciting recent development is the agreement on a technical standard for a very high density read-only CD format for video applications. This device uses both sides of the disk and two layers of storage, yielding up to 18 Gbytes of storage. The critical challenge, which has been met, was to have a CD that could store a minimum of 5 Gbytes, which is needed for one movie of two hours' duration.

Less in the public eye perhaps, but equally important, are the developments in battery technology. Hewlett-Packard has recently announced a zinc-air battery for its Omnibook notebook computer, which gives five times the energy density of standard nickel-cadmium batteries and promises to change the present rather limiting battery life of such devices.

The technology is therefore in excellent shape, and the much larger and more challenging questions lie around the markets which will use this advanced technology.

Telemedia Markets

A definition of marketing that I have always liked runs, "Marketing is not the art of finding clever ways to dispose of what you make; it is the art of creating genuine customer value, helping your customer to become better off." Indeed, apart from the few who will always buy the latest gadgets, consumers do not buy products for their technological innovation, and this is particularly true of telemedia products. Consumers buy new media services which they consider value for money and which change lifestyle in appealing ways, the product being the route to obtain these services.

An increasingly used generic name for such products is "lifestyle products." Examples are the mobile phone, the fax machine, the PC, and the satellite receiver. The phenomena governing the growth of lifestyle products are complex, but the growth in the past has nearly always followed a similar pattern, known as the "hockey stick" curve. A slow initial market penetration of a relatively high-priced product, largely in the business or professional community, is followed by a critical point where the decreasing price and increasing perceived benefit causes a rapid takeoff in the much larger consumer market, driven strongly by the further price reductions obtained through large market volumes.

Although the profit margins may be higher in the business user market, the prize goal for a manufacturer or service provider is to achieve rapid penetration of the potentially very large consumer market. To tackle this and to overcome the very justifiable reluctance of consumers to commit significant sums of money to products that may become obsolete rapidly, service providers are now subsidizing the cost of products so that little initial capital outlay from the consumer is required, but the service provider recoups the cost through the profit margin on the supply of services over a period of one or more years. The provision of mobile telephones is an example of this. Such a process, or equipment rental schemes, may be the only way in future to launch telemedia products into the mass markets. The cable television industry is an example of one that already operates in this way, providing the set-top interface unit to the consumer as part of the service and eliminating the consumer's worry about obsolescence.

Increasing Consumer Demands

Since the services are the key factor in telemedia market growth, we must focus on the new services that are likely to be required. For many years, most of the European countries were accustomed to having only a few national radio and television services. Around 1990, the multichannel television revolution started in Europe, driven by direct-to-home satellite delivery and

steadily increasing cable systems. With the growth in number of the Astra satellites, there are now some 60 television program services, including over 25 in the English language, available to satellite and cable homes.

Although technology played its part as an enabler, the secret of success of satellite television was the negotiation of exclusive rights to the screening of hit movies and key sporting events. This had an interesting side effect in assisting the revitalization of the movie industry and live sports. For example, the battle to obtain rights led to the amount being paid to World Cup Cricket rising from £150,000 in 1988 to £1 million in 1992 and £7.5 million for 1996. Interestingly, despite satellite broadcasting being the driver for this part of the television revolution, cable will steadily overtake satellite as a multichannel delivery medium, because of its ability to integrate other services such as telephony and provide an interactive path. In all likelihood, a change from the present position of uneasy alliances between satellite and cable operators will occur to one of strong competition to win and keep the customer, the satellite television companies engaging in joint ventures with telecommunication operators to provide a multiservice offering. This may provide some interesting challenges for regulators!

It is noticeable that the achievement of customer loyalty (or the avoidance of "churn," as it is called in the cable television industry) is a major priority, receiving greatly increased emphasis in the U.K. in recent months in all service and retail sectors. For example, virtually all the major retail chains now have "loyalty" cards, offering benefits to regular shoppers for their exclusive custom. The *Financial Times* reported recently that sales booked to retailers' own store cards have increased 17% in the last year. An important aspect to the retailer is his ability to track customers' purchases and target them with promotional offers. This will be an increasing feature of the telemedia environment also.

The Economics of Multichannel Television

There are some stark economics concerning the multichannel television

business today. The proportion of consumer spending going on "leisure" is around 8% in the major European countries, and when inflation is taken into account this figure has changed little over the last ten years. A conclusion that was drawn in an analysis by *Screen Digest* is that "The disposable element of income available for discretionary spending, after accounting for housing and other major cost items will not vary significantly when pay is more or less keeping pace with inflation and interest rates are not subject to severe fluctuation." The implication, therefore, is that there is relatively little new revenue for the growth of media services and that new services, to a first approximation, cause a redistribution of revenues across the various services.

Although not a media service, the National Lottery is an interesting example of such redistribution, with nearly £100 million per week having been shifted away from the previous income to bookmakers, football pools, charities, and general retail sales in the "impulse buy" category. Within media services, a graphic example of the redistribution is seen in the effect that the start of satellite broadcasting in 1989, with its movie channels, had on video rentals.

Between 1981 and 1989 in the U.K., the video rental business grew from some £50 million per year to nearly £600 million per year. In the years since 1989, the revenues have declined to around £440 million per year. Without the satellite movie channels, it is reasonable to assume that the video rental business, as a slowly growing lifestyle service, might now have a turnover of around £1 billion per year, so some £500 million of potential business has been lost to satellite broadcasting, and this figure indeed matches quite closely the income derived from subscriptions to the encrypted pay-TV channels.

The way in which this redistribution occurred leads to a conclusion about the availability of revenues for new markets. If a new media service offers a more attractive and, in the consumer's eyes, cost-effective replacement for a previous service, the new media service can show very rapid

growth, even in the space of a year or two, to the detriment of the previous service, as has been the case with videotape rental. Where the new media service involves a lifestyle change, requiring redistribution of revenues across completely different sectors of consumer spending, the time scale for growth will be much longer, maybe requiring 10 or 15 years to achieve critical mass in the market. It has, for example, taken some 15 years for the mobile telephone to achieve the present widespread use. It is well up the "hockey stick" curve now, with over 50 million users worldwide, approximately half of those users having joined in the last year.

If one considers the revenues now flowing into U.K. broadcasting, they are still dominated by the license fee supporting the BBC and by advertising income supporting ITV and the Fourth Channel, although there is some growth associated with pay-TV services and advertising on satellite and cable. In round terms, the terrestrial services correspond to revenues of about £200 per year per viewing household. The cost of providing the program services on the four terrestrial channels thus works out on average at around £90,000/hr. Major series like "The Bill" or good drama cost up to £400,000/hr, making it necessary to have a significant amount of lower cost imported game shows, soaps, and repeats in the overall schedule.

Although major economies have been made in the television industry in the last few years, the inescapable fact is that good programming costs money. Although electronically generated scenes (and even actors) hold some fascination for the future, it is not yet clear that such "virtual environment" techniques will involve a dramatic lowering of costs while maintaining program quality in an environment of a massively increased number of program services.

A comparison of the projected revenues flowing into broadcasting with the projected future number of program services leaves the conclusion that, unless there is some means to extract new revenues from the consumer, the quality of programming must on average decline as the number of services increases.

Revitalizing Television

Equally worrying is the conclusion that the conventional form of television, to which we have become accustomed over the last 50 years, is now a mature market. Despite the enormous increase in the number of program services over the last few years, there is now a decline of some 2% per annum in the average weekly viewing hours. Advertisers, who spend very large budgets in television promotion of their products and services, are becoming increasingly concerned about the effectiveness of the medium; they are showing greater desire to influence program content in order to maximize their advertising impact, and they wish to have better means of measuring the effectiveness of their spending.

To attempt a revitalization of television and draw in new revenues, two potential new markets in program services are being targeted: theme channels (sports, hobbies, and special or ethnic interests), and interactive services. Digital compression technology has made the theme channels more viable, because in this domain a television broadcaster can now run a whole operation with very few people and low overhead.

The business comprises the acquisition of the necessary material and its preparation for transmission. The transmission can be carried out as part of a multiplex of services under the umbrella of a major broadcaster, who also provides the infrastructure for subscriber management and revenue collection. The dominant cost is therefore the acquisition of program material, but simple economics shows that for a subscription theme channel broadcasting 12 hr/day to an audience of 1 million, each paying a £5/month subscription charge, allows not much more than £10,000/hr to be spent on programming.

It is critical, therefore, that such theme channels have worldwide reach to gain the necessary audiences. This thematic approach has worked in the newsprint and magazine publishing world where, despite an overall and continuing decline in the newsprint market, there has been growth in special interest titles as part of the portfolio of a few major publishing houses.

Interactive Services

Interactive services, however, are now representing the major hope for achieving growth in the television market. Television has for many years been a locally-interactive medium, both through channel selection and the access to teletext information services. Neither of these required a return path from the television set back to the broadcaster. Systems now under trial involve the use of a return connection, usually over the normal telephone line provided by BT or the local cable company. Such a connection permits full external interactivity and, in principle, allows the provision of a range of services such as:

- Access, at a time convenient to the viewer, to program material stored by the broadcaster (movies, repeats, news)
- Video games and the ability to have contests with remote players
- Home shopping facilities
- Home banking facilities

It is fair to say that there is as yet little understanding of the market interest in these various facilities; a sizable amount of activity around the world is centered on large-scale trials with the objective of trying to understand what is of interest and of value to the consumer. The BT trial involving 2,500 households, four public access terminals, and eight schools around Colchester and Ipswich is one of the leading trials in the world. It will provide much valuable understanding of what the consumer wants and the price sensitivity of services. There is no doubt that if the right approach can be found, there is the opportunity to transfer large amounts of revenue flow from conventional sectors into the telemedia services sector. A key factor will be the user-friendliness of the electronic interface with the customer. We must not repeat the situation of difficulty that most people have had in programming their VCRs!

The market for home shopping, for example, was analyzed by Goldman Sachs in 1993. They noted that the total retail sales market in the U.K. is around £150,000 million per year; at present some 3.8% of these sales are carried out as home shopping, mostly

through catalogs and telephone ordering, only 0.01% through television shopping.

While one would not suggest that conventional shopping will disappear, home shopping has an important role and is a growing business because of the convenience it offers in our increasingly busy lives and congested traveling environment. There is a willingness, therefore, to pay a small premium for the service, since there is a lifestyle benefit and saving in travel costs.

Home shopping via television is as yet a small part of the overall market, but again growing strongly. QVC, the home shopping channel, recently announced its best ever results with sales of £9 million for the last quarter, a doubling since the equivalent period last year. In the U.S., while the percentage of retail sales done by home shopping is similar to that in the U.K., television shopping is 0.2% of the total, 20 times that in the U.K. Clearly there is much opportunity for growth in this sector, but a vital factor for success will be related to implementing a delivery system that is both rapid and accommodates delivery within a narrow time window specified by the customer.

Remote banking through the use of automatic tellers in most public places is already an accepted and most useful feature of our banking environment. It is difficult to envisage a home banking service for which the consumer will pay extra. Recognizing that challenges to the existing High Street banks are coming from new organizations, unburdened by the legacy and overhead of High Street premises, it is likely that customers will be expecting reduced banking charges as a result of the move to electronic banking. However, as banking in High Street disappears and access to bank staff is replaced by video kiosks and video access from the home, the revenues that were associated with the maintenance of the many physical premises will be directed, although at lower level, to the maintenance of the telemedia infrastructure.

Video-on-Demand

Another interactive service that is attracting much attention is the deliv-

ery of television programming, such as movies, news, or episodes of popular series of the viewer's choice at a moment's notice. The market for this video-on-demand (VOD) service is most difficult to predict. The VCR, now in the majority of homes, already allows the viewer to reschedule programming to more convenient times.

It seems clear that people are not willing to pay a significant premium over the cost of videotape rental for the convenience of being able to make their selection from home, and this sets a major challenge to developing the business. The whole process of the release of movies, from the initial launch in the cinema through launch on videotape and, finally, launch to the pay-TV and network television markets, is a process very tightly controlled by the film studios to maximize and protect revenue.

Through this regulation by the movie industry, the newer technology of video, rather than killing the cinema market as might have been expected, has brought vital new revenues into filmmaking. Cinema attendance has doubled in the last decade and is now showing strong growth thanks to new multiscreen cinema multiplexes and high-profile advertising prior to film release. Some 500 films are made each year, the majority of very mediocre quality, but the industry survives on the few percent of these which become significant box-office hits.

Since the major customer attraction with VOD would be to see such hits more quickly in the home, it seems that for VOD to succeed, a significant change in the pattern of release dates would be required and this the studios may be reluctant to see. The future of VOD thus lies largely in the hands of the film studios. Indeed, the VOD market in the U.S. is very slow in developing, and where such services are available they represent a very low proportion of total revenues for the service providers.

Television Versus PCs

There is now considerable debate about whether the PC or the TV will be the focus for growth of telemedia markets, since the PC already has a head start in interactivity.

For many years, the production of

television sets has seen a steady increase. The world production of TV sets stands at around 110 million units per year, with an annual growth rate of around 3% per year, but this increase in the market is almost entirely in the developing countries. In the developed and industrialized economies, such as the U.K., where most homes have at least one set and 50% have more than one, the market for sets is mature, with consumers more interested in spending money on the new lifestyle products and delaying the replacement of sets for as long as possible. Some 4 million sets were sold in the U.K. last year, split almost equally between large-screen and small-screen versions.

For comparison, the world PC production stood at 55 million units in 1994 and is increasing at 27% per year, at which rate it will overtake TV set production around the end of the decade. In the U.S. in 1994, over 7 million personal computers were sold for home use, exceeding the number of television sets sold that year and bringing the PC into some 35% of homes. In the U.K., a very similar situation is developing, bringing home PC penetration to just under 30%. Some recent surveys have shown that in homes with a PC and a TV, the PC is being used for an average of 18 hours per week and the television for less than 10 hours.

A new development that could lift the television set market is the work going on in Japan on large-scale flat displays. It has for many years been a dream to have a large television screen that would hang on the wall, eliminating the bulk and weight of current large-screen sets. Development of such large flat-screen displays using plasma technology has now reached the point where Japanese companies are making an enormous investment in manufacturing plants to bring such products into the marketplace around 1997.

The main uses of the PC have in the past been work or games-related, but this is changing rapidly with the emergence of the networked multimedia PC — a personal computer with CD-ROM drive and a telephone modem to connect with on-line information and communication networks. It is this interconnectivity, or interactivity over

the global Internet network, which is now enhancing strongly the growth in the PC market. In recent wars or natural disasters, those on the Internet have been able to receive and respond to direct accounts and news from those at the scene, well in advance of reports being put out by conventional radio and television news services.

The Internet

Like many entities which suddenly achieve prominence, the Internet has been in existence for a long time. It was derived from a U.S. government-funded initiative, known as Arpanet, started in 1969 to provide computer links between government scientific research establishments and universities, so that closer contact and more rapid interchange of information could occur on research projects. The telecommunications network linking the computer terminals was funded by the U.S. National Science Foundation.

The so-called "Internetting" project, as part of this initiative, began in 1973, over 20 years ago, and was the start of bringing other research institutes and universities around the world on to the network. During the 1970s and 1980s, the network of researchers grew and, driven by the innovative and open character of the users, the capabilities of the Internet expanded as quickly as the technology developments allowed. Researchers quickly developed techniques for sending pictures and sound, as well as data, over the network.

A key development by Tim Berners-Lee, one of the researchers at CERN in Geneva, then occurred. The Internet was at the time not user-friendly, and it required good knowledge not only of how to use it, but where information was located. He realized that there would be great benefit in being able to link information in different research projects in an informal way, and he developed a technique using software known as hypertext mark-up language (HTML), which embedded one-way pointers in documents directing the user immediately to any other relevant information (pictures, text, audio, or data) held in computers connected to the network, regardless of where they existed in the world. This development led to what

is now known as the World Wide Web (WWW) or simply "The Web."

In the early 1990s, it was realized outside the academic community what a powerful information and communication tool the Internet had become. Commercial service providers quickly came into existence, providing their own proprietary computer nodes, linked by telecommunication lines leased from the major international telecommunications service operators, and connected into the existing Internet. This offered essentially worldwide computer networking facilities to anyone who signed up to a service contract involving a monthly fee.

The fee structure, however, was totally different from that for telephone service in that not only was the fee much lower than that for telephone service and a considerable amount of usage was already included in the monthly fee, but that the costs of use were independent of the distance between the communicating parties. With the recent announcement of software that enables telephone calls and other audio services to be sent over the Internet on a similarly low and distance-independent tariff, the impact on the whole telecommunications world tariff structure could be enormous.

The growth in the use of the Internet has been exponential. The statistics associated with it are not accurately known because it is a network that grows organically, developed by the users, with little central planning or control, unlike all telecommunication networks of the past. The estimates are that the Internet, and the associated networks of commercial on-line service providers linked to it, now involve some 40 million users who are linked through some 7 million computers acting as nodes in the interconnected networks. It has become a true "network of networks," which some authors have likened to a community of 40 million people with no police, no government, no laws, and no taxes!

The academic community is well accustomed to the Internet and uses it as second nature for electronic mail, exchanging of reports, and access to information sources worldwide. The rapid growth now is in the business of the commercial on-line service

providers who serve the business community and home user with an increasing range of electronic services. Indeed, with the growth in this sector, the NSF in the U.S. is now terminating the funding for the original Internet network, its initiating role now completed.

Commercial On-Line Use

With the growth in the number and complexity of services on the Internet, the access and operating software that creates the Web has become essential to the new community of nonacademic users. Some 20,000 business already do over £150 million of trading electronically each year, and this is predicted to rise to several hundred billion pounds within a decade.

Apart from internationally required services such as insurance, finance, and law, it is an ideal trading place for companies with specialty products (such as gourmet foods, wines, and crafts), since they can at very low cost trade worldwide. Some companies in this category in the U.S. are already doing a quarter of their business over the Web.

Larger companies, particularly in the electronic and automotive equipment sectors, are using it for customer care, such as assistance with product or service information, installation, or troubleshooting hints, and distribution of new software. The DTI in the U.K. has spotted that key elements of competitive advantage may lie in the way the Internet is used commercially and is seeking to provide major encouragement to U.K. companies to develop Web sites.

The main problem now arising for the home user of on-line services is the relatively slow access provided by the telephone line modem. Despite very rapid evolution of modems over the last couple of years from 2.4 kbits/sec to 9.6 kbits/sec, then to 14.4 kbits/sec and now the latest to 28.8 kbits/sec, the low speed of downloading large amounts of text, pictures, and particularly video, is very frustrating.

There is an urgent requirement building among active users for higher data rate connections, such as can be provided by 64 kbit/sec ISDN lines, and even 2 Mbit/sec connection where downloading of video material is

important. Although there are some 500 electronic newspapers on the Web, such services will only really take off when these higher data rate connections are provided cheaply.

The price of ISDN connections has been kept high in the U.K., by contrast to France and Germany, but with competition to BT now coming strongly from the cable companies in these higher data rate links, the situation should improve rapidly. Digital direct-to-home satellite channels and the newly-announced proposals in the U.K. for digital terrestrial channels will undoubtedly offer great opportunity for fast downloading to the home PC or TV. It is likely that, bearing in mind what has been said earlier, there will be a greater market on these emerging digital transmission technologies for a variety of new interactive services than for more of the traditional entertainment programming. It may or may not be the traditional broadcasters that provide these!

Teleworking

The growth in use of the PC in the home environment is already having an effect on our working lives through the ability it gives to conduct business from home. Teleworking, or telecommuting, already involves close to 5% of the work force in the U.S., and this proportion is expected to rise to 10 to 15% by the year 2000. The corresponding percentage in the EU overall is below 1% at present, but is about 1.25% in the U.K. and is rapidly increasing as a result of the high number of home computers in this country.

The popular concept of a teleworker being someone who spends all his/her working time in the home at a computer, devoid of other business interaction, is far from reality. The majority of teleworkers only work from home for part of the week, the rest of the time being spent in the normal interpersonal working environment.

Computer companies like IBM and DEC have been the first to embrace the telework concept, and each has many thousands of teleworkers. More recently, companies in the retail sector with geographically distributed outlets have been making increasing use of teleworking managers and staff. Also,

in the remoter areas of the country, televillages and telecottages are growing in popularity. Wales, for example, has over 50 telecottages, each typically with modern communications, computing, and videoconferencing facilities. They act as communication, training, and electronic business hubs, providing facilities and an electronic interface to the world for small local businesses.

A new televillage, developed by Acorn Televillages at Crickhowell in the beautiful Brecon countryside, has houses linked by fiber optics to a work center with modern electronics and communications facilities. This allows in very pleasant surroundings a flexible arrangement of work either from home or, in the company of others at the adjacent work center, on activities which can be carried out remotely for clients or companies around the world.

These new patterns of work have been shown to result in significantly increased productivity and are also of great appeal to women who wish to pursue certain professional careers while bringing up a family. The environmental advantages are also significant; a study by Arthur D. Little indicated that if teleworking became 20% of the total, the environmental impact would be significantly greater than all of the energy conservation measures that have been implemented in recent years.

Teleworking also brings great savings in business office costs, since office facilities need only be provided for the time that a teleworker is actually present at the company premises. While such a development in the pattern of work is entirely logical, it requires an interesting social adjustment for an individual to lose the accustomed privilege of personal office territory in the form of a desk or room or of exclusive access to a given secretary. A teleworker therefore becomes used to "the office" being resident in a computer, accessible from home or from company premises.

An individual now has the ability to carry around and work with a particularly relevant or current subset of the total office information on a laptop PC. Some 50% of PC sales are now laptops, demonstrating the increasing

popularity of this habit. The development of very compact, credit-card size modems to connect such laptops to the fixed telephone network, allowing remote interactivity wherever a telephone socket exists, has enabled the laptop to become an even more powerful teleworking tool. This capability has been even further extended recently with the availability of modems to allow true portable working over the GSM digital cellular network.

Teleworking will receive an even greater boost in the very near future, with personal videoconferencing facilities being a standard feature on the next generation of PC. While videoconferencing can never replace direct personal interaction, there are probably at least a quarter of all meetings, if not more, that can be carried out over a videoconference link with no perceived disadvantage, but a major benefit in the avoidance of frustrating travel. Some insurance companies are using video links, provided through a PC and tiny camera connected to the telephone network, to examine and record damage to motor vehicles in accidents. This reduces greatly the visits of loss adjusters and has given reported productivity gains of a factor five or ten; it has major impact in the responsiveness and competitive position of the insurance company in the market.

The fall in the cost of videoconferencing equipment used for business meetings has been dramatic over the last few years and competition between telecommunication operators is slowly bringing down the usage charges for the linking circuits. When this competition really starts to have an effect in the international link market, presently very much of a cartel, there will be a further enhanced uptake of videoconferencing.

Establishing User-Friendliness

Despite the very rapid growth in the numbers of personal computers in the home environment and the strides that have been made in software, the PC is far from being a user-friendly device. Larry Ellison, CEO of the Oracle Corp., put it more strongly: "The PC as we know it is a ridiculous device and much too complicated. The future lies with a completely different device

called an information appliance, which accesses intelligence around the network." Although Bill Gates, chairman of Microsoft, might disagree, it seems that Ellison's view is shared by some of the consumer electronics industry. We are starting to see a range of new telemedia products appearing on the market. Olivetti, for example, has just launched "Envision," a unit that attaches to the television set and has the functions of:

- A powerful PC with Windows 95 software and Internet access
- A player for audio-CD, photo-CD, video-CD, and CD-ROM
- A fax and answerphone

Philips, with its "Screenphone," has put a screen and computing power together with a telephone, giving Internet access for e-mail and other on-line services. Intel has announced "InterCast," a system using the teletext lines in the television broadcast signal to bring news and entertainment to the PC. HP meanwhile has just announced the "Omnigo," combining personal organizer computing with a GSM phone giving mobile computing and data networking. HP too has done pioneering work in developing low-cost high-quality printers for the mass-market. Despite the advances in the electronic medium, paper will be around for a long time, because of its convenience.

BT has attempted the ultimate in its research labs, with an "office on the arm" concept to test the utility of a variety of combined mobile computing and communications techniques for the future.

In practice, I do not expect to see a battle between the PC and TV, in contrast to what some observers have predicted. The technologies behind the screen will converge, and the head start of the PC in interactive services may be the ingredient that provides very necessary support and growth to the traditional television business in the years ahead.

Regulatory Issues

It is interesting to note that, by comparison with the many billions of pounds invested in technology development and in market assessment trials in the telemedia sector, the investment in shaping the optimum regulato-

ry environment for the future is tiny. It is a great tribute to those in the regulatory sector that our developments in telecommunications, television, and radio have progressed so much through the innovative interaction of business pressures and regulatory requirements. The challenges ahead are even greater, however, as the media converge and even greater attention needs to be paid to the future of the regulatory environment, or progress and social benefit will suffer — either through over-regulation stifling opportunity or under-regulation allowing monopoly exploitation and bias. In the years ahead, the regulators have a much more challenging task than either the technologists or the entrepreneurs.

Copyrights

The maintenance of copyright, in this electronic environment where pictures, text, and data can be copied, altered, and distributed in near effortless and instantaneous manner, is already a major challenge. With a future massive multichannel television program environment, hungry for material, it will be increasingly difficult to enforce copyright legislation. The process has already in practice started to collapse with the ubiquitous and uncontrolled use of the photocopier. It is likely that the structure of the future telemedia industry will need to reflect the requirement to achieve the prescribed financial returns while the material is under the close control of the originators or their affiliates.

Cross-media ownership will become an increasingly important and difficult issue for regulators as the technology continues to destroy the boundaries between previously separate and neatly compartmented media. For example, it is a perfectly justifiable approach for those with major businesses in the print medium to migrate to the electronic on-line services; it is not only justifiable, it is essential for them to do this to maintain the growth expected by their shareholders. Yet in this process, it is vital for the public at large that their information and entertainment come from diverse and independent sources. I think we are a long way from understanding how to achieve a framework

for this. What is certain is that we must evolve from the individual regulatory environments for the previously separate media to one that covers the whole telemedia sector.

Revenue Collection

A very important matter in the whole telemedia environment, and of particular concern to the service provider, is revenue collection. The revenue collection process will be more complex and more vulnerable to fraud in the future than in the past broadcasting environment with its twin sources of license fee and advertising.

The main challenge is to evolve an adequately secure form of electronically based payment. Very considerable effort is going into such developments, ranging from the tests in Swindon of the Mondex electronic money card to the formulation of an international electronic currency on the Internet.

Fraud, sadly, is an integral part of our society and is virtually impossible to eliminate. Preventative measures carry their own cost, and the usual approach is to implement sufficient measures to contain fraud to an acceptable level. It is recognized, for example, that the level of fraud with credit card transactions is around £1 per £1,000 transacted. For mobile telephony services, the figure is much higher. CD piracy runs at about 5% of sales, and pay-TV services in the U.S. have in the past suffered piracy levels of tens of percent. A target level at or below the current figure for credit card fraud could be a sensible starting point for the future electronic currency.

Although skeptics have ruled out safe funds transfer over the Internet, I am of the opinion that an adequately secure method will be agreed upon within a couple of years, and I venture to suggest that at this time the European finance ministers will still be talking about a European currency!

The advantage of an electronic currency is the much lower cost of implementing a financial transaction associated with the supply of goods or services, as compared to present methods which involve some human intervention. In the telemedia environment there will be many low value transac-

tions which can only be carried out sensibly with an electronic currency. Just as "tax havens" have emerged within our current trading systems, the electronic environment will have its own set of havens, related to the financial and strategic movement or warehousing of information.

Pornography

Pornography always seems to be one of the lead applications of the new electronic technologies, and it has always had a significant role in the early growth of the market for the technology. Minitel in France, the pager, the VCR, the camcorder, and satellite television are all examples of this. We should not be surprised to find that the Internet has its share of pornographic services but to suggest, as was done recently, that a large proportion of Internet usage is pornographic and by implication condemn the Internet, is far-fetched in the extreme.

Although it is said that there is no formal regulation of the Internet, it is worth noting that much of the existing copyright and data protection legislation does indeed apply to its use, although enforcement in such a diverse network is difficult. Commercial access providers, such as Compuserve, have perceived a market need for an added regulatory function and are exercising this by providing software that blocks access to certain Web sites and thereby gives a controlled access environment for family users and businesses anxious to remove nonbusiness-related temptations from their staff.

Gambling

More addictive and potentially dangerous is electronic gambling, which is also in existence on the Internet from casinos and betting establishments based in the Caribbean, among other places. The state of Texas in the U.S. has banned access to such services, but it is difficult to see how such a ban may be policed effectively. The popularity of the National Lottery and other forms of gambling or gaming would seem to indicate that careful attention will need to be paid to this area in the evolution of future telemedia services.

Privacy

Almost certainly, however, the largest issue ahead is that of privacy. We have already seen legislation associated with data protection, designed to allow an individual access to any relevant personal information held in computer files. The networking of personal computers poses even more massive challenges. By connecting our PC or TV to a communications network, having acquired networking software which is so complex that we cannot know its full capabilities, we think we are in full control of our interaction with the external world, but we have in fact opened a bidirectional gateway for our telemedia appliance, which contains substantial private information and was previously totally secure as long as we kept it in careful ownership.

At present, on the Internet, when a particular on-line service is accessed it is recorded as a "hit," but there is no record of the originator. The number of "hits" is a very useful indicator of the attractiveness of the service, but what a service provider or advertiser really needs to know is the profile of the individual behind the "hit." There are many financial imperatives that seek to erode the present anonymity and who knows what is latent in the currently available software that may allow this anonymity to be eroded. An interesting first step has been made in Canada with the formulation of a standard against which all relevant new products may be tested for privacy.

Politics

It is difficult also to believe that our political system, which is suffering increasing credibility problems in the eyes of the public, will not be substantially affected by telemedia. Not only do individuals have direct access to information from around the world, but more and more government documents and draft legislation are available on the Web, giving the opportunity for a much closer relationship between the individual and the process of government, but also changing the role of our elected representatives.

Conclusion

The subject of telemedia and their evolution is vast. I have not even

touched on the implications of "virtual reality." Even without predictions about that, it seems that one can be confident that:

- Semiconductor technology evolution will continue at a rapid pace.
- A flexible mix of video, sound, and data services will be available between individuals.
- With personal worldwide networking, the broadcast function will lose its exclusivity.
- Conventional entertainment television is a mature market; expansion in the number of services of this type will lead to a decline in overall quality.
- Technology convergence will occur between the PC and TV; interactive services will support the traditional television business.
- User-friendliness will be central to the uptake of new telemedia services.
- There is unlikely to be a single "killer application"; new revenues will come largely from shifts in spending in other sectors, namely lifestyle changes.

Economists have noted that for the last 200 years, the economy of the West has moved in 50-year cycles, each upswing initiated by a transport revolution. It is some 50 years since widely available commercial air trans-

port changed dramatically many aspects of commerce and leisure. The next revolution has arrived on time, but now the revolution is one which involves the transport of information through a vast network of integrated electronic media — the telemedia environment.

There were Luddites in the industrial revolution and they have their parallels today. Just as the Luddites have been forgotten and achieve scant mention in the history books, those who reject the current tide will be forgotten. With our liberal regulatory environment, probably the most open in the world, and with our high penetration of computer skills in the home and in business, we are well placed in Britain to take advantage of this revolution. Major changes to attitude, for example to the nature of work, will be required, but we must all try to keep an open mind on these changes and take keen interest in this revolution so as to shape it in the most positive directions commercially and socially.

Just in my own recent experience, we have developed in NTL a company that is a leader in many aspects of the telemedia environment and which is now using that expertise in world mar-

kets. Brewton is another telemedia company that is growing at a rate high even by U.S. high technology standards, through exploiting the convergence between computing, videoconferencing, and the whole audio-visual sector. There are many other similar examples in large and small companies in this country. Let's not get it wrong — Lord Mountbatten would never forgive us!

I know he would have appreciated an innovation I thought it appropriate to bring to this Mountbatten Memorial Lecture. Today the text was put on the IEE pages on the World Wide Web, so it accessible worldwide to all those on the Web. However, for those of you who have not quite yet got round to the telemedia revolution, there are printed copies outside, but don't rely on this service for too long! I am also delighted to exchange e-mail with anyone who has comments or wants to discuss this fascinating topic further. I can be reached on 100106.2677@compuserve.com.

It remains for me to thank all those who have assisted me with information for this lecture and to thank you, the audience this evening, for your most kind attention.

THE AUTHOR

John R. Forrest received his undergraduate degree in electrical sciences at Cambridge University. After participating in research in plasma physics at Oxford University, he went to Stanford University, Calif., in 1967 as a research associate and lecturer. In 1970, he joined University College, London, as a lecturer in electronic engineering, eventually becoming reader and then professor in 1982.

In 1984 he joined Marconi Defence Systems Ltd. as technical director, having responsibility for much of GEC's advanced technology development. This was followed in 1986 by his appointment as director of engineering to the Independent Broadcasting Authority, with responsibility for the operation and ongoing development of the ITV, Channel 4, satellite TV, and radio transmission networks. He oversaw the privatization of the



IBA engineering infrastructure in 1991, the same year he became the chief executive of the newly formed National Transcommunications Ltd. (NTL). With the rapid growth and diversification of NTL into telecommunications and digital television

products, he was appointed its deputy chairman in 1994.

Dr. Forrest also serves as chairman of Brewton Ltd., a company specializing in the supply, installation, and rental of computer workstations, videoconference systems, and audio-visual presentation services.

Consultant to the European Commission on Information Technology, Dr. Forrest is chairman of the Commercial Satellite and Cable Module of the DVB Project and a member of the Steering Board; he has also taken on responsibility recently for the coordination of promotion and communications aspects of DVB. He was honored by the French Government in 1993 by nomination as Chevalier de l'Ordre des Arts et des Lettres for his services to European broadcasting technology development.